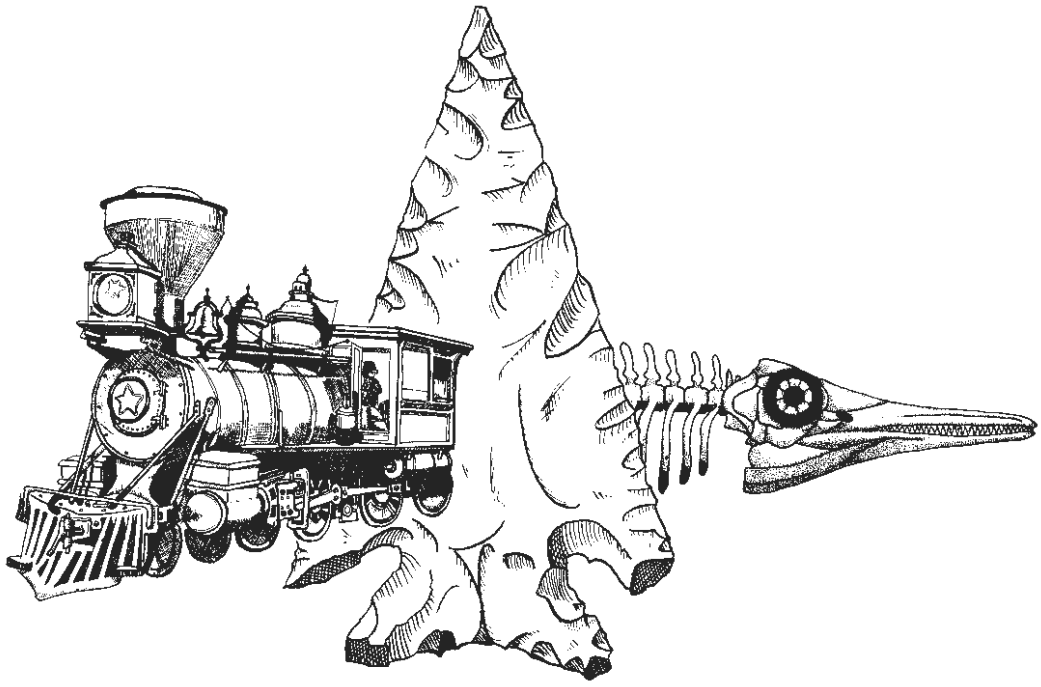
U.S. DEPARTMENT OF THE INTERIOR
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NEVADA



An Intensive Reconnaissance of the Tosawihi Quarries Archaeological District (Site 26EK3032)

by

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AN INTENSIVE RECONNAISSANCE OF THE TOSAWIHI QUARRIES ARCHAEOLOGICAL DISTRICT (SITE 26EK3032)

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Preface: A Guide to the Tosawihi Quarries Reports

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June, 2006

Introduction

Between 1987 and 1992, Intermountain Research (IMR) conducted a program of survey, testing, and data recovery at Tosawihi Quarries, north-central Nevada, for which I was project director. The work was done on behalf of various mining development consultants and gold mining companies (Galactic Services, Inc.; Ivanhoe Gold Company; Touchstone Resources Company; Newmont Exploration, Ltd.), and generated several reports comprising the most intensive look at a toolstone quarry yet conducted in North America. Not widely available before now, the Tosawihi reports have been compiled in this collection and distributed by the Nevada Bureau of Land Management (BLM) in electronic format. These files contain the key reports of the Tosawihi project that comprise our theoretical stance, research designs, descriptions, data and interpretations. To support the IMR reports, we add some supplemental materials: Callaway (1991, this collection) on the constraints and opportunities that shaped the project; contemporary White Knife Shoshone ethnography (Clemmer 1990, this collection; Rusco and Raven 1992, this collection), and the present state of the quarries (Hockett 2006, this collection).

I was asked by Pat Barker and Tom Burke, Nevada BLM, to recommend the best order in which to read these documents, since during the project we wished we could have done some things in a different order (Callaway 1991). But in re-reading the reports for this preface, I think they are best confronted in the order the work was conducted. In this way, the reader can see the project much as we saw it, and better understand the constraints under which we worked, and the decisions we made, good or not. Because each report was meant to stand alone, the reader will encounter in each, CRM boilerplate and reprises of the local environment, regional prehistory, and ethnography that can be safely skimmed after a certain point. The reports speak for themselves, but this preface should help the reader anticipate their contents.

The Project Unfolds

We now know that use of the quarries has a history from deep antiquity to the White Knife (*Tosawihi*) people of the Western Shoshone, even to the present day (Clemmer 1990, Rusco and Raven 1991). Toolstone from this source area, volcanic tuff transformed by hydrothermal activity into cryptocrystalline "opalite," is very high quality chert that can be obtained in large packages. Raw material from this source has been utilized more than 10,000 years, and is found at distances up to 300 km from the quarry (Lyons et al. 2003). Although the existence of the Tosawihi toolstone source was known to ethnographers (Harris 1940; Steward 1941), and modern flint knappers (Stephenson and Wilkinson 1969), it had been neither precisely located nor described by any scholar prior to Mary Rusco's series of unpublished reports of the 1970s. Her draft Tosawihi Quarry National Register District (NRD) nomination (Rusco 1983) showed that Tosawihi

Quarries was the largest prehistoric bedrock toolstone quarry in the Great Basin and one of the largest in North America. The intensity of prehistoric activity at Tosawihi Quarries was unprecedented and unexplained. Our involvement in the Tosawihi Quarries project offered a rare opportunity for a detailed study of this prehistoric toolstone quarry, as well as of the processing and residential sites associated with it.

Until we made the first site visit with our geologist client, we had only a vague idea of what Tosawihi Quarries represented (see Callaway 1991). On the ground there, we were impressed by the size and complexity of the place. A landscape of several hundred acres cratered with quarry pits and more or less continuously covered with debitage, Tosawihi seem to exemplify Ericson's (1984) characterization of toolstone quarries as a "....*shattered, overlapping, sometimes shallow, nondiagnostic, undatable, unattractive, redundant, and at times voluminous material record.*" Even the Sugarloaf Obsidian Quarry in the Coso Volcanic Field, with which we had previous experience (Elston and Zeier 1984), was not so daunting. Nevertheless, our Coso experience convinced us that, given a systematic approach, toolstone quarries could be understood.

Our first goal at Tosawihi was, through intensive survey, to identify the kinds of archaeological phenomena present, and their distribution in the landscape (Elston et al. 1987, this collection). Our approach was developed in close consultation with Bureau of Land Management, Elko Resource Area (BLM) and the Nevada State Historic Preservation Officer (SHPO), Nevada Division of Historic Preservation and Archaeology. This consultation established the first priority as the area delineated by Rusco (1983) in her NRD nomination. Rusco's district boundary was a line drawn around what she had perceived to be the greatest density of quarry features and debitage: the "heart" of the quarries, as she expressed it to us. However, because BLM and SHPO found Rusco's curvilinear boundary difficult to describe in terms of metes and bounds, and thus problematic for a NRD nomination, we squared it off into a rectilinear form enclosing 812 acres (Elston et al. 1987, this collection). As so defined, the district was given the Smithsonian site number, 26Ek3032. Discrete archaeological features (defined in Elston et al. 1987) and complexes of features within 26Ek3032 were recorded as numbered localities.

Our 100-foot interval transect survey of 26Ek3032 employed the 400 foot grid staked by our mining client. On each transect, we recorded all cultural features, and for each 100-foot transect segment, estimated the average debitage density (none, sparse, light, moderate, heavy). These data were used to construct a debitage density to help define archaeological localities (Elston et al. 1987). As part of the intensive survey, we also investigated a smaller area within 26Ek3032 where the interest of the mining company was focused. Here we selected a sample of archaeological localities for closer scrutiny and description, including quarry features or complexes of features, as well as light to moderate density lithic scatters.

The intensive survey confirmed that the Tosawihi archaeological record was highly structured, and not a chaotic jumble after all. There were localities with a residential character, localities dominated by biface reduction debris, undifferentiated lithic scatters,

isolated artifacts, and several types of quarries (cobble quarries, quarry pits, outcrop quarries) demonstrating different extraction strategies. Structure was imposed by the terrain in which drainages isolated ridges, by where opalite was exposed at or near the surface, by the availability of flat places for reduction and residential activities, by presence of surface water to support residential sites, and by the organization of toolstone extraction and reduction. We found it convenient to group archaeological features and localities on the basis of proximity to one another and their location on geographic features such as ridges, stream terraces, benches and alluvial flats (Elston et al. 1987:Fig.8). Nevertheless, the nearly continuous blanket of surface debitage in the study area sometimes required us to arbitrarily define locality and feature boundaries, leaving their final resolution to subsequent investigators and resource managers (e.g. Hockett 2006).

In passing, I note that subsequent add-ons to the project area were not incorporated into the NRD site 26Ek3032. Archaeological localities within these areas were designated sites and given Smithsonian numbers. Because all archaeological manifestations were given unique numbers, either as localities in site 26Ek3032, or as sites with their own Smithsonian numbers, this scheme worked well for purposes of evaluation and data recovery. However, it later proved to be unwieldy in terms of resource management, and was recently rationalized by BLM, who enlarged the NRD and converted surviving localities in the original 26Ek3032 to sites with Smithsonian numbers (Hockett 2006).

As mine development proceeded, specific impact areas were identified for evaluation: two mining areas adjacent the southern borders of 26Ek3032, the 480 acre USX West (Budy 1988), and the 170 acre USX East (Raven 1988), as well as the North Access Corridor Willow Creek up Ivanhoe Creek near its head west of Big Butte (Drews 1988). These first two survey reports are included in this collection, as is the report of subsequent testing (Elston 1989).

The surveys peripheral to the main quarry areas revealed considerable archaeological variability, due in part to underlying geology/geomorphology, and in part to differences in human use. The tuff- and basalt-dominated, steeper, more dissected USX West area lacked a continuous blanket of debitage where archaeological site boundaries were much more discrete than in NRD 26Ek3032. Site boundaries in USX East were more diffuse in a landscape ranging from gently rolling silt-covered tuff slopes, to a rhyolite mesa and rimrock, to alluvial stream terraces. Sites in the North Access Corridor were discrete lithic scatters on benches and terraces overlooking Willow and Ivanhoe Creeks. Compared to the area within NRD 26Ek3032, task-specific sites and residential sites were much more abundant (we tested 51), and quarries far fewer in these add-on areas (we tested 14). This allowed us to examine archaeological manifestations of behavior not directly involved with toolstone quarrying and initial processing, and to look at distance from toolstone source as a component of archaeological variability.

In the data recovery phase of the project (Elston and Raven 1992, this collection), the USX West and USX East areas became known as the Western and Eastern Peripheries, respectively (Leach et al. 1992; Botkin et al. 1992). Although the overall goal, shared by

BLM and the mining company, was to avoid archaeological localities in NRD 26Ek3032, disturbance could not be avoided at a few localities around its southern margin. Description of data recovery at eight of these localities is included in the Eastern Periphery (Botkin et al. 1992). A separate report (Leach and Botkin 1991, this collection) documents evaluations of localities 26 and 27 in site 26Ek3032, and site 26Ek3516. Localities 26 and 27 are both located along a short reach of Little Antelope Creek in the southeast portion of NRD 26Ek3032. These localities are, respectively, a small quarry pit complex on a strath terrace, and an open residential site on an alluvial terrace. Locality 27 has up to 140 cm of stratified alluvial and eolian sediments, and both localities contain strata with cultural material below Mazama tephra deposited at 7627± 150 cal yrs BP (Zdanowicz et al. 1999). A failed Clovis preform from the surface of North Corridor site 26Ek3237, made of chert resembling that from Butterscotch Ridge in 26Ek3032, suggests use of the quarries as old as 13,000 cal. yrs. B.P.

Also slated for disturbance by expansion of mining activity was Locality 36 in NRD 26Ek3032. Locality 36 presented an opportunity for an intensive look at a large quarry pit complex. Data recovery there (Elston and Raven 1992) included mechanical trenching and scraping, as well as hand excavation and surface collection.

A BLM Class II survey of nearly 29,000 acres surrounding Tosawihi Quarries (Leach and Botkin 1992) assessed the appropriateness of the proposed NRD boundaries, provided a baseline for cumulative effects of mining and related activities on cultural resources, and investigated archaeological variability beyond the core quarries area of NRD 26Ek3032. A concurrent overview of historic use of Tosawihi and vicinity (Rogers 1992) is included in the survey report.

Survey along the Silver Cloud Road led to the last IMR investigation at Tosawihi, the excavation of site 26Ek5040, 3 km southwest of Tosawihi (Ataman et al. 1995, this collection). Located near smaller opalite outcrops, this site was the scene of biface manufacture and manifested some short-term residential characteristics. Projectile point chronology and obsidian hydration suggested the most intensive occupation during the Middle Archaic (ca 5000-1300 B.P.), with a smaller Late Archaic component (probably less than 700 B.P.). Obsidian hydration and stratigraphy suggested a small pre-Mazama (7627± 150 cal yrs B.P.) component as well. Data from 26Ek5040 addressed technological change, site structure and technological organization; the distance fall-off model for Tosawihi opalite; and the role of the Humboldt River as an economic barrier in the obsidian trade.

Research Design and Analytical Approach

The initial survey of 26Ek3032 focused on describing archaeological variability across the landscape (Elston et al. 1987). Informed by this survey, we prepared a generalized research design (Elston 1988) to guide further archaeological investigations at Tosawihi Quarries. This document identified several related themes: the nature of toolstone quarries in general and Tosawihi in particular, economics of toolstone extraction and production, organization of lithic extraction and production, site formation processes and

site structure at quarries and ancillary sites, and temporal variation in intensity of quarrying and lithic technology. This initial document is not included here, but a version appears as Chapter 2 (Budy et al. 1989) of *The Tosawihi Quarries: An Archaeological Testing Program* (Elston 1989).

As the project progressed, and we gained experience and understanding, research designs became more focused. The quarry pits and processing debris at Tosawihi appeared indicative of goal-oriented toolstone procurement, and investment of time and energy very different from casual collection embedded in other activities such as described for Nunamuit hunters (Binford 1979a:260). Not only did these activities seem costly in themselves, but diverted effort that could have been directed toward food gathering, reproduction and social interaction. Considering these competing demands for time and energy generated many questions: What were the physical goals of toolstone extraction and processing (toolstone quality, package size, products)? What were the techniques employed to accomplish these goals? How were quarrying, processing and residential activities organized within the quarry precinct? Did goals, techniques and organization change through time? How much effort was required in raw material extraction and processing? Was the amount of processing related to transportation costs? How could time spent at Tosawihi be best scheduled to fit into a seasonal round and mitigate opportunity costs?

The research design for data recovery in the Peripheries addressed these and other questions from the perspective of several models. A lithic procurement model (Elston 1992a, 1992b) was developed from theoretical considerations of cost, benefit, and risk (Belovsky 1987; Elston 1990; Metcalfe and Barlow 1992; Stephens and Krebs 1986). This, and models of central based foraging (Orians and Pearson 1979), mobility (Binford 1977, 1979a, 1979b, 1980), economic geography (papers in Earl and Ericson 1977; Ericson and Earl 1982; Ericson 1984), nearest neighbor analysis (Hodder and Orton 1976), and site formation processes (Schiffer 1976, 1987), helped address assemblage variability, site structure, function and distribution, technological organization, and lithic production and transport strategies, in addition to subsistence and chronology. Inspired by experimental and ethnographic studies of costs and benefits of food procurement and transportation (Simms 1987; Jones and Madsen 1989; Metcalfe and Barlow 1992; Rhode 1990), our lithic production model employed data from experimental quarrying (Carambelas and Raven 1991) and processing contributed by participants of the Tosawihi Knap-in, and IMR staff members, Kathy Ataman, Bill Bloomer and Mark Moore. In the testing phase, analysis was heavily weighted toward tools and bifaces (most of which were preforms), while debitage was characterized only by counts, weights and raw material. For data recovery in the Peripheries, we added technological and mass debitage analyses (Bloomer and Ingbar 1992). All recovered debitage was subject to mass analysis through graded screens (Ahler 1989a, 1989b), while technological analysis was used for selected debitage samples. For technological analysis, the flake typology was based on our experimental debitage assemblages. Discriminant models for mass debitage analysis were derived our experimental data combined with experimental replication data from the Knife River Flint Quarry project, very kindly shared by Stanley Ahler.

The research design for data recovery at Locality 36 focused more tightly on aspects of the lithic procurement model, and on site structure, assemblage variability and site formation processes. In particular, we were interested in the role of rate-maximizing strategies for toolstone procurement, the efficiency of particular extraction techniques, and the organization of quarrying. These were all topics we had considered before, but Locality 36 offered the opportunity to explore them in some depth.

Locality 36 debitage analyses followed the same general strategies used in the Peripheries study, employing both technological and mass analysis. However, previous experience at Tosawihi suggested some refinements and new approaches to analysis. To more closely approximate the initial processing expected within a quarry pit complex, we conducted an additional 100 experimental reductions beginning with opalite blocks, and used these data to generate new discriminant models. The technological analysis was simplified by using a flake typology that reflected one of five reduction stages (quarrying, mass reduction, bank preparation/initial edging, early biface thinning and late biface thinning). We made considerable use of machine excavation to trench through quarry pits. This not only exposed the stratigraphic record of Locality 36, but also revealed the bedrock and the extent of its human modification, allowing us to evaluate the relative importance of toolstone quality vs. ease of extraction.

The Class II survey was designed to examine aspects of our lithic procurement and transport models, including availability of quality toolstone sources outside the main quarries in 26Ek3032, the existence of a regional "zone of production," and the distribution of residential sites in the region (Leach and Botkin 1992). The study area was divided into 1446 quadrats and divided into strata according to presence or absence of surface water and toolstone. Ten percent of the quadrats in each stratum were selected for investigation. No artifacts were collected on survey; debitage density was estimated, formed tools tallied and described, bifaces and projectile points were measured and traced in outline and bifaces were assigned to a pre-defined technological stage.

The goal of data recovery at site 26Ek5040 was to take a detailed look at a short-term residential site removed from the main quarries but near secondary toolstone sources. Testing the site suggested a major Middle Archaic component there that we compared with the Late Archaic technology so prevalent in the Peripheries and much of Locality 36.

What We Learned at Tosawihi

Tosawihi Quarries taught us a lot about bedrock toolstone extraction, processing and distribution. Here are some important things we learned.

The Clovis preform from 26Ek3237, and numerous Great Basin Stemmed points from the Tosawihi project areas suggest that the quarries were a toolstone source from the earliest times. However, use of the quarries seems to have grown more intense during the Late Archaic, beginning about 1500 years ago.

Our techniques of lithic analysis worked well enough. We were able to compare mass analysis with technological analysis based on flake-types and biface stages, concluding that the latter, performed by well-trained lithicists, is as efficient and more accurate than the former. Both techniques, however, depend on the availability of data from well-executed experimental reductions.

As predicted by benefit/cost models, Tosawihi quarriers sought particular qualities of toolstone and types of bedrock exposures that minimized extractive efforts and maximized toolstone output. For the most part, raw toolstone was transformed into bifaces, and transported from the quarries at a reduction stage that proved toolstone quality, facilitated heat treatment, and minimized transportation costs. The focus on biface production seems to be as ancient as the quarries themselves. We did not observe core and blade technology at Tosawihi, but we did not have the opportunity to look very closely at what we suspect are the oldest parts of the quarry precinct: Butterscotch Ridge and the outcrop quarries along the margins of Velvet Canyon buried by debitage and quarry waste talus.

Bedrock quarrying at Tosawihi produced distinctive types of anthropic and natural sediments that tend to alternate in systematic ways, suggesting intervals of activity and abandonment. The use of fire to attack bedrock frequently left charcoal in these sediments, which along with occasional bone and antler digging tools can provide radiocarbon dates. It may also be possible to date fine sediments accumulated in quarry pits by optically stimulated luminescence (OSL), but this has yet to be demonstrated.

The organization of extraction and processing created a structured distribution of artifacts, with quarry features surrounded by umbras of quarry waste and debitage dominated by early stage reduction, and processing stations and processing/residential sites dominated by later stage debitage. Processing stations are generally located away from quarries, in flatter places more comfortable to work, while residential site location favored places near at least seasonal water. Residential sites at Tosawihi contain domestic and hunting-related tools, and sometimes hearths, but all those we examined suggest only short-term occupation supplied by local resources. Thus, all the debitage and quarry features at Tosawihi represent the accumulated byproducts of thousands of years of toolstone extraction and processing during short-term visits to the quarries by individuals and small groups.

Within 26Ek3032 (the main quarry precinct) and the Peripheries, there is a strong trend toward decrease in biface size and stage, and increase in heat-treatment, with distance from quarry features that is predicted by our transportation cost model, and this trend is also evident in the Class II regional survey. However, the Class II survey revealed more medium-sized debitage and Stage 2 and 3 bifaces than expected in the area surrounding 26Ek3032 and the Peripheries, due we suspect, to the presence of small opalite sources scattered through the region.

Prospects for Future Research

Mining activities at Tosawihi greatly altered the look and feel of the place, but did not encroach much into 26Ek3032 and its localities, Rusco's "heart of the quarry." Mining did not extend into Locality 36 after all. Because we (and BLM and SHPO) thought that Locality 36 would soon be destroyed, we did not backfill our excavations there, so that our trenches with their bedrock exposures remain open for viewing, an unforeseen benefit for research and education. Mining did not encroach, after all, on 26Ek3032 localities 26 and 27, so their pre-Mazama and later records are preserved for future study. However, virtually all of the quarries, processing stations and residential sites in the Peripheries are gone, documented only by our reports, data, and collections. Although there are similar sites north of 26Ek3032, they do not occur in the same density and close proximity to the main quarry precinct as those in the Peripheries.

There is a great deal more to be learned from Tosawihi Quarries. It has deep antiquity, but its chronology is sketchy. While we know that Clovis and pre-Archaic people obtained toolstone there, we know nothing about the earliest extraction and processing technology, and relatively little about the Early and Middle Archaic use of the quarries.

Faced with huge debitage and biface samples, our lithic analysis techniques were designed to be as efficient as possible. Perhaps different data recording and statistical approaches would reveal trends and relationships that we missed.

Our Class II survey failed to discover the boundary of the production zone around Tosawihi, beyond which the transportation model predicts that late stage debitage and bifaces will fully prevail in archaeological assemblages. Another boundary that requires attention is the black/white line described by Stephenson and Wilkinson (1969) from about Iron Point on the Humboldt River, northward. West of this line (more a zone), surface debitage assemblages are "black," dominated by Paradise Valley obsidian, and east of the line, assemblages are "white," dominated by Tosawihi chert. While this strongly suggests an economic boundary for the two toolstones likely determined by distance from source, the black/white zone also runs roughly along the boundary between the Northern Paiute and Western Shoshone, so perhaps the black/white line is a cultural delineator as well. If so, it appears to be older than the Numic Expansion.

We also know that Tosawihi chert in a late archaeological context reached central Oregon, some 300 km from the quarries (Lyons et al. 2003); ethnographic accounts indicate trade to even more distance places. Was Tosawihi toolstone always so widely traveled or is this related somehow to the increased intensity of quarrying activity at Tosawihi from about 1500 B.P.? Why would people devote more time to quarrying and making white knives then – was this driven by trade? If so, what was traded and where?

All of us who worked on the Tosawihi project, with the exception of Bill Bloomer (Bloomer 1991), have been remiss in publishing on Tosawihi. I hope the digital distribution of these of these reports will stimulate publication and additional research.

Our archaeological and experimental collections from Tosawihi, comprising more than million artifacts and other samples, and all of our data are housed at the Nevada State Museum in Carson City, Nevada. These materials are available for study by any qualified researcher.

A Last Word

The Tosawihi project was about as close to a dream job as one can get in CRM archaeology. The IMR staff and crewmembers on the project were the best in the business. IMR General Manager Cashion Callaway made everything (budgets, schedules, personnel, logistics, proponent/agency relations) work, and edited the reports as well. We had great field camps throughout the project and were cared for by Mr. Jimmy Olsen, the world's best camp cook. As always in CRM, we were pushed for time, but we had a lot of it, along with sufficient resources. It was obviously very important to do as well as possible by Tosawihi, and this fostered a rare degree of cooperation between us, the mining proponent, and regulating agencies. Thanks to all who worked on, helped with, and encouraged the Tosawihi project, and thanks to Pat Barker and Tom Burke for making this collection possible.

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WHITE KNIVES, CINNABAR AND GOLD
An Introduction to Intermountain Research Investigations at Tosawihi Quarries, 1987 to 1991

Cashion Callaway
March 2006

Here is introduced the Tosawihi Quarries Project, a program of archaeological investigation undertaken by Intermountain Research under contract to mining interests in the years 1987 to 1992. Here is sketched the architecture of research at Tosawihi in those years, wherein the nature and timing of archaeological inquiry responded to the demands of Federal review, of minerals exploration and development schedules, and of the technical and theoretical predilections of the Intermountain Research group. Opportunities and constraints inherent in the administrative house of the project are reviewed.

This introduction appeared first as a paper preliminary to a Tosawihi Quarries symposium presented by Intermountain Research at the 56th Annual Meeting of the Society for American Archaeology, New Orleans, 1991.

The Tosawihi Quarries are located on public lands in the north central Great Basin, about 50 miles east of the Nevada community of Winnemucca. The gently rolling steppe characterizing the Tosawihi region hosts cryptocrystalline rocks, properties of which have captured the attention of human beings for millennia. The prehistoric industry with which these papers are concerned focused on the rocks as toolstone. Historically, Euroamericans were interested in the rocks for the cinnabar they yielded for mercury production and, thereafter, prospectors for gold laid claim to Tosawihi. In 1987, plans for intensive exploration and development of gold properties triggered Federal review of mining propositions, and Intermountain Research began to study Tosawihi. After that, Intermountain Research fielded numerous expeditions in pursuit of the answers to questions administrative and scientific.

In 1987, a geologist fellow contacted Intermountain Research inquiring after our familiarity with the Tosawihi Quarries. We allowed as how our knowledge of Tosawihi, like that of most archaeologists practicing in Nevada, was pretty much anecdotal, derived from Mary Rusco's unpublished papers and from Julian Steward's ethnographic work among the Shoshone. We understood the Quarries to be the source of white chert toolstone that accounts for the Shoshone appellation White Knife, which appears in archaeological sites up and down the Humboldt River drainage, but we had not been there and no archaeological literature described the place. The caller explained that his company required the services of an archaeologist in connection with a mineral exploration program it was conducting in the vicinity of the Quarries and would we be interested in traveling up there for a one-day walkabout. Clearly, this would be an inspection; while we had a look at the Quarries, our potential client would have a look at us.

Driving the fifty miles of back road from Winnemucca to Tosawihi, we learned that exploratory drilling on four hundred foot centers had been underway for some months, that the company now wished to drill on one hundred foot centers, and that development was imminent. We learned, too, that the areal extent of minerals interests was pretty much coincidental with the nearly one thousand-acre heart of the Tosawihi Quarries as observed by Rusco between 1975 and 1980.

Arriving at the property, we stepped from the truck to what we later named the Pink Pits. We walked over Butterscotch Ridge, and toured Velvet Canyon. The geologist was interested to know if the seemingly endless fields of opalite flakes we were observing did indeed represent rocks modified by human agency, as he had been led to believe. Assuring him that no mistake had been made, we gave our host a short course in lithic technology as we hiked. By and by, our walkabout concluded, the delicate time arrived which decides the fate of many a potential client/contractor relationship. A scientist himself, the magnitude of Tosawihi as a subject of archaeological study had not escaped the geologist's notice and, intent upon assessing our ability to comprehend this, the fellow began to inquire how we might approach a study of Tosawihi. How could we possibly deal with all those rocks? Did we have sufficient expertise? Did our present workload allow the time? Responding with the equanimity of born liars, we replied that the vastness and complexity of Tosawihi merely represented one or another problem of sampling, that lithics was our middle name, and that we would make time.

Tosawihi overwhelmed, yet we could not then admit to it lest the possibility of observing it slip away; the Quarries daunted, but we ignored apprehension in pursuit of the research opportunities before us. However, we studied Tosawihi within an administrative framework known to the world of CRM as Section 106 compliance. Referring to Section 106 of the National Historic Preservation Act of 1966, this bit of legislation directs Federal agencies such as the Bureau of Land Management, which administers the Tosawihi region, to consider the effects of any undertaking it permits upon significant cultural resources. The law is implemented by the Code of Federal Regulations, Title 36, Part 800; regulations which prescribe the sequence and geographical context of archaeological study conducted under the aegis of Federal mandates. These are augmented by performance guidelines and standards particular to Nevada BLM jurisdictions, and, because the permitted undertaking at Tosawihi was minerals exploration and extraction, we were mindful of the Code of Federal Regulations, Title 43, Part 3800, which implemented Federal mining law.

Absent sufficient staff and budget, BLM districts often shift responsibility for Section 106 compliance to the proponents of undertakings in their districts, and that was the case at Tosawihi: We did BLM's work at the pleasure of The Ivanhoe Project. Please note that archaeological research was not the goal of the work. Rather, the goal of the work was satisfaction of the Section 106 process. The research provided the means to that end but, as we shall see, it progressed in ways peculiar and antithetical to logical inquiry.

Taking a look at the known archaeological landscape of Tosawihi at the time, one sees an oddly shaped polygon encompassing about fourteen hundred acres wherein occur nearly four hundred 'sites.' The archaeology of Tosawihi bunched up in this way because this was the shape of our study universe, the so-called area of potential effect, in CRM terms. More correctly, the Tosawihi Quarries constituted our initial survey area. Subsequently, tracts southwest and southeast of the Quarries were added, followed by a long transect extending north. Each of these areas, as we shall see, represented the location of some aspect of contemporary gold mining.

The geography of the research was defined by the geography of the undertaking. Always. And always, the sequence of data collection followed the sequence of mine development. Section 106 compliance proceeds stepwise: define the area of potential effect; inventory all sites in that area and assess their significance; determine the effects of the proposed undertaking on significant sites; mitigate adverse effects expected to accrue to significant sites. Completing the process is straightforward when a fully developed plan of operations for an undertaking is identified at the outset and when implementation of that plan is delayed until all steps in the Section 106 process have been completed. Mining projects, by definition, do not proceed in this manner. Mines expand and rearrange themselves, and every time some adjustment is proposed, the Section 106 process, while continuing with regard to applications already in the pipeline, must be initiated for new propositions. This means that research-in-progress cannot inform research-pending. Taken to a logical extreme, the problem of information lag can result in unchanging interpretations of site after site, completely escaping insights of the research that have gone before. Nonetheless, the integrity of Section 106 compliance will have been preserved.

The Tosawihi Quarries Project fell victim to information lag two years into the research, which had followed this sequence: We surveyed the area known as the Tosawihi Quarries in 1987 in response to minerals exploration plans, then, still in 1987, we surveyed the Western Periphery in response to a mine plan of operations. The Eastern Periphery corresponds to the location of ancillary mine facilities surveyed early in the 1988 field season. At various times in 1988, 1989, and 1990, we surveyed the Northern Corridor, which corresponds to the main access road to the mine. The 1988 field season saw underway a testing program that examined 67 sites identified by these surveys, all but two of them in study areas other than Tosawihi Quarries. The primary objective of the testing program was assessment of the significance and data potential of selected sites that would be affected by mine development, so that detailed mitigation plans could be developed and put into the Section 106 pipeline for review and approval in time for a 1989 season of excavation. The 364,000 artifacts recovered by testing were processed and laboratory data were collected, but analysis and reporting could not keep apace of the urgency of mine development, so that the logical order of the research went awry when the excavation of 25 tested sites preceded analysis and synthesis of the test data by two months. And so, while the test report describes methods, sites, features, stratigraphy, and artifacts, analysis of the data is conspicuously absent. The net result is that, to compensate for an inadequately informed approach to the subsequent 25-site excavation program, we felt compelled to err in favor of over sampling whenever uncertainty prevailed. Happily, nothing was lost, save elegance, and more than enough was gained.

Throughout the two years given over to the tasks just described, we addressed other Section 106 demands relating to the project, with brief forays into the field to do compliance work associated with the odd air quality monitoring station, road realignment, and the like. As well, we inventoried and evaluated historic period sites occurring in the original survey parcel, developed a comprehensive Tosawihi cultural resources management plan for BLM, explicated the research issues suggested by Tosawihi sites, and drafted data recovery plans endlessly. Completion of the 1989 excavations saw Phase I of mine construction in compliance with Section 106, and we now had merely to make sense of a scosh under one and a half million artifacts, trench samples by the hundred, and miles of stratigraphy. The dozen people responsible for various aspects of data collection and analysis devoted six weeks to hammering out a post-field work plan, beginning with an outline of the final report. From there, the one hundred three tasks that would see the report complete were identified. Task leaders calculated their support requirements, critical paths were identified, a performance schedule was established, and from all this, a budget derived. The plan was approved and funded, and we went to work.

The final report, of which these associated papers constitute a preview, was completed shortly after this writing, schedule and budget intact due, in part, to a brisk business in in-house resource trading. In the parking lot market of the time, sixteen principal investigator hours and two hundred eleven 4WD vehicle miles would fetch one extended count radiocarbon assay or two season passes (bleachers) to any major league ballpark on the west coast. The final report appears in this collection.

A complete administrative sketch of the Tosawihi research must mention that the 1990 season saw us in the field once again, this time excavating an extensive and complex quarry locality in the Tosawihi Quarries proper, where we had previously investigated only a handful of loci. The expedition was fielded just as data analysis for the 1989 work was getting underway, but by now we had learned a thing or two, methodologically speaking, from which this new adventure benefited. And because analysis of 1990 data remained sufficiently behind that of 1989, the one would inform the other. And finally, a planned second phase of mine development then on the boards soon would prompt the areally extensive sample survey of the Tosawihi region for which the existing work begged. In sum, this collection of papers relies on data gathered from intensive investigation of seventy sites, nearly all of them adjacent, but not in, the Tosawihi Quarries.

Having described the CRM venue of the Tosawihi investigations, an examination of limitations and benefits inherent in it might inform the larger debate over CRM versus academically enabled archaeological research. Looking first at limitations, three are worth mention. One, the problem of information lag, is apparent in the foregoing discussion. A Tosawihi research effort equivalent to twenty-seven person years was compressed into four. We endeavored to mitigate data lag through judicious manipulation of performance schedules, and often succeeded, but there were occasions when CRM and Section 106 confounded every mitigating strategy. Secondary to information lag spawned by compressed timelines, every student of Tosawihi chafed at denied opportunities to pursue interesting lines of inquiry that manifested too late in the current program to be accommodated by unforgiving, but not necessarily unforgivable, schedules or budgets.

But these two are limitations that do not respect venue and they confront every researcher of dependent means. On the other hand, a third limitation is clearly a function of procedural constraints that CRM imposes on the logic of the order of archaeological inquiry; constraints that do not impede the scholar operating from an academic base. Responding to an in-house survey soliciting perceptions of the good and the bad in our venue, the Tosawihi working group were unanimous in their view that the sequence of Tosawihi inquiry, which was dictated by the geographical demands of Section 106 compliance, was the single most limiting factor in our attempt to understand the Tosawihi Quarries. One of our group observed that ".... some of our real questions linger because we have been granted no invitation to look long and hard at the main body of the quarry. Our work has been a little like palmistry, diagnosing proximal conditions from distal symptoms." Similarly, the fruits of four years' labor remained unenlightened by a regional perspective, and connections between Tosawihi toolstone industries and the socio-economic systems they served remained elusive because the regions beyond mine plans of operation were beyond our purview.

But if the limiting factors of the CRM approach are noteworthy, so too are the remarkable benefits that accrued to research at Tosawihi. Theretofore, the Quarries had suffered inattention born of a perception of the technical difficulties of quarry study. But CRM corrected for scale and permitted concentration on the Quarries as a class of phenomena with theoretical significance as well as relevance to Great Basin prehistory, and funded methodological solutions to the technical problems presented by Ericson's

(1984) ".... shattered, overlapping, sometimes shallow, nondiagnostic, undatable, unattractive, redundant, and at times voluminous material record." Tosawihi investigations were augmented by mass debitage analysis on a massive scale, by experimental quarrying and heat treatment, by large scale replication studies, by computer-enhanced surveying and mapmaking, by aerial photogrammetry, by mechanized crosscutting of quarry features, by ultraviolet light sourcing, and by radiocarbon assay. The regional sample we desired came finally to hand. Thus, CRM rendered the Quarries approachable and assured adequate support of their investigation.

Mindful of the independence our venue afforded us, clearly research issues were ours to decide, data needs ours to define, and theoretical predilections ours to satisfy. Geographical constraints notwithstanding, what got done at Tosawihi, and how, was limited only by the skill and scholarly inclinations of its observers.

AN INTENSIVE RECONNAISSANCE OF THE TOSAWIHI QUARRIES ARCHAEOLOGICAL DISTRICT (Site 26Ek3032)

by

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INTERMOUNTAIN RESEARCH
REPORTS

ABSTRACT

Intermountain Research conducted an intensive reconnaissance of the 823-acre Tosawihi Quarries Archaeological District (26Ek3032) in Elko County, Nevada, on the Little Antelope Creek drainage about 40 miles northeast of Battle Mountain, Nevada. The District contains prehistoric opalite quarries known to have been exploited by the Battle Mountain groups of Western Shoshone.

The study was conducted in two phases. The first included a systematic survey of the entire district, recording 219 prehistoric localities: isolated artifacts, discrete clusters of artifacts, rockshelters, open residential localities, and quarry-related localities (isolated quarry pits, quarry pit complexes, outcrop quarries, adits, and surface cobble quarries). The second phase scrutinized archaeological variability in a 215-acre sample of the District. Second phase study addressed variability among quarry pits, and the nature of the ubiquitous lithic scatter covering the surface of the District.

Areal Intensity Data

Project Area = 823 acres
Area Surveyed = 823 acres

Transect Interval/No./Type = 30/75/linear

ACKNOWLEDGEMENTS

The conduct of this study was assisted immeasurably by Touchstone Resources Company who, in addition to funding the work, provided survey and mapping support. As well, the interest and attention accorded the study by the Bureau of Land Management Elko Resource Area and the Nevada Division of Historic Preservation and Archaeology facilitated its progress.

The Intermountain Research field team, directed by Robert Elston and supervised by Elizabeth Budy, included Robert Clerico, Michael Drews, Kenneth Juell, Christopher Raven, and Dave Schmitt, whose efforts were complemented by volunteers Clay Clerico and Michelle Raven. In the laboratory, Budy organized, verified, and reduced field data, while Elston described geography and analyzed site data and collections, and Raven prepared report background. Drews drafted maps and graphics, Juell processed collections, and Susan Davis and Allen McCabe prepared locality map plots. Cashion Callaway contributed editorial support and Katherine Nickerson saw to word processing and report production.

Special thanks are due Mary Rusco, who initiated systematic study of the Tosawihi Quarries. The present approach to Tosawihi relied on consultation with Rusco and access to her field data, with which she was generous.

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Chapter 1. INTRODUCTION

> .....White Knife [tosa, white + wihi, knife] people of the Battle Mountain region are so called because an excellent grade of white flint occurs in that country.
>
> - Julian Steward (1938:248)

The Tosawihi Quarries are to be found ca. 40 air miles northeast of Battle Mountain, Elko County, Nevada (Figure 1), on lands administered by the Bureau of Land Management Elko Resource Area (BLM). First described by Great Basin archaeologist Mary Rusco (1983), the Tosawihi Quarries Archaeological District (Figure 2) is the subject of the following report.

Just as the mineralization in the study region attracted aboriginal people in need of toolstone over millenia, so has it captured latter day seekers of quicksilver and gold. Touchstone Resources Company (TRC), by its Ivanhoe Project, is exploring for gold in an area corresponding to that of historic and prehistoric mining. Recognizing its sensitivity, TRC engaged Intermountain Research to inventory the Tosawihi Quarries Archaeological District and develop a plan to guide the management of cultural resources there, particularly as they may come into conflict with minerals exploration and, eventually, development.

This report describes the prehistoric localities that occur in the project area and attempts to characterize them. A report devoted to the historic period represented in the District is pending, as is a management plan, now in development. Following this introduction, Chapter 2 describes the physical setting of the project area and region, while Chapter 3 provides prehistoric and ethnographic background. Chapter 4 gives field and post-field study methods. The geography of the Tosawihi Quarries Archaeological District is described in Chapter 5, followed by summary details of prehistoric localities in Chapter 6. Chapter 7 characterizes the Tosawihi phenomena and Chapter 8 offers concluding comments.

Legal Description

Referring to USGS 7.5 min. quadrangles Willow Creek Reservoir SE, Nevada (1965), and Willow Creek Reservoir, Nevada (1965), the project area is located in Township 38N, Range 48E, portions of Sections 32 and 33; and in Township 37N, Range 48E, portions of Sections 4 and 5.

Figure 1. Regional Map.

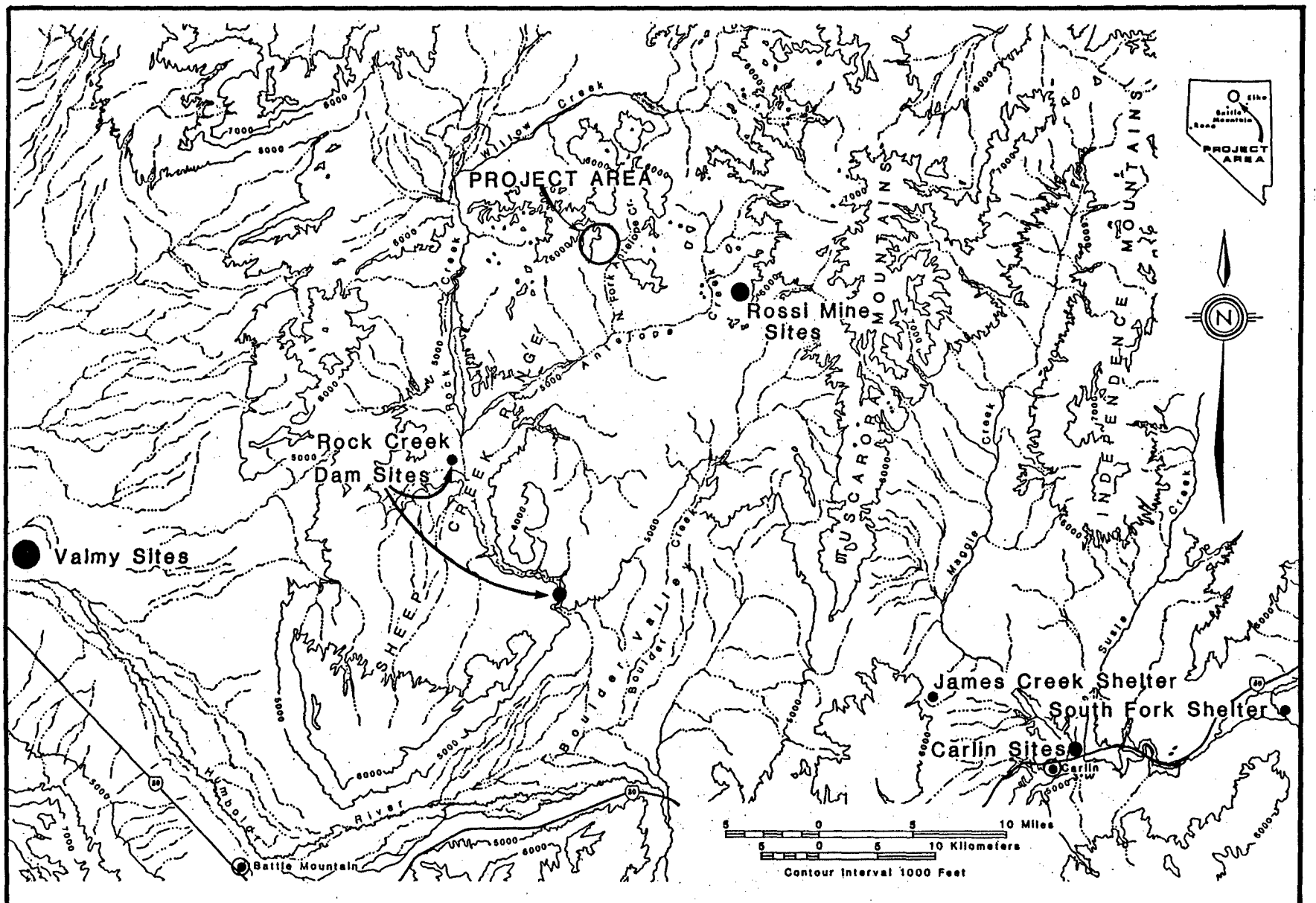
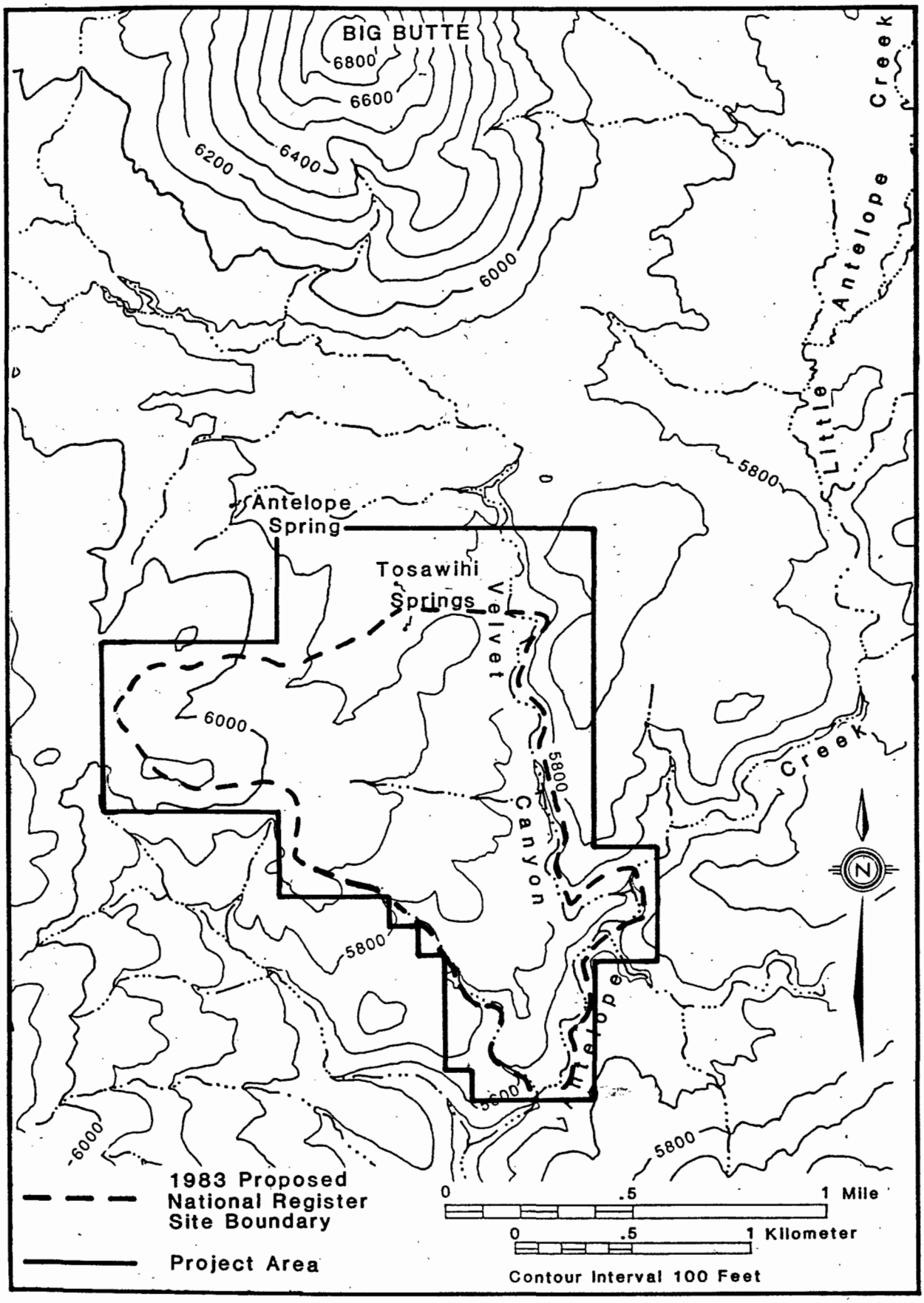

PROJECT AREA
Rossi Mine Sites
Rock Creek Dam Sites
Valmy Sites
James Creek Shelter
South Fork Shelter
Carlin Sites
Battle Mountain
Carlin
PROJECT AREA
N
5 0 5 10 Miles
5 0 5 10 Kilometers
Contour Interval 1000 Feet
Willow Creek
Rock Creek
Antelope Ck.
North Fork
Todd Ck.
Sheep Creek Range
Boulder Valley
Boulder Creek
Humboldt River
Tuscarora Mountains
Independence Mountains
Maggie Creek
Susie Creek

Figure 2. Project Area Map.


BIG BUTTE
6800
6600
6400
6200
6000
Little Antelope Creek
5800
Antelope Spring
Tosawihi Springs
Velvet Canyon
Creek
N
1983 Proposed National Register Site Boundary
Project Area
0 .5 1 Mile
0 .5 1 Kilometer
Contour Interval 100 Feet

Chapter 2. PHYSICAL SETTING

by Christopher Raven

The Tosawihi Quarries Archaeological District as defined here occupies 823 acres of the Ivanhoe Mining District, a rocky, gently undulating expanse lying at the junction of the Sheep Creek Range and the southwestern foothills of the Tuscarora Mountains (see Figure 1). Moderately dissected by currently seasonal drainages, landforms in the area clearly have undergone considerable erosion since their formation, although there is little evidence of high-energy episodes of runoff or deposition save in the gorges at the region's eastern margin. Measured against local vertical relief, the area constitutes a mid-to-upland zone transitional between nearby ecologically distinct milieus; encompassing elevations from 5500 to 6100 feet amsl, it stands some 700 feet above the extensive plains that flank it to the west and south, and some 1900 feet below the peaks of the Tuscarora Range 12-15 miles to the east. Intermediate between two more extensive ecozones, the study area hosts a biotic mosaic composed largely of communities and species more dominant in neighboring settings.

Save as noted, the following discussions are based on field observations made during the course of archaeological reconnaissance in July and August, 1987. A general environmental profile of the area has never been sketched and, aside from certain geological details relevant to the commercial extraction of minerals, few attributes of the local environment have been recorded by specialists. The descriptions presented below, therefore, are intended only to serve as background to this preliminary archaeological reconnaissance.

Geology

The geology of the study area has not been described formally, although a description of the stratigraphy, processes of alteration, and rock types is currently in preparation (Don Hruska, personal communication 1987). The chief component of archaeological concern, however, the extensive surface and near-surface deposits of opalite quarried prehistorically, has been examined and its genesis described relative to historic mercury mining in the area (Bailey and Phoenix 1944) and in the context of earlier stages of Tosawihi archaeological investigations (Duffe' 1976). The formation is the product of late Miocene or early Pliocene

silicification of volcanic rocks and sediments (rhyolitic ash, tuffs, obsidian, and rhyolite) induced by a series of hydrothermal episodes. Permeation of the matrices by silica-rich solutions along fissures and bedding planes resulted in localized deposits of opalite that subsequent millenia of dehydration and crystalization have transformed into a chert-like group of cryptocrystallines (Bailey and Phoenix 1944:17-21). Minimal internal structure and relative homogeneity lent the material desirability as prehistoric toolstone; the entrapment of cinnabar in its lower members rendered it historically desirable as a source of mineable mercury ore.

The other principal surface geologic units consist of rhyolite flows dominating the plateaus of the eastern portion of the study area, and massive basalt that outcrops in the red hills just west of the project area boundary. Both materials were prehistorically transported as boulders, head-size or larger, for use as percussion projectiles and hammerstones in aboriginal quarrying operations.

Hydrology

Surface water is a fugitive resource in the Tosawihi vicinity. Although contributing eventually to the flow of the Humboldt River and flanked at lower elevations on the north and west by major perennial streams, the study area experiences rapid runoff and seasonally depleted aquifers. With the exception of the gorges of Velvet and Little Antelope Canyons, all drainages within the area are ephemeral; during storm episodes, the seasonal streams of the canyons probably are fed as much by direct slope-wash as they are by the contribution of the numerous minor tributaries.

While ground water is persistent and abundant at depth, as evidenced by late-summer drilling (Touchstone personnel, personal communication 1987), only two springs emerge within the study area. The larger (Tosawihi Springs) is located on flats north of the Butte No. 2 mine; the smaller is a seep at the confluence of Velvet and Little Antelope canyons. Both have been developed for livestock use. Testimony to their stability is that the only open habitation sites detected archaeologically occur in their vicinity. By mid-August, 1987, however, both were moribund, suggesting probable seasonality in their prehistoric use.

Vegetation

The study area is an expression of the Artemesian biotic province that is characteristic of the high desert valleys and lower foothills of the northern Great Basin (Billings 1951:110-113; Cronquist et al. 1972:122-125). At Tosawihi, two communities of this sagebrush-grass zone are tightly interdigitated in a complex mosaic responding to variation in soil depth and effective soil moisture. Both communities occur in relatively pure monotypes short distances outside the project area, where their incidence is conditioned largely by elevation.

Occupying much of the silty bottomlands and other areas of deeper soils, and semi-shadowed northern exposures, is a community dominated by big sage (Artemesia tridentata) and rabbitbrush (Chrysothamnus nauseosus) in the shrub component, and by Great Basin wildrye (Elgmus cinereus) and bluebunch wheatgrass (Agropyron spicatum) in the grass component. On the other hand, thin-soiled settings such as knoll-tops, cobble fields, and washes where seasonal drainage has continuously inhibited soil development, tend to be occupied by a community composed chiefly of low sage (Artemesia arbuscula), phlox (Phlox sp.), and the grasses squirreltail (Sitanion hystrix) and Idaho fescue (Festuca idahoensis).

These two communities are so intricately interwoven that, while maintaining their geographic discreteness, neither occurs in unpunctuated form over more than about 40 acres throughout the study area. More characteristically, the landscape is mottled by one-to-ten-acre patches, streamers running down ridgecrests or along drainage bottoms, or isolated pockets where deeper or shallower soils offer favorable habitat. Associated forbs, particularly various buckwheats (Eriogonum sp.), lupine (Lupinus sp.), Mentzelia sp., and globe mallow (Sphaeralcea sp.) have been noted in abundance, but the season of observation excluded many early annuals.

Microenvironmental anomalies support sporadic appearances of species related to other communities, but their prevalence is always dominated by the area's two principal assemblages. Thus the bottoms of gorges are prone to sparse stands of wild rose (Rosa spp.); the bases of rims often shadow clumps of gooseberry (Ribes spp.), chokecherry (Prunus virginiana) or service berry (Amelanchier alnifolia); brief strings of willow (Salix sp.) cluster along the moistest of stream channels, and Artemesia ludoviciana sprouts in the driest and sandiest of them. All these instances, however, constitute probably less than 5% of the total study area. Of doubtless transitory

nature, a large, recently burned zone at the area's northern margin currently hosts mustard (Brassica sp.), thistle (Cirsium sp.), and cheat grass (Bromus tectorum), together with remnants of the pre-fire big sage community.

Fauna

Animals were not observed in abundance during the field exercise, although those species noted suggest broader patterns characteristic of other settings. Antelope (Antilocapra americana), for instance, were seen only once, but their scarceness almost certainly was a function of the lateness of the season of observation; commensurate with other mid-to-upland zones, antelope probably are attracted to the area from the valley bottoms in spring when forbs are most plentiful and water sources most reliable. Mule deer (Odocoileus hemionus), likewise, are likely to be seasonal visitors, their presence in the area limited by the availability of forage and water.

In high valley/foothill settings such as the Tosawihi vicinity, the upper Sonoran life zone (Merriam 1898) hosts as well coyotes (Canis latrans), kit foxes (Vulpes macrotis), badgers (Taxidea taxus), marmots (Marmota flaviventris), jackrabbits (Lepus californicus), cottontails (Sylvilagus spp.), chipmunks (Eutamias spp.), and wood rats (Neotoma lepida), all of which were observed during the 1987 field season. Numerous of the mammalian species listed by Hall (1946) as typical of the zone, particularly several species of rodents, are probably present but went unnoticed.

Species of birds likely to inhabit the area are discussed by Linsdale (1936), reptiles by Stebbins (1966), and fish by LaRivers (1962). None of these phyla was given significant scrutiny during the archaeological investigations.

Chapter 3. CULTURAL SETTING

by Christopher Raven

The following discussions are intended to provide a culture-historical frame of reference for understanding observed patterns in the archaeological record of the Tosawihi Quarries. Derived in large part from primary and secondary sources themselves broader in scope, the synopsis focuses attention on those aspects of White Knife Shoshone culture and the prehistory of the upper Humboldt River drainage that seem particularly germane to explaining how the present archaeological record at Tosawihi came to be shaped as it is.

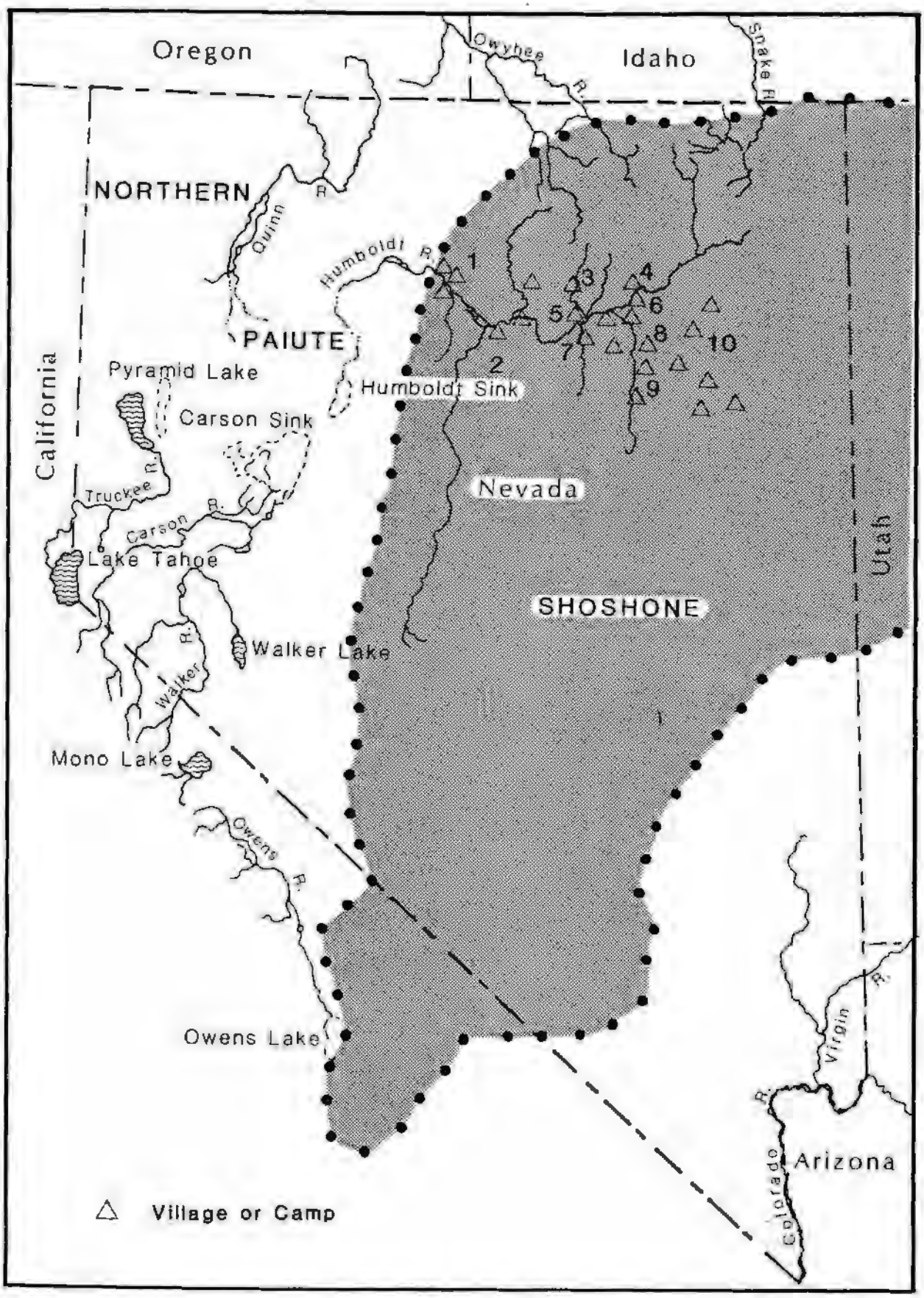
Ethnographic Patterns: The White Knife Shoshone

Of the vast territory (including about one-half the state of Nevada) occupied by the Western Shoshone in the nineteenth century (Figure 3), a much smaller region along the Humboldt River, in the immediate vicinity of Battle Mountain and the adjacent mountains, was inhabited by a local group called the Tosawihi or "White Knives". Steward (1937, 1938, 1939, 1941) regarded the name to apply properly only to those Shoshone who wintered around Battle Mountain and whose principal foraging area lay in the mountains flanking Rock Creek, although it was used variously to identify groups of widely different size and diversity (Harris 1940; Powell and Ingalls 1874). Thomas et al. (1986:283) discuss the synonymy of the name, of some importance here because it refers to the use of a high quality white toolstone found in the mountains north of Battle Mountain (Steward 1938:162), almost certainly the family of opalites that outcrop most prominently in the Ivanhoe Mining District. Possibly the broader application of the name at times may have subsumed more distant groups who procured the stone through exchange; alternately, "Tosawihi" living further east along the Humboldt may have exploited more local sources of visually similar material.

The White Knives shared a boundary to the west with the Northern Paiute (Stewart 1939, 1941), with whom they enjoyed generally amiable relationships including intermarriage and cooperation in hunting (Steward 1938:162); to the north, east, and south they met other Shoshonean groups. Because there was no strongly developed concept of land tenure, or even of exclusive rights in resources (Harris 1940:45), the White Knives and their neighbors were able to benefit mutually from the natural occurrence of scarce but valuable resources. In Harris's terms (1940:55):

Figure 3. Western Shoshone Territory (after Steward 1937, 1938).

Key to Settlements:
1 - White Knives
2 - Crescent Valley
3 - Independence Valley
4 - Elko
5 - Carlin
6 - South Fork
7 - Palisade
8 - Diamond Valley
9 - Huntington Valley
10 - Ruby Valley


Oregon
Idaho
Owyhee R.
Snake R.
NORTHERN
PAIUTE
Quinn R.
Humboldt R.
California
Pyramid Lake
Carson Sink
Humboldt Sink
Truckee R.
Carson R.
Lake Tahoe
Nevada
SHOSHONE
Utah
Walker Lake
Walker R.
Mono Lake
Owens R.
Owens Lake
Virgin R.
Arizona
Colorado R.
1
2
3
4
5
6
7
8
9
10
△ Village or Camp

> There were no important property rights, no wars, no land-owning groups with bitterly defended boundaries, not even a marked ethnocentrism to separate one group from the rest and keep it intact.

The archaeological implications of such a pattern are significant in that, in the absence of exclusive rights to localized resources, ethnically and geographically diverse groups might exploit the same sources of critical materials; conversely, the distribution of such materials in the archaeological record might owe equally to the mechanisms of exchange and direct procurement.

While estimates of White Knife population at historic contact range from 194 (Powell and Ingalls 1874) to 800-1000 (Harris 1940:42), most sources report them to have been numerous and their territory, or at least the river bottomlands, densely populated. Steward (1937:628) estimates that in the more favorable localities (e.g., along the Humboldt River below Battle Mountain) population density may have reached one person per two square miles, a figure exceptionally high compared to other Great Basin subregions, aside from Owens Valley. That this was a microenvironmentally conditioned estimate pertaining only to certain riparian settings within White Knife territory is emphasized by Harris (1940:42) who, while accepting Steward's figure, suggests that, overall, the region was inhabited by about one person per fifteen or twenty square miles.

The heterogeneity of population distribution was especially pronounced in winter, when most people clustered along the banks of the Humboldt River. Steward (1938:161-162) reports that winter camps, comprised of three to five related families, were smaller and less permanent than characteristic of most other Shoshone groups. Harris (1940:44) further emphasizes the relative isolation of even the winter congregation by noting that each camp group (family band) settled from one-eighth to one-quarter mile away from the next, composing large but diffuse clusters of two to ten families.

This is notably at variance with the familiar Great Basin pattern of marked winter clustering, and has been remarked by the principal commentators on White Knife culture. Steward (1938:161) observes:

> Why they did not deliberately concentrate in larger winter villages, which local economy

> certainly would have permitted, is not clear. Apparently they had no great urge, innate or learned, to associate with large numbers of people.

Harris (1940:71) adds:

> The camp group, therefore, was practically a complete ethnic unit, a microcosm of almost the total White Knives culture.

If the pattern described by Steward and Harris had protohistoric or late prehistoric precedent, its archaeological consequences should include small, lowland riverine habitations in greater abundance than exhibited by surrounding regions, and a concomitant dearth of large, semi-permanent habitations. If, as seems more likely, the pattern was an artifact of the historic era, emerging in response to the early incursions of trappers and the subsequent floodtide of emigrants along the Humboldt River corridor, then protohistoric winter settlement in the area can be expected to exhibit the regional characteristic of large seasonal nucleations.

Summer saw the fragmentation of winter clusters into individual, family-based foraging bands. Harris (1940:44-45) suggests the seasonal foraging radius of individual "camp groups" ranged 25-100 miles from the winter camp, and the same round was not necessarily followed in successive years. To the White Knives who wintered in the vicinity of Battle Mountain, Steward (1938:162) assigns particularly the mountains around Rock Creek as foraging range, thus encompassing the the Tosawihi Quarries. The farthest reaches of the seasonal foraging radius often exceeded the limits of the loosely defined territorial boundaries discussed above; both Steward and Harris present examples in which the summer subsistence quest brought foraging groups into the territory of neighbors, and incursions by outsiders were not uncommon.

Few data were recorded ethnographically concerning the structure of summer foraging. While neither pine nuts nor salmon were available locally, they were procured directly through seasonal forays south to the vicinity of Austin and north to the tributaries of the Snake River (Steward 1938:162). Rabbits, antelope, deer, and mountain sheep were the animals most hunted locally (Harris 1940:40), and women engaged in the generalized gathering of plant foods. Both rabbit and antelope drives often benefitted from communal

efforts involving multiple camp groups, with activities directed by task-specific, non-hereditary rabbit chiefs and antelope shamans (Harris 1940:154; Steward 1938:163). Most other subsistence pursuits were performed by the personnel of single camp groups (or from a series of campsites) deployed in a mixed forager/collector strategy (Binford 1980).

The only large gatherings occurred in the context of seasonal festivals. Harris (1940:53) reports that as many as 300 people might congregate from all nearby camps in the spring and fall for dancing and games. Steward (1938:163) suggests that Iron Point and Battle Mountain were particularly prominent festival sites. As during antelope and rabbit drives, the activities of each transitory congregation were directed by ad hoc leaders whose authority did not extend beyond the duration of the festival (Harris 1940:53-54). Since membership in festival gatherings was fluid, contingent upon the geographic proximity of camp groups at the time, festival leadership did not become consolidated into larger patterns of authority. It seems highly unlikely that wealth and prestige played significant roles in the procurement and distribution of material goods, and the archaeological record confidently could be expected to reflect a typically egalitarian society.

White Knife technology was simple, exhibiting a suite of classic Great Basin tools and processes, and the material culture of the group was correspondingly modest (Harris 1940). The archaeologically detectable features definitive of the White Knives probably consist of their isolating winter settlement pattern and their exploitation of Tosawihi opalite. To the extent the former reflects a prehistoric precedent and the latter was in any way exclusive, the White Knives should be distinguishable from their neighbors.

Archaeological Patterns

Little of the archaeological research conducted so far along the upper Humboldt River drainage has focused directly on the prehistory of the White Knife Shoshone, and that which has dealt with attributes of the Tosawihi Quarries remains largely unpublished. Much work has been performed in surrounding regions, however, and this provides a framework for developing expectations relative to the duration, nature, and intensity of prehistoric human use of the area. Moreover, broader syntheses have sketched a background against which to view Tosawihi data from the perspective of the western Great Basin (Elston 1986), northern Nevada (James 1981; Smith et al. 1983), and the Humboldt River Basin (Rusco 1982).

The first published regional survey to address the distribution of archaeological sites in central northern Nevada was performed by the Nevada Archaeological Survey (Stephenson and Wilkinson 1969). Apparently intuitive in approach, the campaign recorded 91 sites scattered through Paradise, Eden, Kelley Creek, Evans, and Squaw valleys; the authors infer a general time depth of human use of the area extending from 2000 B.C. to the protohistoric period. Since the work was conducted in the absence of much explicit problem-orientation, it resulted largely in raw inventory data. Stephenson and Wilkinson note, however, a predominance of hunting equipment in the observed assemblages and a concomitant dearth of groundstone, a pattern they attribute to the valley-margin and upland settings of most of the sites observed (1969:50). More importantly, Stephenson and Wilkinson (1969:50-51) noted an unequal distribution of exploited lithic materials; west of the Osgood Mountains obsidian was observed to dominate local assemblages, while various cherts, evidently including Tosawihi opalite, were favored to the east. Since the chert/obsidian boundary in the area closely approximates the reported ethnographic boundary separating the Northern Paiute from the Western Shoshone, the authors suggest that the cultural boundary may have had an exceptionally long tenure.

Identification of the nature and distribution of lithic materials derived, putatively or ostensibly, from the Tosawihi Quarries has been addressed by subsequent research in the region. At South Fork Shelter, for example, over 90 km from Tosawihi (see Figure 1), Heizer et al. (1968) ascribed the presence of a large number of white chert knives to the ethnographic use of the material reported by Steward. In the studies discussed below, more or less explicit attention was paid to identifying the presence and relative abundance of Tosawihi opalites in local archaeological deposits and, in some cases, to defining the functional role of the material in local assemblages.

The most sustained program of inquiry to date has been pursued around the Valmy power plant site, some 50 km southwest of the Tosawihi Quarries (see Figure 1). Initial surveys (Bard 1980; Busby and Bard 1979; Rusco and Seelinger 1974) had identified numerous sites that lay within the direct impact zone of the proposed power plant and its associated transmission line corridors, and three major data recovery efforts were mounted in response.

First, Davis et al. (1976) conducted intensive surface collections and sample excavations at three sites near Treaty

Hill, to conclude that human use of the area spanned perhaps as much as the past 7000 years, and that two of the sites had functioned as base camps, exhibiting a relatively wide diversity of functional artifact types including a modest but notable (22 specimens) component of ground, pecked, or battered stones. Time-marking artifacts included specimens of the entire Great Basin sequence of projectile points from the Northern Side-notched to Desert Series. Of particular relevance to the present study is that about 82.5% of the total lithic material present appears to consist of Tosawihi chert. Moreover, tool:debitage ratios of apparent Tosawihi material = 2.2:100, while the same ratios for obsidian (the next most prominent tool stone) = 6.3:100. The implication is that, despite the greater proximity of sources of useable obsidian (the authors suggest cobble sources only 15-20 miles north and northeast of Valmy [Davis et al., 1976:51]), the use of Tosawihi material was more profligate and entailed the production of more waste. Too, the pattern underwent little variation through time: "the ratio of obsidian to Tosawihi chert varied only slightly, if at all..." (Davis et al. 1976:36). Lithic analysis suggests that most of the Tosawihi material had been heated before it entered the reduction trajectory enacted at Valmy, although a smaller fraction apparently had been heat-treated on site.

Subsequent investigations near Treaty Hill (Rusco and Davis 1979) consisted of intensive surface collections and the subsurface testing of two additional sites. The results of the work suggested to the authors that at least 7000 years of human use was evident in the area, and that five sites they observed had functioned as base camps, owing to their diversity of functional artifact categories. Again, Tosawihi cherts dominate the local assemblages; 92.9% of the debitage, and 69% of the recovered projectile points, are apparently of Tosawihi origin. Ninety-five percent of the tools observed have been heat-treated, as opposed to 84% of the debitage, suggesting that some measure of heat-treatment of lithic raw materials was performed on-site. The recovery of cultural materials from test excavations was notably low (0-<3 specimens/m^3, as opposed to the ca. 100 specimens/m^3 recovered during 1976 excavations), suggesting the sites in Section 29 were the consequence of a much lower intensity of use. The projectile point assemblage is dominated by forms relating to the Great Basin Stemmed series through the Elko series, with a notable efflorescence of activity marked by a preponderance of Humboldt Concave Base points (which account for 65% of the projectile points recovered). Rusco and Davis (1979:75) note that Tosawihi cherts constituted the preferred material for all tool types (including projectile points), save the few specimens of the Great Basin Stemmed projectile point series.

Finally, the most intensive program of investigation in the Valmy vicinity was performed by Elston et al. (1981), who conducted systematic surface collections, subsurface testing, and backhoe trenching at three major sites and several small localities in Section 20 of the Treaty Hill township. Among the research questions addressed was a more rigorous examination of the identification by Rusco and Davis (1979) of various of the large sites in the vicinity as multi-functional base camps, and an analysis of the lithic production systems operative, particularly during the era in which Humboldt Concave Base projectile points dominate local assemblages. At NV-Hu-634, which exhibited the densest concentrations of cultural materials within the area of inquiry, the investigators report that Tosawihi cherts constitute 92.8% of the lithic assemblage by weight. The occupation is seen as ranging from 6000-3000 B.P., with an earlier component possibly reflecting use of the area between 11,500-8000 B.P. (owing to the incidence of Great Basin Stemmed projectile points). None of the sites investigated suggests use as a semi-permanent base camp; all exhibit a paucity of hearths and fire-cracked rock, and all display artifact assemblages oriented toward hunting and short-term seed-gathering activities. While nearby sites NV-Hu-629 and -631 are viewed as "more or less permanent winter camps" (Elston et al. 1981:154), most of the prehistoric activity in the area is viewed as task-specific and transient, although reenacted over several millennia.

Closer to the Tosawihi Quarries (ca. 29 km southwest), investigations relative to the proposed Rock Creek Dam entailed data recovery from five sites bearing on prehistoric use of the present study area (see Figure 1). Recorded initially by Botti (1985), an open site and four rockshelters were studied for evidence of chronology and function in local lithic procurement systems (Clay and Hemphill 1986). The reduction of bifaces of Tosawihi opalite was found to be a primary activity at the open site; about 99% of the debitage is of Tosawihi material, much of it expressed as tertiary flakes, and it was inferred that the material was brought to the site in the form of Stage II or Stage III bifaces. Various of the rockshelters exhibited well-developed late prehistoric components, with faunal assemblages dominated by small mammals; at least one shelter displayed a much lower proportion (58%) of Tosawihi material in its debitage.,

In the western foothills of the Tuscarora Mountains, some 10 km east of the Tosawihi Quarries, Rusco (1982) conducted intensive surface collection and limited subsurface testing at seven sites in the vicinity of the Rossi Mines (see Figure 1).

Recovered time markers indicate a possible time depth of 8500 years, with all the principal projectile point types, Great Basin Stemmed to Desert Series, represented. Numerous groundstone artifacts, as well as a diversity of flaked stone implements, were recovered. The relatively small faunal assemblage indicates a focus on grassland species.

Tosawihi opalites dominate the lithic profile of the sites, accounting for more than 90% of the tools and more than 99% of the debitage; other materials seldom were knapped, as evidenced by the observed tool:debitage ratios (1:46.7 for Tosawihi opalites, 1:3.2 for all other materials). Rusco (1982:52-74) uses the Rossi Mine data to test a generalized gravity model of resource product distribution, with special reference to qualitative variation in assemblage as a function of distance from Tosawihi; data from the Valmy sites and from two sites near Carlin (Rusco et al. 1979) were included. The results generally support the gravity model, in that at greater distances from the Tosawihi Quarries, lithic assemblages exhibit progressively later stages in biface and core reduction. On the other hand, a predicted decline in the frequency of cortical flakes was not found; the Carlin sites, furthest from Tosawihi, exhibit the highest incidence of cortical flakes. This may be the result of misidentification of material source, since, unknown to Rusco at the time of her study, a Tosawihi-like white chalcedony is available from a source near the Carlin sites (Elston and Budy, in press).

The only investigations directly concerned with the Tosawihi Quarries have been conducted by Rusco and her associates over a period of more than a decade. In a series of unpublished papers (Rusco 1976a, 1976b, 1978, 1979, 1983), the composition of the Tosawihi Quarries has been characterized, the distribution of apparent Tosawihi material in sites outside the District has been examined in light of gravity models and ethnic boundaries, and the chemical characterization of Tosawihi opalites has been attempted. Results of the latter effort, utilizing X-ray fluorescence, so far have proven equivocal (Duffe' 1976a, 1976b), but other approaches still are being contemplated (Mary Rusco, personal communication 1987). The matter is of critical concern for understanding not only the culture history, but also the anthropological implications, of the Tosawihi data; given the unreliability of visual identifications of lithic materials, it is only when it becomes possible to identify Tosawihi opalites objectively and irrespective of context that we can begin to address questions of ethnicity and exchange networking in the archaeological record.

Cultural Chronology

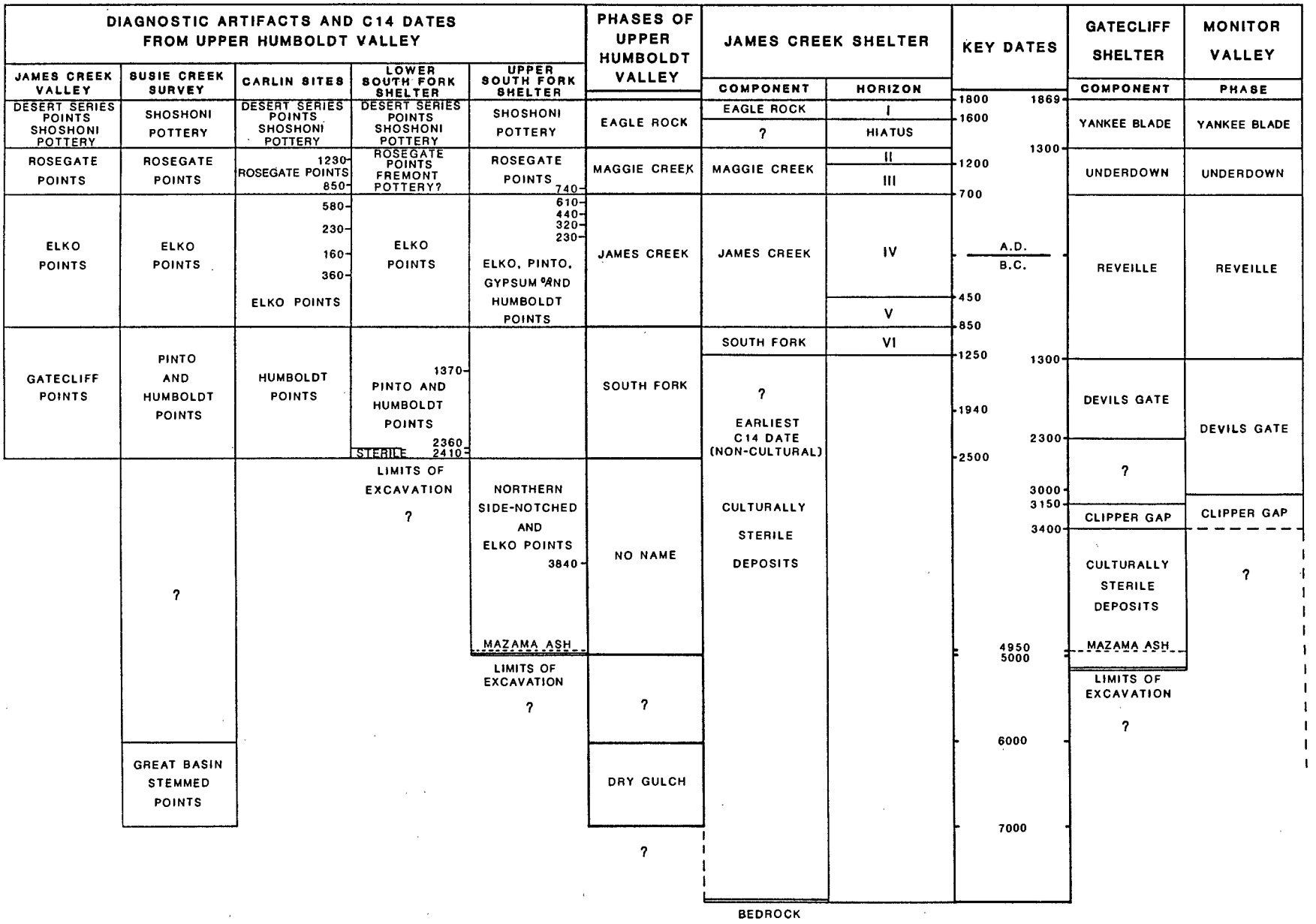
Among the factors limiting the integration of archaeological data into regional culture-historical sequences and, in turn, into processual models of culture change, is the gradual, often piecemeal, manner in which the archaeological record yields information on when its reconstructable events occurred. Thus, while research on the prehistory of the upper Humboldt River drainage has been pursued for more than two decades, the structure of the regional chronology is emerging only now and, in the view of the most current assessment, it remains prone to certain gaps that only further research will be able to close.

The sequence proposed for the upper Humboldt (Elston and Budy in press) is based on recent excavations at James Creek Shelter, some 50 km southeast of Tosawihi (see Figure 1), and incorporates data from several regional surveys and excavations (Figure 4). Its probable relevance for Tosawihi is a function of geographic proximity, ecological comparability, and, in the recent past, ethnic relationship.

The Dry Gulch Phase is the earliest proposed for the Humboldt River drainage. Terminating at about 6000 B.C., its diagnostic attributes include large concave-base projectile points as well as points of the Great Basin stemmed series, flaked stone "crescents" (Tadlock 1966), heavy core tools, scrapers, and choppers. Originally defined as a Western Pluvial Lakes Tradition (Bedwell 1973) because of its prevalence in ancient lacustrine landscapes, hallmarks of the phase have been recognized in riparian and upland settings as well. Regarded as "pre-Archaic" in the broader sequence of Great Basin adaptations (Elston 1982), the phase is characterized by big game hunting on an encounter basis (Binford 1980); little intersite variability in assemblages has been detected so far. Although not represented at James Creek Shelter (Elston and Budy in press), attributes of the phase have been noted at Valmy (Elston et al. 1981), Susie Creek (Armentrout and Hanes 1986), and Rye Patch Reservoir (Rusco and Davis 1982); too, Great Basin Stemmed projectile points, distinctive features of the phase, have been recovered during our preliminary reconnaissance within the Tosawihi District.

The No Name Phase marks the emergence of the early "Archaic" adaptation in the upper Humboldt River drainage (Elston and Budy in press); elements of the transition from the pre-Archaic to Archaic so far have not been forthcoming. Spanning the period 5000-2500 B.C., the phase is marked by Northern Side-notched and Humboldt Series projectile points

Figure 4. Prehistoric Chronology for the Upper Humboldt Valley, Nevada (from Elston and Budy, in Press).


DIAGNOSTIC ARTIFACTS AND C14 DATES FROM UPPER HUMBOLDT VALLEY
JAMES CREEK VALLEY
SUSIE CREEK SURVEY
CARLIN SITES
LOWER SOUTH FORK SHELTER
UPPER SOUTH FORK SHELTER
PHASES OF UPPER HUMBOLDT VALLEY
JAMES CREEK SHELTER
COMPONENT
HORIZON
KEY DATES
GATECLIFF SHELTER
COMPONENT
MONITOR VALLEY
PHASE
DESERT SERIES POINTS
SHOSHONI POTTERY
ROSEGATE POINTS
ELKO POINTS
GATECLIFF POINTS
PINTO AND HUMBOLDT POINTS
HUMBOLDT POINTS
1230
850
580
230
160
360
1370
2360
2410
STERILE
LIMITS OF EXCAVATION
?
GREAT BASIN STEMMED POINTS
FREMONT POTTERY?
610
440
320
230
740
3840
MAZAMA ASH
EAGLE ROCK
MAGGIE CREEK
JAMES CREEK
SOUTH FORK
NO NAME
DRY GULCH
BEDROCK
I
II
III
IV
V
VI
HIATUS
EARLIEST C14 DATE (NON-CULTURAL)
CULTURALLY STERILE DEPOSITS
1800
1869
1600
1300
1200
700
A.D.
B.C.
450
850
1250
1940
2500
3000
4950
5000
6000
7000
YANKEE BLADE
UNDERDOWN
REVEILLE
DEVILS GATE
CLIPPER GAP
3150
3400

(Heizer and Hester 1973; Thomas 1981, 1983). The early Archaic adaptations (inception of intensified seed use, increased locational diversity in land-use patterns, probable increase in diet-breadth, and logistical structuring of subsistence pursuits) are not signalled strongly by the sparse data presently available along the upper Humboldt, where few details beyond chronology have been recovered (Elston and Budy in press).

The South Fork Phase (2500-850 B.C.), marked by Humboldt and Gatecliff Series projectile points, reflects a fully Archaic adaptation, although ambiguities blur the distinctive features of the phase in the upper Humboldt River drainage (Elston and Budy in press). Few artifacts are associated with the phase at James Creek Shelter, and data from nearby sites do not clarify much.

With the James Creek Phase (850 B.C.-A.D. 700), the Archaic adaptation reaches its fullest expression. Elko Series projectile points are the principal phase-markers, and their distribution indicates the exploitation of an extremely wide range of settings and resources. While certain chronological ambiguities persist regarding the placement of Elko projectile points (O'Connell 1967; Thomas 1983; Elston and Budy in press), their ubiquity across diverse landscapes signals a marked broadening of the prey-base and a more eclectic use of the environment.

The Maggie Creek Phase, extending from A.D. 700-1300, is characterized by further intensification of plant exploitation, increased pursuit of small game, and introduction of the bow and arrow. The phase is recognized archaeologically chiefly by the occurrence of Rosegate Series (Rose Spring and Eastgate) projectile points, and by the infrequent incidence of Fremont Grayware ceramics. The abundance of time markers (chiefly projectile points) recovered archaeologically suggests that the phase may have been characterized as well by a peak in local population levels (Elston and Budy in press).

The Eagle Rock Phase is marked along the upper Humboldt by Desert Series projectile points (Desert Side-notched and Cottonwood), and by Shoshone Brownware ceramics (Elston and Budy in press). The phase spans the period from A.D. 1300 to the protohistoric era, apparently representing the archaeological record of the Numic peoples who occupied the area at historic contact. Elston and Budy (in press) note that the incidence of time-marker artifacts suggests the phase witnessed an intensity of occupation diminished significantly from that of earlier times; whether this reflects reduced

population levels or merely a diminished emphasis on hunting (as signalled by the incidence of projectile points) remains to be tested.

Chapter 4. STUDY METHODS

by Christopher Raven

Field work was accomplished in two ten-day field sessions, with a ten-day interval between them devoted to preliminary data analysis and refinement of the technical approach to study objectives. The methods and procedures employed by field and post-field investigations are the focus of the following discussion.

Field Methods - Session I

June 15 through June 24, 1987

Initial survey of the project area was designed to identify the range of variation in the kinds, quality, and distribution of cultural resources at a level of scrutiny sufficient to characterize the overall abundance of the resource base, to segregate zones of minimal research potential, to signal those areas requiring further investigation to evaluate their significance, and to provide a point of departure for planning such evaluative studies. To this end, a party of four was fielded with the charge of examining at a uniform intensity the entire project area and recording at a preliminary level its cultural attributes. The effort consumed 32 workdays (8 calendar days).

Project Boundary

Delineation of the project boundary responded to the coincidence of the Tosawihi (White Knife) Quarry National Register of Historic Places draft nomination (Rusco 1983) with mining interests identified by Touchstone Resources Company. TRC provided topographic maps of its area of concern (scale 1:6000; contour interval 5 feet), and upon these the boundary of the proposed National Register district was superimposed. To accommodate examination and reliable geographic control, the project boundary was regularized to a rectangular polygon encompassing the original irregular boundary of the district; in the field, minor adjustments, particularly at the southern and western margins, responded to observations of continuities and discontinuities in the distribution of cultural resources. In all, 823 acres comprise the area scrutinized (see Figure 2).

Ground Survey

Survey of the project area was accomplished by following a series of regularly spaced, north-south transects blanketing the entire study area. In order to take advantage of a grid staked and flagged at 400-foot intervals by TRC surveyors, transects were aligned to the grid and spaced 100 feet apart. In effect, every fourth transect corresponded to a north-south ordinate of the staked grid and could derive therefrom a much tighter geographic precision than otherwise would have been feasible. Transects were plotted on 1:6000 scale topographic maps of the project area marked with the coordinates of the TRC grid.

The field party surveyed sets of four adjacent transects simultaneously, the westernmost surveyor anchored along a staked grid line, and the remaining team arrayed at 100-foot intervals to the east. Each surveyor was equipped with an appropriate section of the project map, recording materials, compass, pin flags, and a two-way radio. The party advanced along a generally uniform front, the gridline anchorman calling by radio the coordinates of each grid stake as it was passed, until the end of the transect set or an agreed subdivision of it was reached. In most instances the party then realigned along the adjacent transect set and surveyed in the opposite direction, returning to a point 400 feet from its original station of departure.

In practice, the manner of coverage deviated from the above approach in response to two field contingencies. In one case, it proved strategically advantageous, owing to the disposition of roads in the area, to allow a two-member team to survey the four transects of a set in a single round trip. In another case, a small measure of geographic precision was lost owing to the occurrence of transects or portions thereof outside the zone in which grid corners had been staked. Survey of these transects relied upon close attention to topographic details and compass bearings, distance pacing, and group consultation via radio. While these approaches allowed generally good cross-checks on locational accuracy, features in the less topographically distinctive northern and western margins of the project area, may have been recorded with less geographic precision than they were where the grid provided a continuous frame of reference.

Recording

Each field party member was responsible for recording all cultural attributes observed along each transect that he/she

traversed. Two general categories of data were collected, based on expectations derived from prior surveys and preliminary project reconnaissance.

Features

Features were defined as geographically discrete cultural phenomena of identifiable type, size, location, and constituency. As recorded in the field, individual features consisted of single distinctive artifacts, clusters of artifacts, structures, and discernible modifications of the landscape. Roads, cairns and other mining claim monuments, and survey stakes were not recorded.

Upon encountering a feature along a transect line, the surveyor assigned it a transect-specific sequential number, plotted its location on the appropriate transect map, and recorded details of its location, type, size, and associations on a record form maintained for each transect. Descriptions and pertinent observations were incorporated in the recording. Radio communication allowed adjacent surveyors to confer on the coincidence of like features, with the result that in several instances the boundaries of feature clusters or complexes were sketched approximately with the intent of subjecting them to more intensive scrutiny in a subsequent phase of investigations. Pin flags marked with the corresponding feature number were placed in all features to facilitate their future relocation.

While it was customary practice to record only features lying directly along transect lines, and not to search for intertransect features, deviation from this approach was entertained along Velvet and Little Antelope canyons in the eastern portion of the project area, where the coincidence of rockshelters, intensive prehistoric quarrying activity, and extremely irregular relief mandated additional measures to avoid missing features of preeminent significance. Accordingly, survey of these areas, while maintaining the standard transect interval as a <u>minimal</u> level of coverage, sought to identify and record <u>all</u> features present. The exercise was aided by the advantage in perspective that the steep slopes always afforded one or the other end of the survey line; in several instances surveyors could be directed off-transect by team members with a better overview to examine promising rockshelters, alcoves, and shelves otherwise in defilade.

Debitage Density

Owing to the near ubiquity of knappable lithic resources, only a relatively small proportion of the project area is utterly vacant of scattered debitage. In order to define better the distribution of this material and to assess its relationship to the incidence of recorded features, a running observation of debitage density was maintained along each transect, recorded at 100-foot intervals.

Since actual counts would have been prodigiously time-consuming to affect, the estimation and recording of debitage density observed the following conventions:

0:	No debitage noted over 100 transect-feet.
Sparse:	Average density of less than 1 flake/m^2.
Light:	Average density of 1-100 flakes/m^2.
Moderate:	Greater than 100 flakes/m^2; bare ground visible.
Heavy:	Unbroken pavement of debitage; bare ground not visible.

Frequent radio consultation allowed surveyors to confer on the assignment of density rankings, and the field supervisor monitored the accumulating record for consistent patterning of estimates; it seems inevitable, nonetheless, that a small degree of individual variation may have entered the record of debitage density. On the other hand, the generally gradual clines, both along and across the grain of the transects, evident in the compilation of the individual records suggests that the effect of minor individual variation has been minimized.

Collection

While the collection of artifacts encountered during survey was not a principal component of this phase of research, temporally diagnostic projectile points were plotted and recorded as features in the field and then were collected for further analysis. Their locations were flagged for more precise mapping during a subsequent phase of investigation.

Summary of Results

A total of 489 features or feature clusters was recorded, 167 historic and 322 prehistoric.

Field Methods - Session II

July 6 through July 15, 1987

A party of five archaeologists characterized and recorded a sample of those archaeological observations made during the first field session. Forty workdays (8 calendar days) were expended by the field party, whose efforts were incremented by 9 workdays of volunteer labor. During the course of the session, 40 feature complexes and areas of special interest were revisited and examined in detail.

Objectives

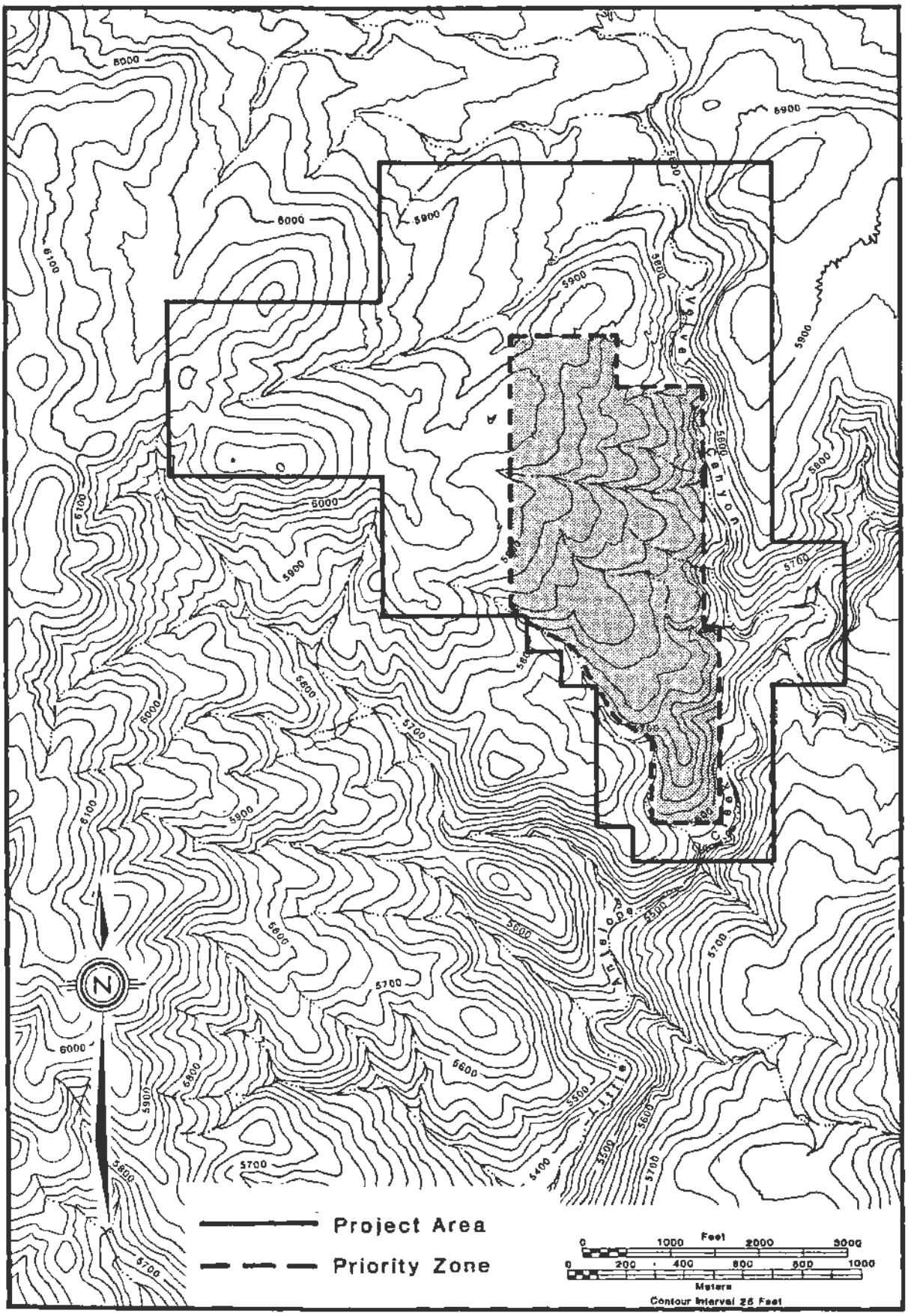
The second field session was designed to return data on the structure and range of variability of archaeological phenomena recorded during transect reconnaissance, with special attention given the abundance and distribution of discrete features, their composition, and associated lithic debris. It was the intent of the exercise to support the design of site-specific, as well as thematic, research strategies and, at the same time, to signal zones of minimal research potential.

Study Units

Session II was confined entirely to a 215-acre priority zone of immediate concern relative to minerals exploration (Figure 5). Having judged that our initial transect inventory had characterized sufficiently certain discrete localities such as rockshelters, small flaking stations, small outcrop quarries, and isolated artifacts, we excluded such categories from treatment during the second field session. Instead, we concentrated on formally characterizing quarry pit complexes. These are the most abundant features in the project area, and pose the greatest challenge to formal characterization owing to their size and internal complexity.

On the basis of data assembled during Session I, boundaries were identified for 36 localities targeted for further examination (although more than 36 localities occur within the priority zone). Twenty-eight of these were prehistoric quarrying features or complexes of features; eight

Figure 5. Project boundary and priority zone.


Project Area
Priority Zone
Feet
0 1000 2000 3000
Meters
0 200 400 600 800 1000
Contour Interval 25 Feet

were areas of light to moderate debitage density selected for closer scrutiny (see Chapter 7). Boundaries of these localities reflected the previously observed distribution of features and feature complexes, patterns of debitage density, topographic configurations, and the occurrence of naturally exposed sources of raw lithic material.

Field Procedures

Field operations at each locality consisted of mapping, feature recording, and the observation and recording of cultural attributes. All aspects of the work were performed concurrently, with specific tasks assigned a 2-person mapping team and a 2-person feature-recording team; the project lithics specialist was charged with locality description and characterization of the cultural attributes of features.

Mapping

Plan maps were prepared depicting each of the 28 prehistoric quarry feature localities. At each locality, a datum point marked by a 2-in. x 2-in. wooden stake was located with reference to mapped corner stakes of the 400-foot grid network. Mapping was accomplished with transit and stadia rod, locating precisely all features selected for formal recording, delineating the boundaries of feature clusters, and establishing the elevations and dimensions of significant geological associations. Zones of intruding historic disturbance were plotted as well.

Feature Recording

Within each mapped locality, special attention was given the formal recording of attributes of those features identified during Session I transect survey. Of the several features comprising a feature cluster, only that representative flagged in the earlier exercise was selected for additional scrutiny.

In the case of quarry pits, the selected examples were drawn in plan and profile using measured distances from a staked datum (usually placed in the bottom of the pit) and a levelled line for control. The locations of tools (especially bifaces and hammerstones) and anomalies (e.g., cobble clusters, sub-depressions) were plotted on the plan drawings.

Subsequent to the drawing of plans and profiles, each recorded feature was visited by the project lithics specialist, who recorded observations on the character of the cultural attributes and available raw lithic material in the feature. Particular attention was given the recording of the quality, color, size, and abundance of raw material; the size and material type of hammerstones; the size, stage, and material selection of bifaces; and the character, abundance, and distribution of debitage. A sample of debitage was collected from each recorded feature to characterize the range of variation in material quality and flaking technique. In addition, several non-pit features (outcrop quarries, discrete lithic scatters) were visited and characterized for the same suite of attributes.

Areas of Special Interest

Session I transect survey identified areas of light (1-100 flakes/m^2) or moderate (100+ flakes/m^2) density debitage scatters within which no discrete features had been recognized. A sample of these areas was revisited by the entire field party with a view to identifying portions of the priority zone where research potential is minimal. The areas selected for scrutiny consisted of relatively flat or topographically homogenous places where the effects of colluvial redeposition are believed to have been minimal. At each, the party conducted surface reconnaissance to identify and record discrete features, and record observations on the character, abundance, and distribution of debitage and available raw lithic material. Four areas of light density scatter and four of moderate were so treated; the exercise resulted in the recording of 10 features not noted during Session I survey.

Post-field Methods

The information recovered in the field was analyzed, manipulated, and reduced variously, and collections were processed and analyzed, as described below.

Data Reduction

Field investigations generated data on nearly five hundred cultural features. Confronted with a great deal of raw data and a pressing need to make sense of it without delay, we attempted to structure information for

interpretation and presentation in ways that would address the needs of research and of cultural resources management at the same time.

First, we decided to address the historic and prehistoric periods separately. Results of investigation of the historic period are pending, to be presented in their own document. Left with 332 observed and recorded prehistoric phenomena, we grouped related features based on topographic association, to arrive at a total of 219 prehistoric localities. Boundaries for mapped prehistoric quarry localities in the priority study zone are defined accurately, established by transit data; maximum boundaries for other, unmapped localities in the priority zone and all localities outside it are approximate, established by mapped artifact density clines surrounding features or feature clusters.

A narrative description of each locality (Appendix A) was compiled from transect feature records (Session I) and sample feature-locality descriptions (Session II); locality dimensions and topographic information were taken from 1:6000 contour map plots made in the field. Each description, which is accompanied by a USGS 7.5 minute topographic map plot, includes the following categories of information:

-- reference number (1-219);
-- general type of cultural manifestation (rockshelter, open residential site, reduction station, soil mound, quarry);
-- UTM grid coordinates;
-- physical dimensions;
-- description of topographic setting (landform, slope, aspect) (slope terms are from Soil Survey Manual, Agricultural Handbook No. 18);
-- description of nature of opalite source (bedrock edge outcrop, near-surface bedrock, cobbles in colluvium);
-- description of toolstone color and quality;
-- description of features, relevant feature numbers, and associated artifacts;
-- condition of site (kind and degree of historic and/or recent disturbance); and
-- remarks indicating inferred relationships, notable artifact and/or natural opalite associations, interpretations, and research potential.

Finally, localities were grouped on the basis of topography. Thus, the "neighborhoods" of the District, to which we assigned place names, have been defined and can be discussed as discrete entities.

Collections Management

Collected artifacts were cleaned, numbered, cataloged, and bagged for storage. Field and laboratory notes and logs, mapping notes, photo logs and negatives, artifact assemblage and catalog, and this report will be accessioned by the Museum of Anthropology, University of Nevada, Reno, where they will be available to future teaching and research endeavors. An Intermountain Antiquities Computer System (IMACS) site form, to which are appended all 219 prehistoric locality descriptions and map plots, has been forwarded to the BLM Battle Mountain District office. One Smithsonian trinomial designation, 26Ek3032, has been assigned to the Tosawihi Quarries Archaeological District as delineated herein.

Lithics Analysis

Classification of projectile points is based upon morphological criteria specified by Thomas (1981). Bifaces were classified according to the 3 stage reduction scheme developed by Muto (1971). Projectile point and biface measurements and observations appear in Appendix B.

Chapter 5. THE GEOGRAPHY OF THE TOSAWIHI DISTRICT

by Robert G. Elston

The Tosawihi Quarries Archaeological District is located in an upland of volcanic buttes and plateaus cut by canyons and ravines. Since most of these topographic features in and around the project area heretofore lacked placenames, we have assigned many to ease present and future discussion of the microterrain. Place names, the lay of the land and the positions of prehistoric localities relative to it, are given in the following discussion and depicted in figures 6, 7, and 8.

The roughly conical Big Butte rises about 1100 feet above surrounding terrain, to 6889 feet asl. Somewhat higher buttes rise a few miles to the north and northeast. Wrapped around Big Butte on the west, south, and east is crescent-shaped Big Butte Valley, about four miles long and one mile wide. The southern boundary of the valley is the highland area of the Tosawihi Quarries Archaeological District, including Mary's Ridge (6107 feet), Twin Butte (6125 feet), Tosawihi Ridge (5934 feet), and Little Butte (5962 feet).

In the eastern portion of the valley, the valley floor is at 5750 feet elevation. Here heads the main branch of Little Antelope Creek which flows south-southwest, east of Little Butte, 1.5 miles through a steepwalled canyon cut in Tertiary rhyolite. Perennial Hunting Blind Spring occurs on the far southeast margin of the valley in the drainage of Little Antelope Creek.

The valley floor in the southwestern portion of the valley, at 5820 feet, is drained by Velvet Creek which flows 0.75 mile southward through steep-walled Velvet Canyon, between Owl Ridge on Little Butte and Tosawihi Ridge, to its confluence with Little Antelope Creek. A northward extension of Owl Ridge forms a low divide (> 20 feet) in Big Butte Valley between the two drainages.

The Tosawihi Quarries Archaeological District occupies a roughly triangular area in the highlands south of Big Butte Valley. The highest point in the District is on its eastern edge at Twin Butte (6125 feet); the topographic trend is a slope eastward to Little Antelope Creek.

Just outside the eastern boundary of the project area, north-south trending Talus Ridge rises to 6193 feet. The ridge is named for prominent stripes of basalt and rhyolite

Figure 6. The geography of the project vicinity.

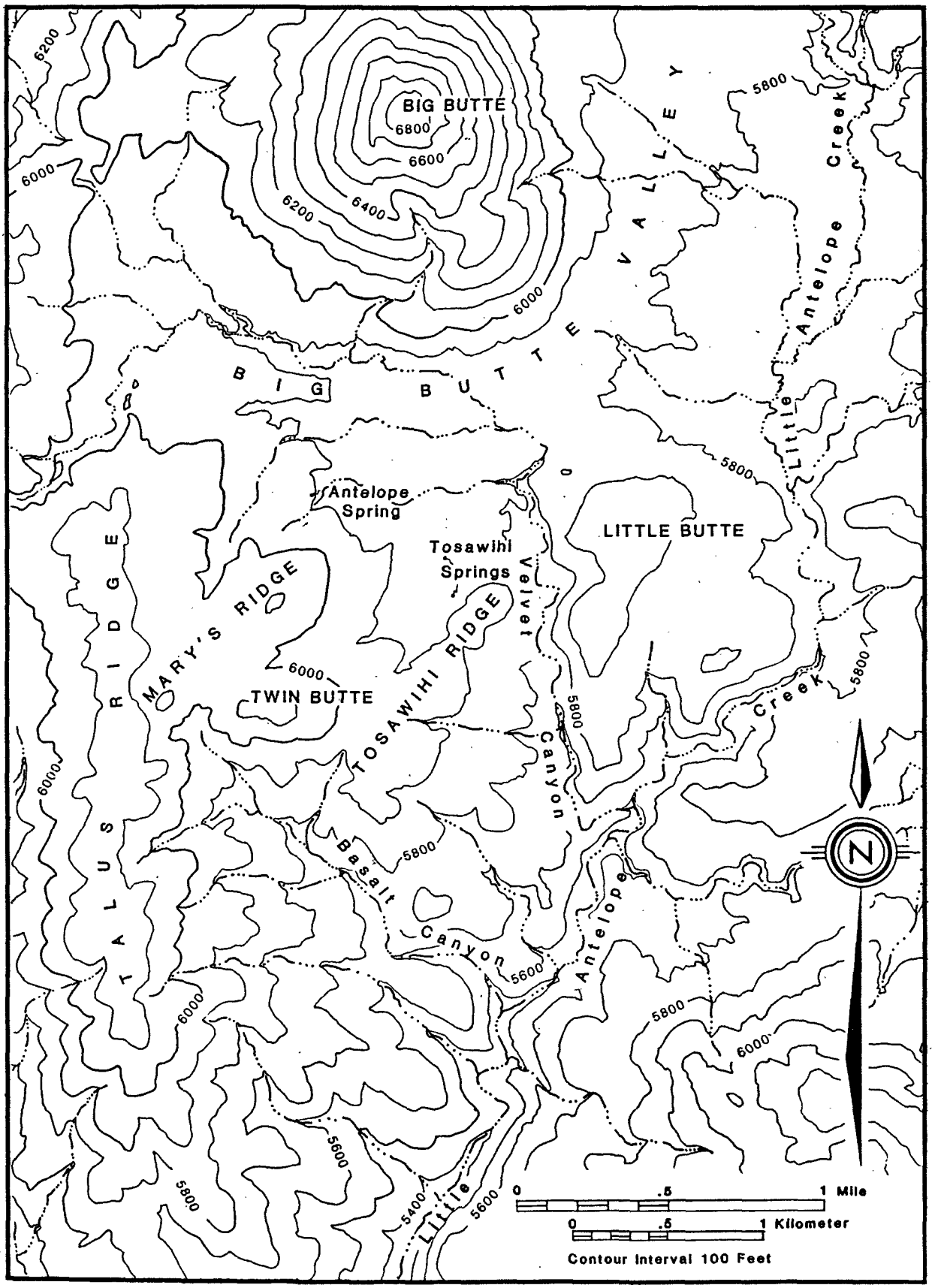

BIG BUTTE
6800
6600
6400
6200
6000
5800
5600
5400
6200
6000
BIG BUTTE VALLEY
Little Antelope Creek
Antelope Spring
Tosawihi Springs
LITTLE BUTTE
MARY'S RIDGE
TWIN BUTTE
TOSAWIHI RIDGE
Tosawihi Creek
Canyon
TALUS RIDGE
Basalt Canyon
Little Antelope
N
0 .5 1 Mile
0 .5 1 Kilometer
Contour Interval 100 Feet

Figure 7. The geography of the project area.

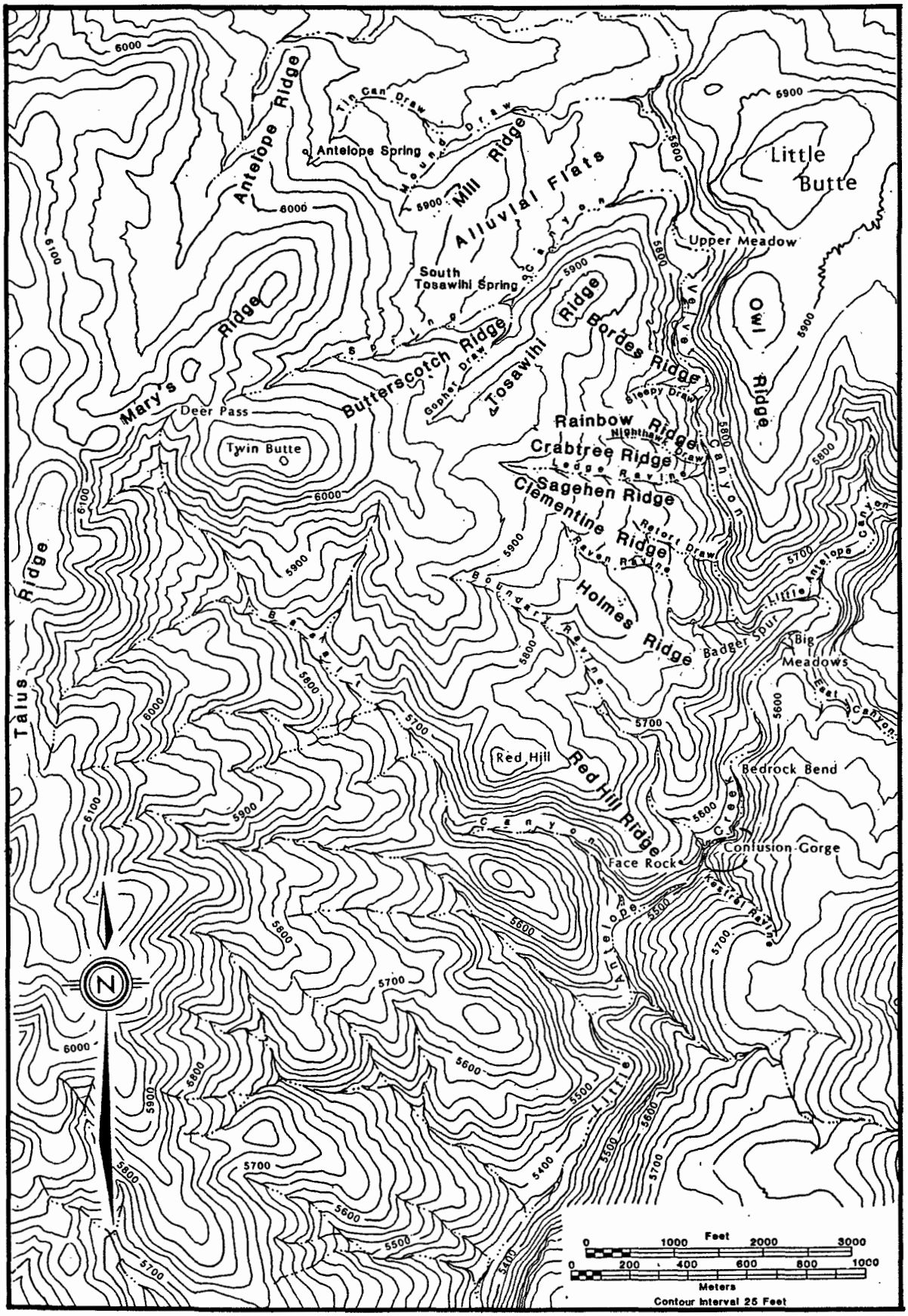
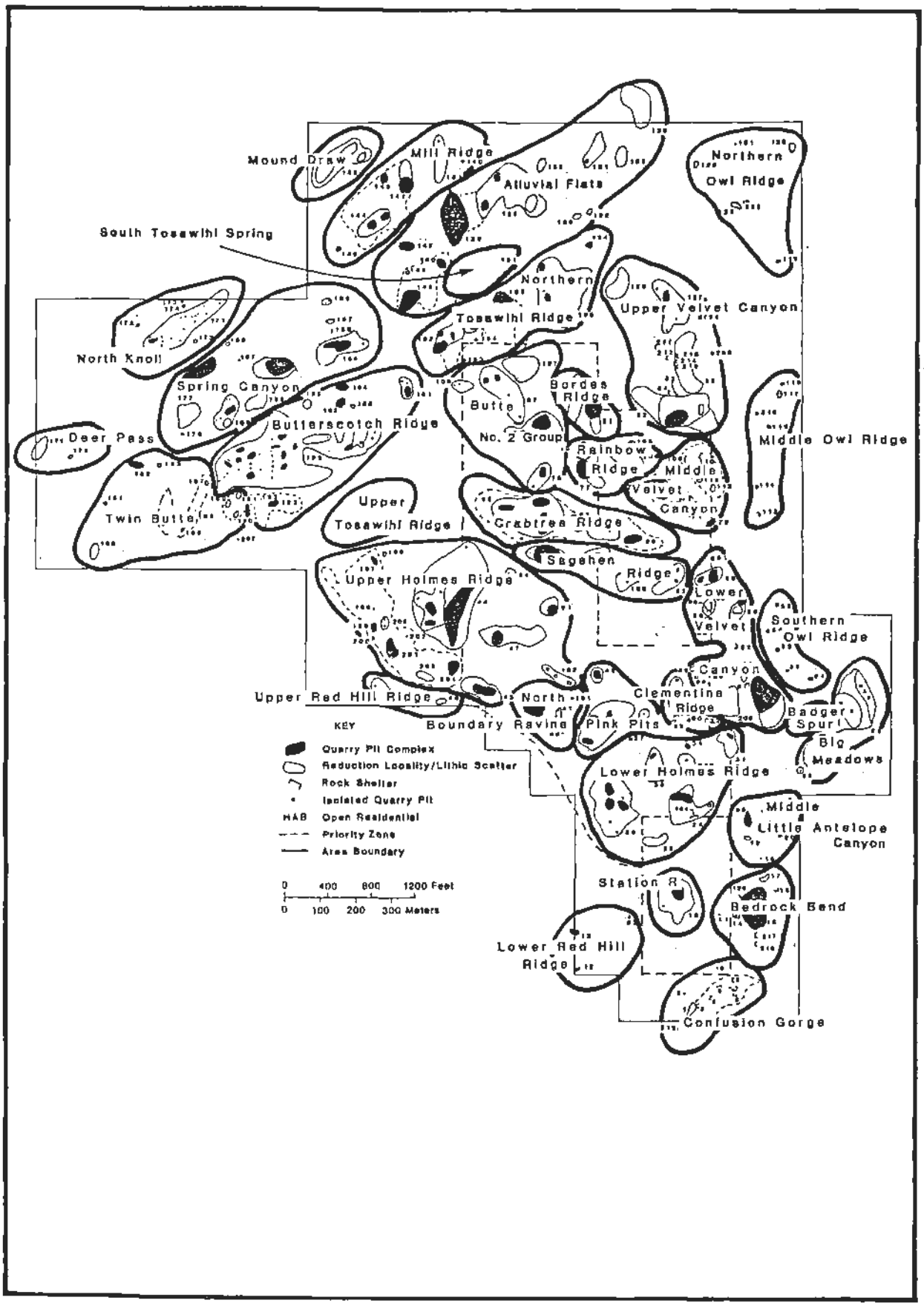

Antelope Ridge
Tin Can Draw
Antelope Spring
Mill Ridge
Alluvial Flats
Little Butte
Upper Meadow
South Tosawihi Spring
Tosawihi Ridge
Borden Ridge
Owl Ridge
Mary's Ridge
Butterscotch Ridge
Gopher Draw
Deer Pass
Twin Butte
Sleepy Draw
Rainbow Ridge
Nighthawk Draw
Crabtree Ridge
Ledge Ravine
Canyon
Sagehen Ridge
Clementine Ridge
Retort Draw
Raven Ravine
Holmes Ridge
Badger Spur
Little Antelope Creek
Big Meadows
Talus Ridge
Red Hill
Red Hill Ridge
Bedrock Bend
Confusion Gorge
Face Rock
Kestrel Ravine
Little Antelope
N
Feet
0 1000 2000 3000
0 200 400 600 800 1000
Meters
Contour Interval 25 Feet

Figure 8. Archaeological localities grouped by geographic area.


Mound Draw
Mill Ridge
Alluvial Flats
Northern Owl Ridge
South Tosawihi Spring
Northern Tosawihi Ridge
Upper Velvet Canyon
North Knoll
Spring Canyon
Butterscotch Ridge
Bordes Ridge
Butte
No. 2 Group
Rainbow Ridge
Middle Velvet Canyon
Middle Owl Ridge
Deer Pass
Twin Butte
Upper Tosawihi Ridge
Crabtree Ridge
Sagehen Ridge
Upper Holmes Ridge
Lower Velvet Canyon
Southern Owl Ridge
Upper Red Hill Ridge
North Boundary Ravine
Clementine Ridge
Pink Pits
Badger Spur
Big Meadows
Lower Holmes Ridge
Middle Little Antelope Canyon
Station R
Bedrock Bend
Lower Red Hill Ridge
Confusion Gorge
KEY
Quarry Pit Complex
Reduction Locality/Lithic Scatter
Rock Shelter
Isolated Quarry Pit
HAB Open Residential
Priority Zone
Area Boundary
0 400 800 1200 Feet
0 100 200 300 Meters

talus that appear on its slopes. Mary's Ridge is an offshoot of Talus Ridge.

The northwest shoulder of Twin Butte is connected to Mary's Ridge at Deer Pass. Mary's Ridge trends to the northeast, terminating in Big Butte Valley, and has two roughly parallel, northeast trending spurs; Antelope Ridge extends from the northern flank of Mary's Ridge, and Mill Ridge from the southern flank. Antelope Spring rises in Tin Can Draw on the east side of Antelope Ridge.

Two drainages head on the slopes of Twin Butte, one on each side of Deer Pass. The largest is Basalt Canyon, trending southeast past Red Hill Ridge, to its confluence with Little Antelope Creek south of Kestrel Ravine. The other is Spring Canyon, trending northeast past Mary's Ridge and Mill Ridge to enter Velvet Creek just above Upper Meadow in the entrance to Velvet Canyon. This drainage is fed by South Tosawihi Spring rising just downstream from the end of Butterscotch Ridge and Gopher Draw. North Tosawihi Spring, which rises at the northeastern margin of Mill Ridge, apparently flows only in winter. Grass and/or sage covered mounds of fine grained soil in the Velvet Creek drainage of Big Butte Valley, and in the highlands as well, may represent old spring locations.

Underlain by massive beds of opalite and other silicified rocks, the terrain east of Twin Butte is more subdued and has less relief than surrounding areas of more easily eroded rhyolite and basalt bedrock. The eastern flank of Twin Butte is a broad bench that slopes eastward to Velvet and Little Antelope canyons. The upper portion of the bench, between 5925 feet and 5975 feet, forms the long, northeast trending Tosawihi Ridge, parallel to Mary's Ridge. The lower slopes of the bench are dissected into several smaller east-southeast trending ridges by minor drainages. South to north, these are Basalt Canyon, Red Hill Ridge, Boundary Ravine, Holmes Ridge, Raven Ravine, Clementine Ridge, Retort Draw, Sagehen Ridge, Ledge Ravine, Crabtree Ridge, Nighthawk Draw, Rainbow Ridge, Sleepy Draw, and Bordes Ridge.

The eastern wall of Velvet Canyon rises abruptly to the crest of south trending Owl Ridge on Little Butte. Just above its confluence with Little Antelope Creek, Velvet Creek makes a sharp bend east, around the toe of Owl Ridge on the north and Badger Spur (an outlier of Holmes Ridge) on the south. In the short reach of Little Antelope Canyon between Velvet Canyon and East Canyon to the south, is Big Meadows, a series of low, broad, grassy terraces. Pools and seeps were observed in Velvet and Little Antelope Canyon through June; a perennial

spring may have been present where a stock pond now is located at Big Meadows, at the confluence of Velvet Canyon and Little Antelope Canyon.

Below Big Meadows, Little Antelope Canyon narrows. At Confusion Gorge, Little Antelope Creek flows through a deep (23 m), narrow cut in bedrock, making a bight around a bedrock spur at the confluence of Boundary Ravine on the west and Kestrel Ravine on the east. Face Rock, a monolith some 7 meters high (which resembles a human face when viewed from the north), stands on the western rimrock about 200 m southeast of Boundary Ravine.

In the following sections, the 219 archaeological localities observed in the District have been grouped tentatively on the basis of geographic proximity and geology (see Figure 8).

Basalt Canyon

Basalt Canyon is named for the basalt cropping out in talus stripes on Talus Ridge and present in stream deposits in this drainage to at least 5900 feet. The drainage apparently was the source of basalt boulders and cobbles used as hammers throughout the quarry area.

Red Hill Ridge

Red Hill Ridge, between Basalt Canyon and Boundary Ravine, is named for the bright red, iron-rich soil on much of the ridge, especially that exposed in numerous road cuts made during past mining activity. Opalite is present on Red Hill Ridge only toward its eastern end and along Boundary Ravine.

Two prehistoric localities were found on slopes near the western head of Boundary Ravine. Locality 45 is a small pit complex where relatively poor quality toolstone was quarried, while locality 46 is a discrete lithic scatter on a slope a little further downstream. Near the east end of the ridge, localities 12 and 13 are small outcrop quarries; locality 93, on a slope overlooking Boundary Ravine, is an isolated metate. Numerous other localities on Red Hill Ridge are represented by discrete flake scatters or reduction stations. Several of these were observed, but not recorded, outside the project area on benches overlooking Basalt Canyon northwest of Red Hill.

Boundary Ravine

Boundary Ravine heads in the terrain southeast of Twin Summit Hill, and trends southeast between Red Hill Ridge and Holmes Ridge for about a mile (roughly parallel to Basalt Canyon) to its confluence with Little Antelope Canyon in Confusion Gorge. This feature marks a natural divide between the opalitic and silicified rocks of the Tosawihi Quarries Archaeological District, and the red, iron-rich rhyolites and tuffs to the south.

North Boundary Ravine

Two archaeological localities on Holmes Ridge overlook the north side of Boundary Ravine. Localities 40 and 41 are adjacent (east) to a small, north-south tributary ravine, just below rim rock on the 5825 foot knoll. Locality 41 is a single quarry pit and associated lithic scatter, while locality 40 is comprised of a single quarry pit; a filled, south facing rockshelter (Boundary Shelter); other alcoves, and associated lithic scatter. The soil below the rimrock at locality 40 is grey and the place has a residential "feel" to it.

Locality 42, a small group of quarry pits at a bedrock outcrop west across the tributary ravine from locality 41, has one of the deepest quarry pits we observed. Locality 101 is an isolated quarry pit located east of locality 40.

Little Antelope Canyon

A mile-long reach of Little Antelope Canyon lies inside the project area. This reach extends from just above the confluence with Velvet Canyon to the confluence with Boundary Ravine in Confusion Gorge.

Confusion Gorge

Little Antelope Creek in Confusion Gorge was dry in late June, but apparently water had pooled there a short time before. Currant and wild rose are common along the creek bottom and along ledges of the cliffs above. Steep slopes and rocky cliffs form both sides of Confusion Gorge, but most cultural material is on the west side where Boundary Ravine cascades into the gorge. A group of localities in and adjacent to Confusion Gorge appear to be related. An isolated quarry pit (locality 2) is located on the southern edge of

Boundary Ravine, just above Confusion Gorge; poor quality chert outcrops along the rimrock between Boundary Ravine and Face Rock. Locality 216, represented by 11 bifaces discarded or forgotten below Face Rock, and a complex of discrete lithic scatters along the edge of the rimrock (locality 1) may represent material from either or both these sources. Several small rockshelters and overhangs (localities 3, 5 through 8) among the western cliffs contain small lithic scatters apparently representing reduction and biface thinning activities, and another small, discrete scatter (locality 9) occurs on a ridge slope to the north. Most of these shelters lack any depth of deposit, except Rose Leap Shelter (locality 4) which extends back into the rock at least 8 m, and seems to have considerable depth of deposit, much of which may be dry. Artifacts observed at the shelter include a metate, drill, and Cottonwood Triangular point, suggesting residential occupation.

It is worth noting that the most direct route between the Tosawihi Quarries and the Humboldt River is down Little Antelope Creek to Antelope Creek, thence to Rock Creek and on to Boulder Flat on the Humboldt. For people travelling this route, Confusion Gorge offers the first (or last) residential base close to the quarry area, although lack of water may have rendered it an undesireable place to stop in certain seasons.

Bedrock Bend

North of Confusion Gorge, Little Antelope Creek makes a sharp bend (Bedrock Bend) west around an outcrop of resistant, opalite bedrock. The outcrop contains an intensive bedrock quarry (locality 15), associated shallow rockshelters (localities 16, 126, 217, and 218), and a biface reduction station (locality 17). An isolated pit feature (locality 11) where blood-red toolstone was quarried, and a rockshelter/lithic scatter (locality 14) occur west of locality 15 on the western slope of the canyon.

Middle Little Antelope Canyon

Little Antelope Canyon is somewhat wider in its middle reach, between Bedrock Bend and the confluence with a large drainage to the east (East Canyon). Through late June, the middle reach contained several pools of water, but cultural localities are relatively sparse, limited to single pit features (including locality 18 where mustard yellow chert was obtained, as well as localities 20 and 23), a bedrock outcrop (locality 98), two streamside lithic scatters (localities 21

and 22), and a small lithic scatter with groundstone (locality 19). The latter is interesting because it occurs on a small bench well above the canyon floor and covers a very small area.

Big Meadows

In the short reach between East Canyon and Velvet Canyon, Little Antelope Canyon contains broad, grassy, meadow-like terraces, 0.5 to 1 m above the stream bed. This reach also contained pools in late June, and a large stock pond there appears to be fed by a perennial spring. Locality 26 is a small pit complex in bedrock which represents high quality toolstone. Locality 27 is series of overlapping flake scatters (at least one with groundstone) and historic debris scatters on a terrace at the confluence with East Canyon. Just below the confluence with Velvet Creek, flake scatters (locality 28) were observed on low terraces on both sides of Little Antelope Creek.

Badger Spur

Through most of its length, Velvet Creek trends south-southeast, but just before its confluence with Little Antelope Creek, it bends sharply to the east-northeast, creating Badger Spur, a narrow ridge between Velvet Creek and Little Antelope Creek, overlooking Big Meadows. Locality 29 is a small quarry pit complex exploiting high quality cream-to-light-yellow opalite. This locality seems more likely related to the terrace localities of Big Meadows than to other localities further up Velvet Canyon.

Holmes Ridge

Holmes Ridge trends southeast from the east flank of Twin Butte between Boundary Ravine on the south and Raven Ravine on the north, to Little Antelope Canyon. Station R is a contemporary mapping point established on a south trending spur off the lower end of Holmes Ridge between Boundary Ravine and Little Antelope Canyon north of Confusion Gorge. Groups of archaeological localities are abundant on Holmes Ridge; they include Station R, Lower Holmes Ridge, Pink Pits, North Boundary Ravine (described above) and Upper Holmes Ridge.

Station R

Station R, at 5707 feet, is just below the 5710 foot knoll at the end of Holmes Ridge and occurs within locality 10, where the soil contains angular, multi-colored chert cobbles and resembles an alluvial fan deposit. Locality 10 is comprised of a single large pit (probably a complex of overlapping pits) and associated lithic scatter from surface exploitation. The saddle above the knoll probably once contained a discrete lithic scatter possibly related to both localities 10 and 25, but this has been nearly obliterated by historic mining activities.

Lower Holmes Ridge

Lower Holmes Ridge comprises a number of archaeological localities above the knoll between 5705 and 5790 feet, including 24, 25, 31, 34 through 37, and 164. Locality 24 contains two pit complexes and a lithic scatter; Prospect Shelter (locality 164) is adjacent. The shelter has been disturbed by historic mining exploration, but at least 50% of the prehistoric deposits remain, and these are at least 1 m deep. Locality 25 is a series of discrete lithic scatters along a bedrock outcrop. Locality 36 is a complex of more than 55 individual quarry pits where good quality toolstone was obtained; a few pits have been disturbed by a historic road, but most of the locality is intact. Locality 35 contains quarry pits in association with a bedrock outcrop; material quality is only so-so. Locality 34 is represented by a discrete flake scatter and locality 206 by a single small quarry pit which appears to have been disturbed by past mining and road construction. Locality 31 is a place where surface lithic material exploitation occurred, involving angular, multi-colored chert cobbles in a deposit similar to that at locality 10; just down slope are four quarry pits where white to bluish white opalite was obtained.

Pink Pits

The Pink Pits area is located on the major axis of Holmes Ridge between 5770 and 5810 feet, and includes localities 38, 39, and 48. Locality 38 (the Pink Pit) is an isolated quarry pit and associated lithic scatter where the toolstone is good quality, predominately salmon pink opalite (and about 30% cream-to-buff material). A few purple flakes and a possible metate fragment also were observed here. Locality 39 comprises several relatively shallow quarry pits; material color is similar to that at locality 38, but quality is

poorer. Locality 48 is smaller in area than 39, but quarry pits are much larger and deeper; toolstone is good quality pink and buff opalite.

Upper Holmes Ridge

This is a large area containing numerous archaeological localities; while some were examined in detail and transit mapped for the present study, others were recorded only briefly. Of those transit mapped, locality 44 is the largest and most complex. Between 5880 and 5920 feet elevation, talus stripes of chert cobbles occur on the ridgetop where numerous large quarry pits appear to have been sunk into the talus and into thin colluvium over bedrock. Subsequent twentieth century minerals exploration trenches have revealed a deposit of debitage, cores, and soil at least 2 meters thick. The origin of this deposit is not understood, unless it is derived from prehistoric quarrying and reduction on the knolltop where, however, there is little surface evidence of such intensive activity.

To the east and downslope are localities 43, 47, 64 and 91. Locality 43 is a large quarry pit complex along a bedrock ridge. Locality 47 is a small complex of three adjacent quarry pits in shallow colluvium, exploiting high quality cream-to-tan opalite; bedrock is near the surface at locality 47 and surface boulders are common. A narrow stripe of surface boulders extends from locality 47 toward the east and locality 91; this area contains a moderate density lithic scatter. Locality 91 is a small quarry pit complex (7 features) excavated into colluvium between bedrock boulders. Raw material is similar to that at locality 47, but poorer quality. Locality 64 is a single quarry pit and associated lithic scatter.

Further west, overlooking Boundary Ravine, localities 196 and 200 are open lithic reduction stations. Localities 197, 201, and 204 are bedrock outcrop quarries; localities 199 and 205 are small quarry pit complexes; and locality 203 is a possible talus quarry. Localities 198 and 202 are isolated quarry pits.

Locality 102 is comprised of three discrete flake scatters (each associated with stands of big sage) in the saddle above the tributary ravine on which localities 40, 41, and 42 are located. These scatters contain mostly white opalite flakes, but a few obsidian flakes were also observed, and a point preform collected.

Clementine Ridge

Raven Ravine drains southeasterly to its confluence with Velvet Canyon, separating Clementine Ridge from Holmes Ridge to the south. In its lower reach, Raven Ravine makes a Z-shaped bend around the 5775-foot knoll at the end of Clementine Ridge. Several archaeological localities are situated on this knoll; on its southern slope above Raven Ravine are shallow rockshelter localities 88 and 89, and locality 90 where two large bifaces were observed on the top of a boulder. Raven Shelter (locality 32), near the confluence of Raven Ravine and Velvet Canyon, is a deep, possibly residential, rockshelter with potential for depth of deposit; bifaces are abundant on the apron in front of the shelter and debitage represents a range of opalite colors.

Locality 33 occupies the top and western slopes of the knoll where it is capped by unsilicified bedrock. One quarry pit occurs at the north end of the locality, while the western slopes bear a large diffuse flake scatter with numerous discrete flaking stations.

Twentieth century debris from the Clementine Mine is found in Retort Ravine, which separates Clementine Ridge and Sagehen Ridge to the north, as well as in the saddle between the knoll and the rest of Clementine Ridge.

Sagehen Ridge

Sagehen Ridge is bounded by Retort Ravine on the south and Ledge Ravine on the north. Archaeological localities on upper Sagehen Ridge include locality 62, a quarry pit complex which has been disturbed by historic mining activities, and locality 63, a complex of widely scattered quarry pits in a boulder and cobble field. Localities 100 and 104 are isolated quarry pits surrounded by moderate density lithic scatters.

Crabtree Ridge

Crabtree Ridge is bounded by Ledge Ravine on the south and Nighthawk Draw on the north. Ledge Ravine is named for the 3 m high opalite ledge exposed along the southern margin of Crabtree Ridge. Several archaeological localities are arrayed along this ledge, both along its base and in the colluvial mantle above. Locality 65 comprises several quarry pit complexes, including pits excavated into both shallow colluvium and bedrock ledges. Locality 67 is a small complex of seven quarry pits in colluvium and an adjacent moderate

density flake scatter in a stand of big sage along the ledge margin. Locality 68 is a bedrock outcrop quarry that includes a prehistoric adit in the bottom of the ledge, and an adjacent quarry pit in the colluvium below. The sheltered location at the bottom of the ledge makes residential occupation a possibility here; a fragment of groundstone was found on the berm of the quarry pit. Locality 69 is a deep pit, possibly a true vertical shaft, excavated in colluvium at the base of the ledge, and into the underlying bedrock to an undetermined depth. Locality 75, also on Crabtree Ridge, is described later with the Velvet Canyon Group.

Rainbow Ridge

Rainbow Ridge is bounded by Nighthawk Draw on the south and Sleepy Ravine on the north. Archaeological localities 77 and 103 are both small quarry pit complexes; locality 103 is remarkable for the colors of opalite (ranging from yellow through orange to red) available there. Locality 105 is an isolated quarry pit in colluvium and locality 106 is an area on the ridgetop where several small, discrete lithic scatters occur.

Bordes Ridge

Bordes Ridge is north of Sleepy Ravine. On upper Bordes Ridge, locality 81 is a quarry pit complex excavated into thin colluvium over bedrock. Material colors include grey-white with pink streaks as well as a distinctive brown, purple, and pink material. Locality 86 is a small quarry pit complex yielding opalite of salmon and cream with red streaks similar to locality 81.

The twentieth century Velvet Mine occupies a large area, mostly on upper and northern Bordes Ridge.

Velvet Canyon

Lower Velvet Canyon

Lower Velvet Canyon is the reach between Raven Ravine and Ledge Ravine. Localities 52 and 97 are small rockshelters, while locality 96 is a rockshelter with a surface lithic scatter. Just north of Raven Shelter (locality 32), on the southeastern slope of the knoll overlooking Velvet Canyon, is locality 208, a moderate density lithic scatter with no

recorded quarry pits or adits. This locality was not examined in detail during the field phase of work and needs further investigation.

On the northeastern slope of the knoll in Velvet Canyon are locality 51, a small shelter, and localities 49, 50, and 99, all discrete lithic scatters. Across Velvet Creek, on the toe of Owl Ridge, locality 30 is a very large bedrock quarry complex exploiting high quality opalite exposed there. The locality contains numerous small pits and adits excavated into the bedrock and colluvial benches; reduction debris forms a thick talus deposit on the slopes and below. This locality marks some of the most intensive prehistoric quarrying in the District.

Several archaeological localities are located on the eastern end of Sagehen Ridge in Velvet Canyon. Locality 56 is a bedrock quarry along a ledge near the bottom of Velvet Canyon. Localities 58 and 59 are smaller outcrop quarries located higher up the slope. Locality 57, Clementine Shelter, is a residential rockshelter with considerable depth of deposit. Both burned rock and groundstone, along with abundant later stage bifaces, were observed on the apron outside the shelter. Two localities are associated with a narrow bedrock ridge; a small rockshelter of undetermined type (locality 80) on the south side of the ridge is nearly filled to the ceiling, while a moderate density flake scatter and incipient quarry pits (locality 66) are found along the north side. Locality 60 contains two quarry pit complexes in a moderate density scatter; locality 61 is a possible prehistoric adit and small debitage scatter in an opalite outcrop.

Middle Velvet Canyon

Middle Velvet Canyon is the reach between the confluence of Night Hawk Ravine and Sleepy Ravine.

Localities 74 and 75 are quarry pit complexes; locality 75 is situated in a small saddle and on slopes near the end of Rainbow Ridge, while locality 74 is located further downslope to the southeast. Locality 76 is a reduction station north of locality 75, in front of a small overhang in rimrock overlooking Velvet Canyon. Locality 73 is a similar feature located southeast of locality 75 below the rimrock. Just a few meters northeast, Rainbow Shelter (locality 72) is a small residential rockshelter similar to Clementine Shelter (locality 57), with a cached metate inside, also overlooking Velvet Canyon. Yellow opalite debitage resembling material

from locality 103 on Rainbow Ridge is on the apron of the shelter. Locality 71 is a small bedrock outcrop quarry located downslope from locality 72. Localities 70, 92, and 109 are small bedrock outcrop quarries; locality 109 has been disturbed by past mining activity. Locality 110 is a small rockshelter and associated lithic scatter. Locality 111 is a small shelter, where no cultural deposits were observed, adjacent to the stream bed. Locality 112 is a small open reduction station above locality 111. Locality 113 is a small bedrock outcrop quarry near the bottom of the canyon.

Upper Velvet Canyon

Upper Velvet Canyon is the reach between Sleepy Ravine and Upper Meadow, where several intermittent springs occur along the creek bottom. The bedrock spur of Bordes Ridge north of Sleepy Ravine forces Velvet Creek into a sharp bend to the east. All archaeological localities in this reach are on the west side of the canyon. Locality 128, on the shoulder of Butte Ridge north of the twentieth century Velvet Mine, is a moderate density scatter without recorded features. Locality 82 on the end of Bordes Ridge is an intensive bedrock quarry pit complex with a pit and adit feature, six large pits excavated into the colluvium at the base of the slope, and myriad smaller pits in the upper slopes.

The lowest terrace along Velvet Creek is covered with flakes and may have served as a base for short-term residential use. Localities 85 and 127 are zones of intensive quarrying activity along bedrock ledges in Velvet Canyon north of Bordes Ridge. A thick accumulation of cultural talus (debitage, cores, and bifaces) occurs below the ledges. Locality 127 contains quarry pits excavated into colluvium on the slope below the ledge. Localities 214 and 215 are prehistoric adits into the bedrock ledge; locality 213 is a small rockshelter in the bedrock. Localities 84, 211, and 212 are small rock overhangs with associated flake scatters, although locality 84 actually may represent packrat accumulation rather than cultural deposition. Locality 83, Velvet Shelter, is the largest rockshelter site in the District. It is comprised of three adjacent chambers opening into a common mouth 30 m long; one chamber extends back at least 8 m. All three chambers are nearly filled (distance from present surface to ceiling is ca. 0.5 m) with soil and debitage. A road cut along the front of the apron shows cultural material to over a meter in depth.

Localities 124 and 209 are small flake scatters on the east side of the canyon below Owl Ridge.

Owl Ridge

Owl Ridge is a north-south trending ridge on the west side of Little Butte, above Velvet Canyon. Most of the ridge is rhyolite; opalite outcrops only in Velvet Canyon. Consequently, debitage is present only in patches of sparse density or in small discrete scatters. Small rockshelters or overhangs are present above Velvet Canyon.

Southern Owl Ridge

The southern end of Owl Ridge is narrow and steep. Localities 53, 54, 55, 94, and 95 are small flake scatters which may be related to the very large quarry pit complex at locality 30.

Middle Owl Ridge

Localities 114, 116, 117, 118, and 210 are small, discrete flake scatters on the top and west slopes of Owl Ridge. Locality 115 is a small rockshelter with associated flake scatter.

Northern Owl Ridge

Localities 119, 120, 122, and 125 are small, discrete flake scatters; locality 121 is comprised of two large bifaces sitting on a rock. Locality 123 is a small rockshelter with associated flake scatter.

Tosawihi Ridge

The localities in this group are to be found on the top and northwest slopes of Tosawihi Ridge.

Northern Tosawihi Ridge

Localities in this area overlook residential locality 151 at South Tosawihi Spring in Big Butte Valley. The presence of groundstone at several localities on the ridge give a residential appearance to the entire area. Locality 134 is an isolated quarry pit in colluvium, while locality 135 is comprised of several pit feature complexes surrounded by a moderate density scatter, disturbed in part by past minerals extraction at the Velvet Mine.

Localities 152 through 155 are a group of features which are probably closely related to each other and to locality 151, the open residential site at South Tosawihi Spring. Locality 152 is a large quarry pit complex on the top of the 5890-foot knoll at the end of Butterscotch Ridge. Just across a minor drainage to the east, locality 177 is a small quarry pit complex; locality 219 is an isolated Elko Series point within locality 177. Two metates were found in quarry pits here. In addition, localities 153 and 154 are isolated metates on the slopes above locality 152. Locality 155 is a small quarry pit complex on the slopes above southern Tosawihi Spring.

Butte No. 2 Group

The 5950-foot knoll on the southwest end of Tosawihi Ridge was one of the areas exploited most intensively in prehistoric times. Much of the prehistoric activity in the center of the knoll has been disturbed by workings of the twentieth century Butte No. 2 Mine, but several prehistoric localities were observed around the edges of the mine disturbance. Locality 108 is a badly disturbed small quarry pit complex. Locality 107 is a light-to-moderate density flake scatter in the saddle just south of Tosawihi Springs containing a wide variety of lithic materials. A feature consisting of seven bifaces and an Elko point was collected in this locality. Locality 87 is a large quarry pit complex in colluvium, also disturbed by past mining activities. Locality 79 comprises a series of shallow quarry pits excavated into weathered bedrock along a ledge outcrop. A lobe of fine-grained soil covered with grass (possibly an old spring mound) overlies the bedrock ledge on the north; several large quarry pits have been excavated (1m+) through the soil to the underlying bedrock. Locality 78 is a small quarry pit complex in shallow colluvium.

Upper Tosawihi Ridge

Localities 194 and 195 are discrete reduction stations located on upper Tosawihi Ridge below Twin Butte.

Big Butte Valley

South Tosawihi Spring

Locality 151 is a large, open, moderate density flake scatter on flats along the ephemeral Spring Canyon. Debitage includes many different opalite types; other artifacts include stage I through stage III bifaces, a mano, and firecracked rock. This locality is probably a prehistoric residential base camp which saw similar use by twentieth century miners, as evidenced by a concrete foundation, a debris scatter, and a spring box.

Alluvial Flats

Archaeological localities in southern Big Butte Valley are in alluvial flats north of Tosawihi Ridge and South Tosawihi Spring. Locality 137 is an isolated metate. Localities 132 and 133 are grassy mounds with flake scatters; locality 133 also contains a flaked stone knife fragment and bifaces. Locality 136 is a grassy mound where no surface cultural material is apparent; other grassy mounds observed bore cultural material as this one may on closer inspection. Locality 138 is a large area containing several small discrete lithic scatters that contain many different types of chert, obsidian, and basalt flakes, small bifaces, and projectile points. Localities 139, 147, 148, and 149 are boulder field quarries; locality 150 is a small quarry pit complex. Locality 129 is a moderate density flake scatter with no recorded features. Locality 130 is an undifferentiated lithic scatter in a stand of big sage. Locality 131 is a possible circular stone alignment in a moderate density scatter.

Mill Ridge

Mill Ridge is a northeast trending ridge between Spring Canyon and Mound Ravine. Archaeological localities on Mill Ridge include locality 140, an isolated metate. Locality 141 is an isolated quarry pit in a light-to-moderate density scatter with numerous bifaces. Locality 146 is a boulder field quarry. Localities 142, 143, and 144 are probably all related; 142 and 144 are quarry pit complexes, while locality 143 is a light-to-moderate density scatter of pink and white debitage.

Mound Draw

Mound Draw is on the north side of Mill Ridge. Locality 145 is comprised of three grassy mounds in the draw, each of which bears a light density lithic scatter.

Spring Canyon

Spring Canyon is a major drainage between the north side of Twin Butte and Mary's Ridge. The twentieth century Butte No. 1 mine is located on the top of a small knoll on the north side of the drainage. Locality 156 is a small pit complex in a boulder field, while locality 157 is a small outcrop quarry. Locality 158 is an isolated Desert Side-Notched projectile point. Localities 159 and 160 are quarry pit complexes along a bedrock ledge below the mine; they apparently reflect intensive prehistoric quarrying along the weathered bedrock edging a small knoll, and now are separated by Butte No. 1 mine disturbance.

Further west, locality 166 is a lithic scatter of undetermined type, locality 167 is an isolated quarry pit feature in a moderate density lithic scatter, and locality 168 is a small reduction station. Locality 170 is a quarry pit complex where the toolstone to wasterock ratio seems low. Locality 169 is a quarry pit complex associated with a grassy mound. Locality 176 is an isolated pit at the head of a cone-shaped, medium density lithic scatter.

Mary's Ridge

North Knoll

Locality 171 is a very large outcrop quarry and quarry pit complex on the southeastern slopes of Mary's Ridge below the 6105-foot knoll. Locality 175 is a small cobble quarry. Localities 172, 173, and 174 are discrete lithic scatters with abundant biface thinning flakes.

Deer Pass

When surveying this portion of the District, we flushed a mule deer in Basalt Canyon. The deer ran up the drainage and crossed into Spring Canyon over Deer Pass. Locality 179 is a small flake scatter in the pass, while locality 178 is a

complex of several small discrete, scatters on the top of a small knoll overlooking it. Both localities are probably hunting stations.

Twin Butte

Most archaeological localities on the upper slopes of Twin Butte are discrete lithic scatters or reduction stations, including localities 180, 181, 183 through 187, and 189 through 191. Locality 182 is a small outcrop quarry pit complex. Locality 207 is an isolated quarry pit near a boulder outcrop surrounded by a light density scatter of grainy off-white and pink opalite.

Butterscotch Ridge

Butterscotch Ridge, trending northeast from the eastern summit of Twin Butte, is bounded by Spring Canyon on the north and Gopher Ravine on the south. Locality 188, the largest quarry pit complex in the District, is located down the axis of the ridge. Shallow pits on the upper (west) end of the complex may be older, based on greater vegetation development and more rounded contours. Opalite of several colors was exploited here, but particularly distinctive is opaque yellow to translucent "butterscotch" material in the central part of the pit complex. Several late stage bifaces with hafting elements were noted in this locality. Locality 188 is also noteworthy for an abundance and large size of basalt hammerstones and hammerstone spalls.

Somewhat south of locality 188, locality 192 is an isolated quarry pit, and locality 193 is a small quarry pit complex. Further downslope to the northeast, localities 161, 162, and 163 are small quarry pit complexes, while locality 165 is a moderate density lithic scatter defined from survey data.

Chapter 6. PREHISTORIC LOCALITY TYPES IN THE TOSAWIHI DISTRICT

by Elizabeth E. Budy

Two hundred nineteen prehistoric localities have been been identified in the Tosawihi Quarries Archaeological District, ranging from isolated artifacts such as projectile points and grinding stones, to discrete clusters of artifacts (usually debitage), to features or clusters of features. Each locality has been assigned to one of eight general types isolated by the present study: rockshelter, open residential locus, reduction station, quarry pit, outcrop quarry, surface cobble quarry, undifferentiated lithic scatter, and isolated artifact. Subtypes have been identified among general types, as well.

Locality type and subtype definitions and assignments are the topics of the following discussion. It should be noted that the site type analysis is based on limited examination of surface cultural manifestations and, therefore, is provisional.

Open Residential Localities

Eleven localities are identified as open residential (Table 1). Habitation is inferred from abundance of tools other than bifaces, lithic raw material variety, and range of biface stages; groundstone artifacts were noted at three open residential localities.

Open residential localities are segregated according to size and geomorphic situation. Large open residential localities (ranging from 5,400 to 21,600 square meters in area) are located on stream terraces (927 and 28) or on ridges near perennial springs (107 and 151). Others (130, 138 and 145) are on grass or sagebrush-covered mounds in western Big Butte Valley. Small open residential localities range in area from 10 to 150 square meters. Two (132 and 133) are located in western Big Butte Valley on grassy mounds, while one (19) was recorded on a bench above Little Antelope Canyon. Locality 131 is, apparently, a partially buried rock circle feature, which has been designated a small open residential/ rock circle.

Table 1. Open Residential Localities.

Subtyped	Locality No.	Maximum Area (m^2)
Small Open Residential	19	10
Small Open Residential/ Soil Mound	132	150
	133	110
Small Open Residential/ Rock Circle	131	25
Large Open Residential	27	6,750
	28	21,600
	107	5,400
	151	18,000
Large Open Residential/ Soil Mound	130	6,750
	138	21,600
	145	10,200

Quarry Pit Localities

Quarry features comprise the most abundant locality types in the District. Quarry locality types are segregated according to presence or absence of useable toolstone outcrops and to extraction features.

Prehistoric toolstone procurement in quarry pit localities (n=22) focuses on extraction of subsurface raw materials; this is evident by the presence of quarry pit features where high quality opalite outcrops are absent. Numerous pits have been excavated through thin layers (10-30 cm) of colluvium into underlying weathered bedrock, others into thick colluvial deposits (upwards of 2 meters) containing sparse to abundant opalite cobbles. Quarry localities are variable in size, raw material quality, numbers and sizes of extraction pits, and numbers and kinds of artifact associations. Subtypes include isolated quarry pit, quarry pit complex, quarry pit complex/groundstone, and quarry pit complex/soil mound (Table 2).

Table 2. Quarry Pit Localities.

Subtype	Locality No.	Maximum Area (m2)
Isolated Quarry Pit	2	15
	11	100
	18	150
	20	200
	23	30
w/groundstone	38	15
	41	1,800
	64	225
	100	2,700
	101	100
	104	900
	105	25
	134	400
	141	3,600
	167	200
	176	5,400
	192	50
	197	450
	198	25
	202	225
	206	2280
	207	30
Quarry Pit Complex	10	10,000
	15	10,800
	24	9,000
	26	150
	29	2,250
	31	3,375
	35	2,700
	36	21,600
	39	24,000
	42	2,100
	43	7,200
	44	45,000
	45	2,700
Quarry Pit Complex (cont'd)	47	8,100
	48	900
	60	2,250
	62	3,500
	63	4,500
	65	24,000
	66	1,800
	67	1,350
	75	2,700
	77	3,000
	78	2,250
	81	3,375
	82	20,700
	86	3,900
	87	12,750
	91	3,600
	103	900
	108	1,350
	135	27,000
	150	375
	152	4,725
	155	1,650
	156	200
	159	6,750
	160	5,400
	161	1,800
	162	108
	163	400
	170	3,000
	188	69,000
	199	600
	205	450
Quarry Pit Complex w/Soil Mound	79	9,000
Quarry Pit Complex/Groundstone	177	3,600
Quarry Pit Complex/Soil Mound	169	4,050

Isolated quarry pits (n=22) are localities distinguished by the presence of only one excavation pit feature. Reduction debitage surrounding each pit varies in area from as little as 15 to as much as 5,400 square meters. These localities are of special interest because of their spatial limits, often distinctive opalite materials (e.g., the Pink Pit), and lack of disturbance from other kinds of quarrying activities.

Quarry pit complexes (n=46) are defined as two or more quarry pit features and their surrounding reduction debris. Pit complexes vary in size, from 150 square meters with no more than 2 pit features to 69,000 square meters with as many as 55 pits. Associated artifacts include debitage, bifaces, cores, chunks, assayed cobbles, and hammerstones. Quarry pit complexes reflect the most intensive prehistoric quarrying in the District. The largest complexes probably were utilized over the longest period of time.

A single quarry pit complex/groundstone locality represents the unique association of two metates with intensive pit quarrying above southern Tosawihi Spring. The only quarry pit complex/soil mound locality is distinguished by an enigmatic deep soil feature.

Outcrop Quarry Localities

Twenty-five localities are classified as outcrop quarries, where the primary focus of prehistoric opalite quarrying was on exposed bedrock outcrops or ledges. Quarry pits may or may not be present, but, in any case, are of secondary importance. Subtypes include small outcrop-assay quarry, small outcrop quarry, outcrop quarry complex, and adit (Table 3).

Small outcrop-assay quarries (n=7) are distinguished by debitage which reflects, primarily, raw material assay (battered bedrock, angular shatter, irregular chunks of opalite, and some primary flakes); they range from 60 to 900 square meters in area. Small, incipient quarry pits are present at locality 71.

Small outcrop quarries (n=4) range from 75 to 900 square meters in area; all lack quarry pits. Associated debitage reflects core and/or biface reduction (primary and secondary flakes, cores, bifaces); use of the local exposed bedrock is assumed.

Table 3. Outcrop Quarry Localities.

Subtype	Locality No.	Maximum Area (m^2)
Small Outcrop-Assay Quarry	12	150
	50	60
	70	600
	71	200
	92	300
	98	900
	113	150
Small Outcrop Quarry	1	900
	13	375
	59	500
	157	75
Outcrop Quarry Complex	30	11,250
	56	2,400
	68	2,250
	69	900
	85	9,000
	127	11,250
	171	16,125
	182	900
	201	1,200
	204	1,200
Adit	58	25
	61	9
	214	50
	215	50

Outcrop Quarry Complexes (n=10) are characterized by intensive exploitation of exposed bedrock at ledges or vertical faces on outcrops. Reduction debris often forms a thick talus composed of cores, bifaces, and primary and secondary flakes, as well as rejected cobbles and waste rock. Quarry pits (at localities 30, 68, 69, 85, 127 and 171) and adits (at locality 68) also may be present, but usually they are relatively small, minor components of the quarry complex.

Adits (n=4) are small tunnels excavated into bedrock outcrops for the purpose of toolstone extraction. Similar historic features occur in the Tosawihi Quarries

Archaeological District and it is sometimes difficult to distinguish between them. The four adits defined as prehistoric localities include evidence of toolstone extraction and reduction (debitage and/or bifaces, cores, extracted nodules).

Surface Cobble Quarry Localities

All surface cobble quarry localities are located on low ridges or alluvial flats in western Big Butte Valley, at the extreme northern edge of the District (Table 4). Here, poor quality opalite cobbles are mixed with natural shatter and colorful pebbles. Although most cobbles and pebbles are opalite, they seem to represent a range of colors different from those exhibited by the opalite toolstone sources throughout the larger quarry district to the south. The origin of the deposits and the prehistoric extraction/ processing technology used at surface cobble quarries remains enigmatic at this time.

Table 4. Surface Cobble Quarry Localities.

Subtype	Locality No.	Maximum Area (m^2)
Small Cobble-Assay Station	148	100
	175	100
	193	300
Surface Cobble Quarry	139	9,000
	142	1,575
	143	225
	144	4,500
	146	300
	147	1,350
	149	3,375

Small Cobble-Assay Stations (n=3) are discrete areas covering less than 300 square meters. Quantities of shatter and assayed cobbles indicate a focus on raw material assay.

Surface Cobble Quarries (n=10) are components of cobble-boulder fields characterized by light-to-moderate density flake scatters and quantities of natural shatter; some

localities (142 and 144) have shallow quarry pits. Surface cobble quarries are generally quite large (averaging about 2,900 square meters in area), but range in area from 225 to 9,000 square meters. Artifacts suggest that surface cobbles were assayed and some raw materials reduced on-site.

Reduction Station Localities

Reduction station localities evidence little or no on-site quarrying; rather, they represent small concentrations of lithic reduction debris that includes cores, primary and secondary flakes, bifaces, biface thinning flakes, and chunks of raw material. Some of these may reflect brief, isolated episodes of tool reduction; others probably reflect several such visits. Since tool reduction often is embedded in other activities (such as hunting) that leave a less visible archaeological record, the primary functions of these sites may not be evident from surface observations. Reduction station localities are listed in Table 5 below.

Small reduction stations (n=36) are discrete debitage scatters ranging from 1 to 300 square meters in area. One locality (84) was identified as a small reduction station/ secondary deposition because of the possibility that the cultural material there may have been accumulated by pack rats. Another locality (183) is defined as a small reduction station/soil mound due to its proximity to a grassy soil mound.

Reduction station complex localities (n=10) are defined as two or more adjacent, discrete reduction stations (102 and 106) or as apparent overlapping accumulations of reduction debitage in areas where no on-site quarry source was noted. One locality (25) was further segregated as a reduction station complex/outcrop assay, due to extensive assaying along a poor quality outcrop ledge where many flaking stations were noted.

Rockshelter Localities

Rockshelters are localities where protection from the elements is offered by overhangs at the bases of cliffs, in cliff faces, or rock outcrops. Some rockshelters are true caves, deeper than they are wide. In the Great Basin, rockshelters saw residential use, as well as providing short-term protection from the elements while task-specific activities were in progress; they also were employed as goods caches and as burial chambers. Based on surface indications, the first two uses are represented at Tosawihi.

Table 5. Reduction Station Localities.

Subtype	Locality No.	Maximum Area (m^2)
Small Reduction Station	9	300
	21	100
	22	5
	34	345
	37	10
	53	25
	54	225
	55	10
	94	3
	99	2
	112	28
	114	16
	116	100
	119	2
	122	25
	124	15
	125	225
	168	225
	172	4
	173	100
	174	100
	179	25
	181	20
	184	4
	185	10
	186	1
	187	4
	189	90
	190	300
	191	25
	194	4
	195	9
	196	1
	200	25
	209	5
	216	20
Small Reduction Station/ Secondary Deposition(?)	84	2
Small Reduction Station/ Soil Mound	183	6

Table 5, continued.

Subtype	Locality No.	Maximum Area (m^2)
Reduction Station Complex	17	450
	33	2,700
	46	600
	74	600
	102	6,000
	106	3,600
	120	600
	178	4,050
	180	1,000
	203	1,400
Reduction Station Complex/ Outcrop Assay	25	2,250

Thirty-five rockshelter localities are segregated into six subtypes: residential, rockshelter complex/residential, reduction station, assay station, undetermined type, undetermined type/adit (Table 6).

Four rockshelter/residential localities appear to have potential for significant buried cultural deposits and may contain habitation features and artifacts. Tools (bifaces, projectile points, and/or groundstone) found on the surface at Clementine, Raven, Rainbow, and Rose Leap shelters are indicators of residential use.

Two rockshelters are designated as rockshelter complex/residential types. Velvet and Boundary shelters are complexes of several adjacent shelters; in each case, one shelter in the group demonstrates evidence of cultural deposition (but no tools were found on the surface).

Rockshelter subtypes with small alcoves, bedrock floors, and only limited associated reduction debitage or assay materials are designated as rockshelter/reduction station (n=17) and rockshelter/assay station (n=1).

Table 6. Rockshelter Localities.

Subtype	Locality No.	Maximum Area m^2
Residential		
(Rose Leap Shelter)	4	200
(Raven Shelter)	32	70
(Clementine Shelter)	57	200
(Rainbow Shelter)	72	150
Rockshelter Complex/ Residential		
(Boundary Shelter)	40	*1800
(Velvet Shelter)	83	900
Reduction Station	3	50
	5	25
	6	15
	7	50
	8	15
	14	50
	16	10
	51	75
	73	75
	76	45
	88	50
	89	50
	110	25
	115	10
	123	35
	126	50
	210	10
Assay Station	111	50
Undetermined Type	52	75
	80	15
	96	50
	97	75
(Prospect Shelter)	164	25
	211	50
	212	50
Undetermined Type/Adit	109	75
	213	50
	217	20
	218	25

* includes area surrounding rockshelter.

At eight localities designated Rockshelter/undetermined type, depth of deposit is unknown and surface evidence of function is lacking. For instance, localities 80 and 97 both show potential for deep deposits, and historic disturbance at Prospect Shelter (locality 164) suggests at least one meter of deposits. However, functionally diagnostic artifacts are not present on the surface at any of the three localities. One enigmatic rockshelter/undetermined type/adit also has a possible prehistoric adit feature.

Undifferentiated Lithic Scatters

Seven localities are lithic scatter/undetermined type; two more have been designated lithic scatter/undetermined type/ soil mound (Table 7). Locality 118 is associated with a sagebrush-covered mound on the crest of Owl Ridge; locality 136 is on a grassy mound in the alluvial flats of Big Butte Valley. Undifferentiated lithic scatters include moderate density debitage scatters where no features were observed during transect survey, as well as possible short-term habitation loci on ridge tops and saddles.

Table 7. Undifferentiated Lithic Scatters.

Subtype	Locality No.	Maximum Area (m^2)
Undetermined Lithic Scatter	49	525
	117	300
	128	3,375
	129	1,800
	165	400
	166	3,375
	208	5,000
Undetermined Lithic Scatter/ Soil Mound	118	81
	136	1,200

Isolated Artifacts

Ten localities consist of only one to three artifacts each (Table 8). Two localities are projectile points collected near recorded features; they were assigned discrete locality numbers to provide reference in mapping notes and

artifact catalog. Five are isolated metates (significant given the rarity of groundstone in the District), and three are collections of two or three bifaces found in unusual contexts.

Table 8. Isolated Artifact Localities.

Locality No.	Artifact Type	Description
90	Biface	White Chert, Stage II (n=2)
93	Groundstone	Metate fragment (n=1)
95	Biface	White Chert (n=3)
121	Biface	White Chert (n=2)
137	Groundstone	Metate fragment (n=1)
140	Groundstone	Metate fragment (n=1)
153	Groundstone	Metate fragment (n=1)
154	Groundstone	Metate fragment (n=1)
158	Projectile Point	Obsidian Desert Side-notched (n=1) (collected)
219	Projectile Point	Obsidian Elko Series (n=1) (collected)

Summary

The 219 localities recorded in the Tosawihi Quarries Archaeological District are summarized in Table 9, below.

Table 9. Summary of Localities by Type

Open Residential Localities (n=1)	
Small Open Residential	1
Small Open Residential/Soil Mound	2
Small Open Residential/Rock Circle	1
Large Open Residential	4
Large Open Residential/Soil Mound	3
Quarry Pit Localities (n=70)	
Isolated Quarry Pit	22
Quarry Pit Complex	46
Quarry Pit Complex/Groundstone	1
Quarry Pit Complex/Soil Mound	1

Table 9, continued.

Outcrop Quarry Localities (n=25)	
Small Outcrop Quarry	4
Small Outcrop-Assay Quarry	7
Outcrop Quarry Complex	10
Adit	4
Surface Cobble Quarries (n=10)	
Surface Cobble Quarry	7
Small Surface Cobble Assay Quarry	3
Reduction Station Localities (n=49)	
Small Reduction Station	36
Small Reduction Station/Secondary Deposition	1
Small Reduction Station/Soil Mound	1
Reduction Station Complex	10
Reduction Station Complex/Outcrop Assay	1
Rockshelter Localities (n=35)	
Residential	4
Rockshelter Complex/Residential	2
Reduction Station	17
Assay Station	1
Undetermined Type	7
Undetermined Type/Adit	4
Undifferentiated Lithic Scatters (n=9)	
Lithic Scatter (Undetermined Type)	7
Lithic Scatter (Undetermined Type/ Soil Mound	2
Isolated Artifacts (n=10)	
Biface(s)	3
Groundstone	5
Projectile Point	2
Total	219

Chapter 7. ARCHAEOLOGICAL LOCALITIES WITHIN THE PRIORITY STUDY ZONE

by Robert G. Elston

The major goal of the second phase of field work was to characterize archaeological variability in the priority study zone (see Chapter 4), particularly among quarry pits and outcrop quarries. Quarry features are not only the most abundant classes of archaeological phenomena in the priority zone, but are crucial to an understanding of prehistoric lithic quarrying and processing throughout the District.

We prepared transit maps of 28 prehistoric localities in the priority zone, as well as detailed descriptions, maps, and profiles of 41 archaeological features within those localities. Localities sampled are given in Table 10. Geographic areas represented include several localities on Holmes Ridge: Station R, Lower Holmes Ridge, Pink Pits, North Boundary Ravine, and Upper Holmes Ridge. Other areas sampled were Lower Velvet Canyon, Sagehen Ridge, Crabtree Ridge, Middle Velvet Canyon, Rainbow Ridge, Bordes Ridge, Upper Velvet Canyon and Butte No. 2 Group.

A second problem addressed was presented by the veneer of debitage overlying the surface nearly everywhere throughout the District (Figure 9). While convinced that most of this material had been generated by assaying, quarrying, and processing, and further scattered by various geologic and biotic processes, we were concerned that some of it might reflect non-quarry related activities. Predicting where such evidence was most likely became a process of elimination. We assumed that residues of non-quarry activity would be hopelessly masked by moderate-to-heavy density quarry-related debitage, or by historic mining disturbance. We further assumed that little or no <u>in situ</u> material exists on slopes greater than 5%, leaving for consideration the flatter portions of ridge crests (benches and saddles) in sparse-to-light density areas. Four such "areas of special interest" (L1 through L4) were chosen for investigation (Figure 10).

In addition, density plots revealed small areas of moderate density debitage unassociated with transect-recorded quarry features. In order to understand what prehistoric activities these localities represented, four (M1 through M4) were also chosen for further investigation (Figure 10).

Table 10. Archaeological Localities by Type and Area In Priority Zone

* Locality transit mapped, plans and profiles prepared.

Confusion Gorge

9 - Small Reduction Station

Lower Red Hill Ridge

12 - Small Outcrop - Assay Quarry
13 - Small Outcrop Quarry
93 - Isolated Artifact

Station R

* 10 - Quarry Pit Complex

Bedrock Bend

11 - Isolated Quarry Pit

Lower Holmes Ridge

* 24 - Quarry Pit Complex
* 25 - Reduction Station Complex/Outcrop Assay
* 31 - Quarry Pit Complex
* 34 - Small Reduction Station
* 35 - Quarry Pit Complex
* 36 - Quarry Pit Complex
37 - Small Reduction Station
164 - Rockshelter (undetermined type) - Prospect Shelter
206 - Isolated Quarry Pit

Pink Pits

* 38 - Isolated Quarry Pit
* 39 - Quarry Pit Complex
* 48 - Quarry Pit Complex

Table 10, Continued.

North Boundary Ravine

40 - Rockshelter (Residential)/Quarry Pit
41 - Isolated Quarry Pit
* 42 - Quarry Pit Complex
101 - Isolated Quarry Pit

Upper Holmes Ridge

* 43 - Quarry Pit Complex
* 44 - Quarry Pit Complex
* 47 - Quarry Pit Complex
* 64 - Isolated Quarry Pit
* 91 - Quarry Pit Complex
*102 - Reduction Station Complex

Clementine Knoll

32 - Rockshelter (Residential) - Raven Shelter
33 - Reduction Station Complex
88 - Rockshelter (Reduction Station)
89 - Rockshelter (Reduction Station)
90 - Isolated Artifact

Lower Velvet Canyon

49 - Lithic Scatter (undetermined type)
50 - Small Outcrop - Assay Station
51 - Rockshelter (Reduction Station)
57 - Rockshelter (Residential) - Clementine Shelter
58 - Adit
59 - Small Outcrop Quarry
* 60 - Quarry Pit Complex
61 - Adit
66 - Quarry Pit Complex
80 - Rockshelter (undetermined type)
99 - Small Reduction Station
208 - Lithic Scatter (undetermined type)

Table 10, Continued.

Sagehen Ridge

* 62 - Quarry Put Complex
* 63 - Quarry Pit Complex
100 - Isolated Quarry Pit
104 - Isolated Quarry Pit

Crabtree Ridge

* 65 - Quarry Pit Complex
* 67 - Quarry Pit Complex
* 68 - Outcrop Quarry Complex
* 69 - Outcrop Quarry Complex

Middle Velvet Canyon

70 - Small Outcrop Quarry - Assay Quarry
71 - Small Outcrop Quarry - Assay Quarry
72 - Rockshelter (Residential) - Rainbow Shelter
73 - Rockshelter (Reduction Station)
74 - Reduction Station Complex
75 - Quarry Pit Complex
76 - Rockshelter (Reduction Station)
92 - Small Outcrop - Assay Quarry
109 - Rockshelter (undetermined type/adit)
*110 - Rockshelter (Reduction Station)
111 - Rockshelter (Assay Station)
*112 - Small Reduction Station
113 - Small Outcrop - Assay Quarry

Rainbow Ridge

* 77 - Quarry Pit Complex
103 - Quarry Pit Complex
105 - Isolated Quarry Pit
106 - Reduction Station Complex

Bordes Ridge

* 81 - Quarry Pit Complex
86 - Quarry Pit Complex

Table 10, Continued.

Upper Velvet Canyon

* 82 - Quarry Pit Complex

Northern Tosawihi Ridge

*153 - Isolated Artifact
*154 - Isolated Artifact

Butte No. 2 Group

* 78 - Quarry Pit Complex
* 79 - Quarry Pit Complex
* 87 - Quarry Pit Complex
 107 - Large Open Residential
 108 - Quarry Pit Complex

Figure 9. Surface debitage density in the Tosawihi Quarries Archaeological District.

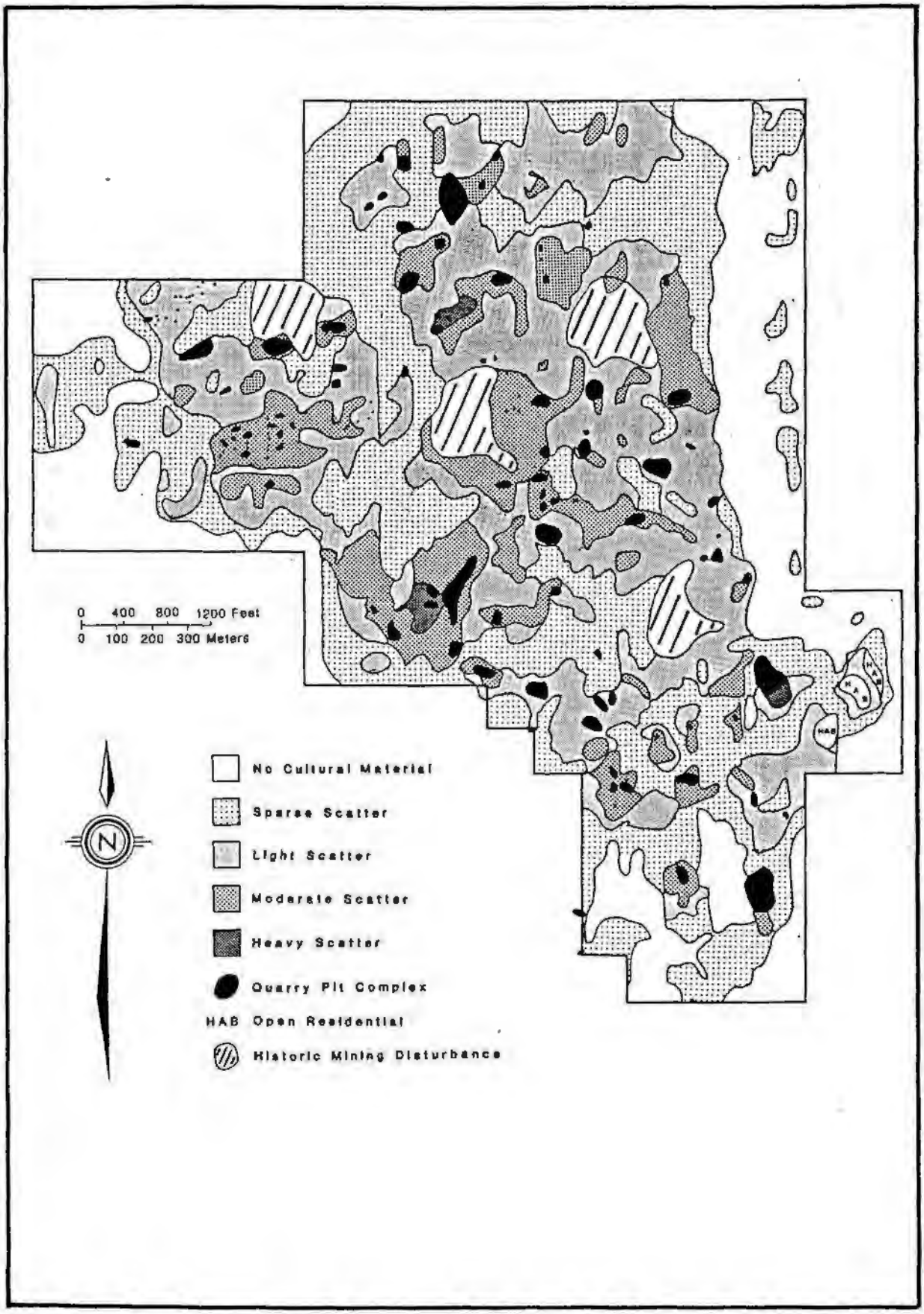
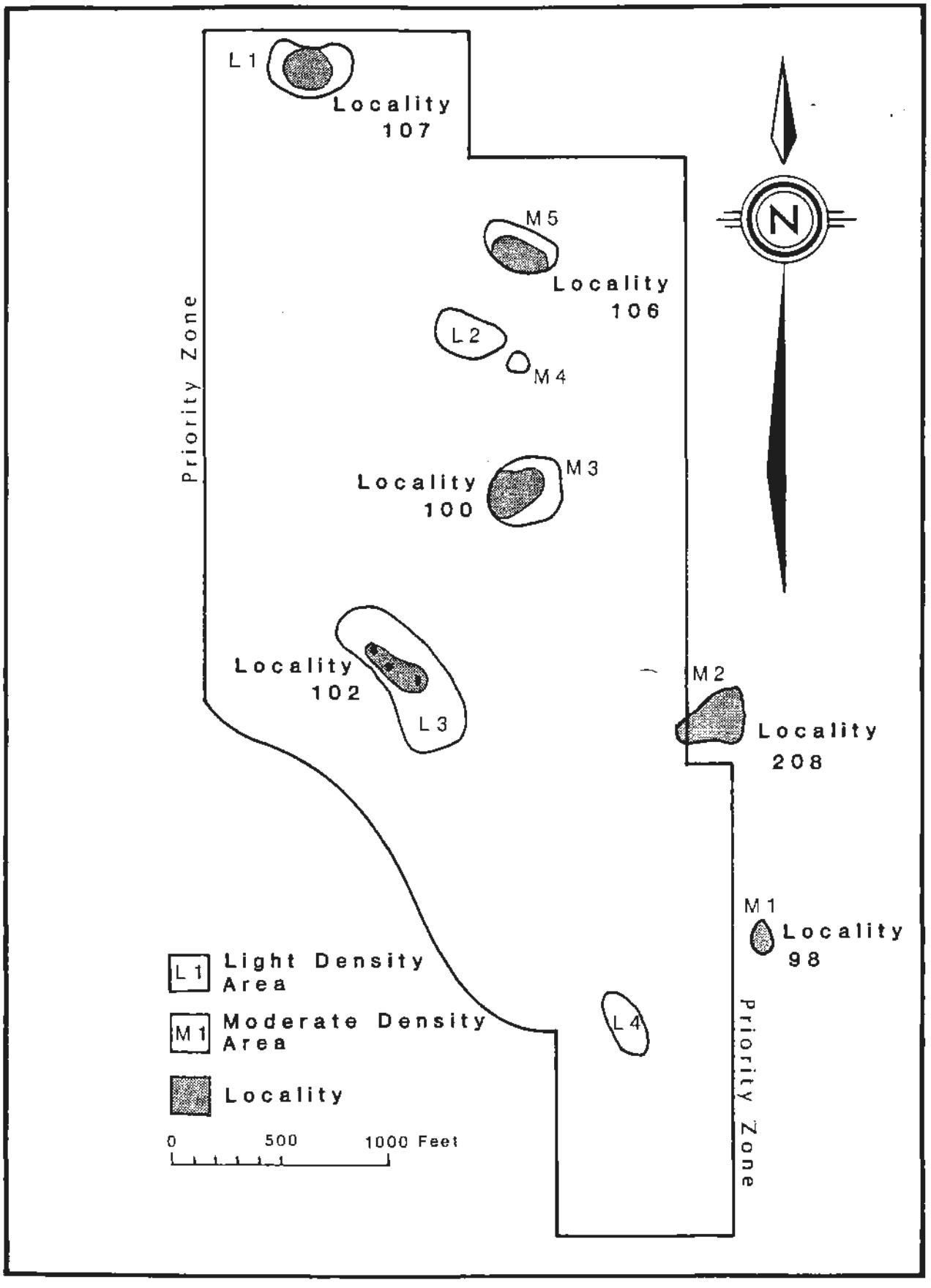

0 400 800 1200 Feet
0 100 200 300 Meters
N
No Cultural Material
Sparse Scatter
Light Scatter
Moderate Scatter
Heavy Scatter
Quarry Pit Complex
HAB Open Residential
Historic Mining Disturbance

Figure 10. Moderate and light density areas selected for investigation.


L1
Locality 107
M5
Locality 106
L2
M4
M3
Locality 100
Priority Zone
Locality 102
L3
M2
Locality 208
M1
Locality 98
L4
Priority Zone
N
L1 Light Density Area
M1 Moderate Density Area
Locality
0 500 1000 Feet

In the following discussion, the distribution of archaeological locality types in the priority zone are compared to the District as a whole, and then variability among the localities selected for closer study is examined.

Distribution of Prehistoric Locality Types

Of the total 823 acres comprising the Tosawihi Quarries Archaeological District, the priority zone comprises 215 acres, or 26%. However, 35% of all prehistoric localities in the District lie inside the priority zone boundary. The density of prehistoric localities inside the priority zone is 0.36 localities per acre, as opposed to 0.23 localities per acre outside the zone.

Moreover, the proportions of locality types are different inside and outside the zone. These are compared in Table 11, where proportions for the District overall also appear. The greatest difference between the two populations is the much higher proportion of quarry pit localities in the priority zone (45%) compared to the District outside the zone (25%).

Table 11. Proportions of Prehistoric Locality Types in the Tosawihi Quarries Archaeological District

	Outside Priority Zone			Inside Priority Zone			Total District	
	Observed	%	Expected	Observed	%	Expected	N	%
Open Residential	10	7.0	(7.1)	1	1.0	(3.9)	11	5.0
Quarry Pit	35	25.0	(45.4)	35	45.0	(24.6)	70	32.0
Outcrop Quarry	14	10.0	(16.2)	11	14.0	(8.8)	25	11.0
Surface Cobble Quarry	10	7.0	(6.5)	0	-	(3.5)	10	5.0
Reduction Locality	39	27.0	(31.8)	10	13.0	(17.2)	49	22.0
Rockshelter	21	15.0	(22.7)	14	18.0	(12.3)	35	16.0
Lithic Scatter	7	5.0	(5.8)	2	3.0	(3.2)	9	4.0
Isolated Artifact	6	4.0	(6.5)	4	5.0	(3.5)	10	5.0
Total	142	65.0		77	35.0		219	

Within the priority zone, 69% of archaeological localities are quarry-related, but only 35% of localities outside the zone are quarry pits or outcrop quarries. This is due in large part to the more dissected geomorphology of the priority zone with its ridges, canyons, and ravines. More opalite bedrock outcrops are exposed in the terrain east of Tosawihi Ridge and colluvial fragments are rich in toolstone fragments.

Differences of lesser magnitude include lower proportions of open residential, surface cobble quarry, and reduction localities inside the priority zone compared to the remainder of the District; on the other hand, rockshelters are somewhat more abundant inside the priority zone. Again, these differences most likely are related to differences in geology and geomorphology. For instance, rockshelters tend to be found in bedrock outcrops of canyons and ravines typical of the priority zone, while open residential localities and surface cobble quarries are found in the flatter, alluvial areas that occur outside the priority zone.

The significance of differences between the two populations were tested statistically using the chi-square two sample test (Blalock 1979:279-292). The observed and expected frequencies given in Table 11 were used to construct a chi-square table with seven degrees of freedom. Since 25% of the cells in the table had low values (less than 5), the table was adjusted using the correction for continuity (Blalock 1979:290-291). The null hypothesis is that there is no difference between prehistoric locality populations inside and outside the priority zone. The chi-square value was 17.332, above the critical value of 14.067 for rejection of the null hypothesis at the 0.05 level. Therefore, the two populations are different.

As discussed in Chapter 6, the major types of prehistoric localities are divided further into subtypes. The proportions of these in the priority zone are given in Table 12.

Table 12. Frequency of Prehistoric Locality Subtypes in Priority Zone.

		Priority Zone (26% of Total)	
		N	%
Open Residential		1	1.0
Quarry Pit	35		45.0
Isolated		8	10.0
Quarry Pit Complex		27	35.0
Outcrop Quarry	11		14.0
Small Outcrop-Adit Quarry		5	6.0
Small Outcrop Quarry		2	3.0
Outcrop Quarry Complex		2	3.0
Adit		2	3.0
Surface Cobble Quarry		0	-
Reduction Locality	10		13.0
Small Reduction Station		5	6.0
Reduction Station Complex		4	5.0
Others		1	1.0
Rockshelter	14		18.0
Residential		3	4.0
Residential Complex		1	1.0
Reduction Station		6	8.0
Undetermined Type		3	3.0
Other		1	1.0
Undifferentiated Lithic Scatter	2		3.0
Isolated Artifacts	4		5.0
Total	77		

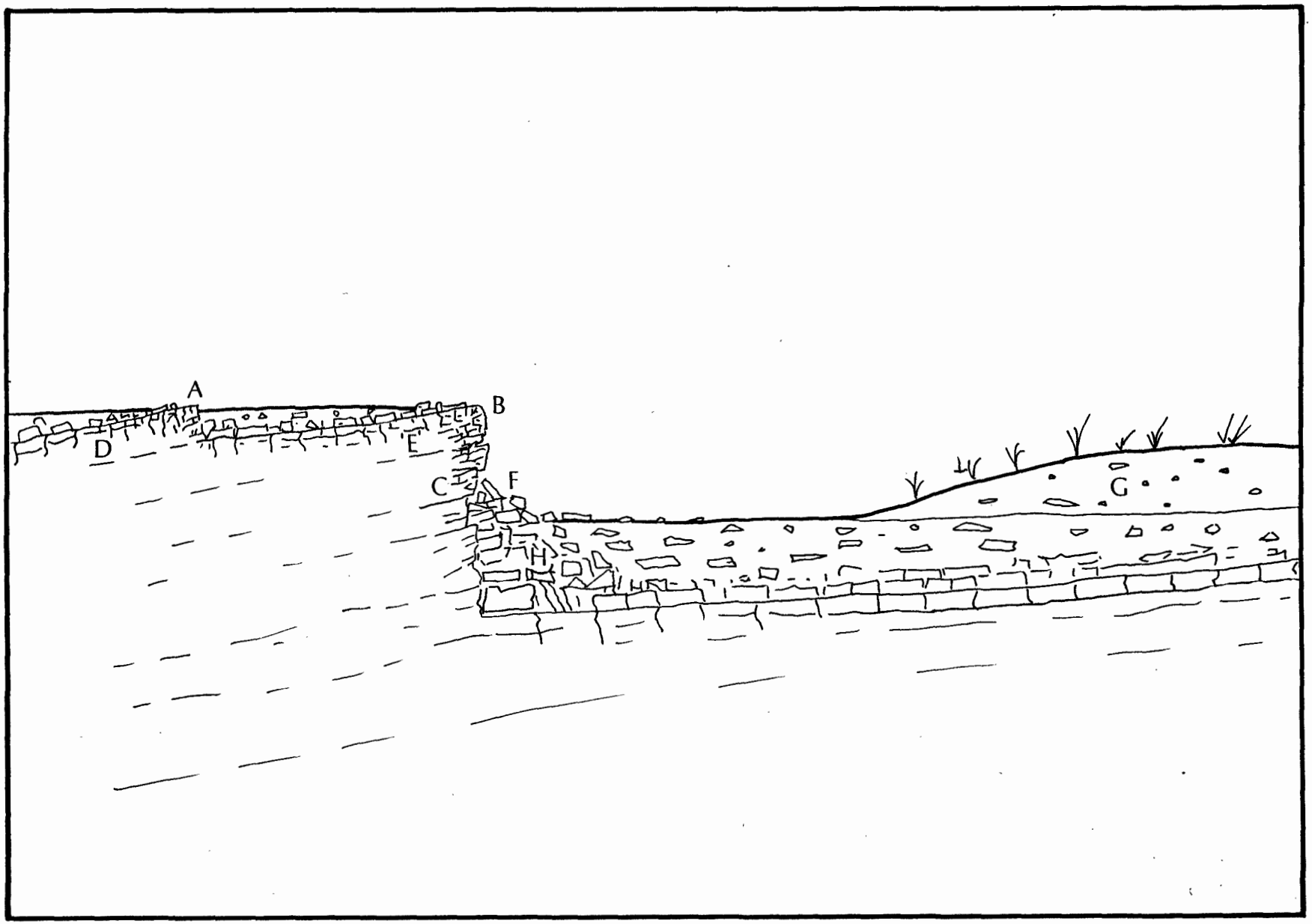
Raw Material Sources and Quarrying Strategies

It was as true in prehistoric times as it is now: the strategies used to extract and process any valuable mineral are determined by the available technology and the nature of the ore. In the quest for opalite toolstone, prehistoric technology involved simple tools such as wooden (or possibly antler) digging sticks, wedges and levers, stone hammers, basketry or hide containers powered only by human muscle. Fire was used to improve the workability of toolstone once extracted, and it may have been used to help break up rock at Tosawihi.

Ultimately, all the opalite raw material in the District is derived from bedrock. Sometimes the bedrock is exposed at the surface (Figure 11a, b), and one might suppose that the most productive sources of opalite would be surface outcrops. However, surface opalite is exposed constantly to chemical weathering, winter freeze-thaw cycles, summer heating and cooling, and wild fire so that surface material is flawed by extensive cracking and spalling, tending to break into small, irregular pieces. Thermal excursions build up mechanical stresses in these fragments, making controlled flaking difficult or impossible. Quarrying bedrock exposed at the surface requires removal of the cracked and stressed outer material to expose less weathered stone; then, some means of breaking up the tough, massive, inner rock is necessary. Thus, exploitation of surface bedrock outcrops is costly in terms of time and effort. One might expect intensive bedrock quarrying only under certain conditions which make the effort worthwhile: the quality of the toolstone must be high, and it is helpful if geologic processes work fast enough to remove the weathered rock as it is formed (running water is particularly effective), and/or the rock is somewhat protected from weathering on vertical faces or under slight overhangs (Figure 11c). Large cracks in the rock are helpful to the quarrying process; surfaces with myriad small cracks are useless.

Bedrock covered by colluvium is protected from weathering to various degrees. Generally, the rate of weathering decreases with depth, and eventually stops altogether. Colluvium is formed as bedrock weathers and breaks up into angular pieces and ultimately into sand, silt, and clay-sized particles usually thought of as soil (although much of the soil-sized material in the colluvium of the District probably has been deposited there by eolian processes). The largest fragments generally are found nearest the bedrock. Thus, the

Figure 11. Schematic cross-section showing toolstone sources.


A
B
C
D
E
F
G
H

closer bedrock is to the surface, the more abundant are cobble and boulder-sized opalite fragments suitable for manufacture of stone tools (Figure 11d, e).

In terms of prehistoric technology, extracting pieces of opalite from colluvium is much less difficult than mining massive surface outcrops; one need only dig up the already broken pieces. Some of these may be large and require further reduction, but this is a less difficult problem technically than opening adits or shafts into solid bedrock.

Talus is colluvium composed entirely of cobble-to-boulder-size particles. Talus often accumulates at the bases of cliffs (Figure 11f) and steep slopes, and in long streams or "stripes" on slopes perpendicular to contours. If the particles are relatively unweathered, talus may be a good source of easily extracted toolstone; one might even expect such talus to be the first source to be exploited in a given area.

Where bedrock is more deeply buried, and plants have trapped quantities of wind-blown sediments, opalite fragments are much less abundant and smaller in average size (Figure 11g). Unless the opalite is very good quality, it may not be worthwhile to extract it from such deposits.

The extraction of toolstone from loose, unconsolidated colluvium has its problems. Shoring apparently was not part of prehistoric quarrying technology, so pit walls were sloped to prevent slumping, resulting in conical quarry pits. When toolstone is concentrated at depth, a large amount of relatively unproductive overburden must be removed before "paydirt" is reached. At some point, a conical pit becomes uneconomical to work further and must be abandoned.

In order to minimize this problem, prehistoric miners are likely to have followed two strategies. One strategy would be to exploit colluvial deposits in a particular thickness range: not too shallow (avoiding highly weathered rock), but not too deep (avoiding removal of too much unproductive overburden). Another strategy would be to exploit colluvial deposits in which toolstone abundance varies little with depth. Such deposits often are found below vertical bedrock outcrops where the bedrock face contributes stone fragments at a constant rate (Figure 11h). Of course, none of these strategies should be thought of as mutually exclusive; as we shall see, toolstone sources and the means used to exploit them grade into one another.

Toolstone Quality

We assume that toolstone quality was an important factor in prehistoric decisions regarding whether or not to quarry a particular source of toolstone, and which extraction strategies to employ. By quality, we mean the combination of factors that contribute to the workability and durability of the material. Tool manufacture by flaking (knapping) requires non-crystalline or cryptocrystalline material that is without texture or grain, and is isotropic, or able to fracture in any direction. The presence of voids, crystals or fracture planes, or, as previously discussed, strains in the rock set up by mechanical or thermal stress, reduce control in flaking. Material with these defects usually is avoided in assay or initial reduction, but heat treatment (slowly heating and cooling the rock) often can improve the isotropic behavior of even very poor material. Toolstone should be brittle (in order for knapping to be possible), breaking with a sharp edge, and yet be durable or resistant to wear. Raw material size is a consideration; obviously, large tools cannot be made from pebbles.

It is not often that a particular lithic raw material meets all these criteria, but Tosawihi opalite comes close. Large pieces of it can be obtained, much of it perfectly free of voids and fracture planes. Some opalite contains embedded quartz grains ranging from less than 0.25 mm to 2.0 mm in diameter. These grains do not appear to affect the flaking qualities of the material at the level of quarrying and initial processing that employs hard hammer percussion, and they are likely to enhance durability of edges. The quartz grains might influence reduction at later stages employing soft hammer or pressure techniques. In any case, quartz grains give some Tosawihi opalite (perhaps 25%) a characteristic "glittery" surface.

Tosawihi opalite is not brittle, but tough and resistant to breakage. Consequently, great force must be used to detach flakes from opalite cores; one must use a massive hammerstone and swing it hard. The platform of virtually every primary or secondary reduction flake examined by the present study exhibits multiple ring cracks, indicating the knapper struck the platform several times before getting a flake to come off. This suggests that quarrying and initial reduction of Tosawihi opalite was laborious and possibly difficult to control.

Fortunately, heat treatment not only enhances isotropism, but greatly reduces the amount of force required for flaking. Heat treated Tosawihi opalite has excellent knapping

properties. However, we have observed very little evidence that heat treatment was practiced at the quarry per se. The usual pattern seems to have been to take reduced pieces (flake blanks and bifaces) to open residential sites and residential rockshelters where they were heat treated and further reduced or "finished".

Most Tosawihi opalite in the priority zone is opaque white or cream in color. Some "white" material actually has a faint grayish yellow or grayish green hue. Most of this material does not appear to change color on exposure to light and air, but some turns a light to medium gray. On the other hand, the cream colored material often weathers to a pale orange or tan. It is most abundant on Upper Holmes Ridge, particularly at localities 47 and 44, but is also present on Lower Holmes Ridge at localities 25 and 35.

A salmon pink opalite occurs throughout the priority zone, always interbanded with white or cream colored opalite. Localities in which the pink material is present occur in a northwest-southeast trending band beginning at locality 87 in the Butte No. 2 Group at 5900 feet asl, including localities 86 and 81 on Bordes Ridge, through locality 78 in the Butte No. 2 Group and locality 77 on Rainbow Ridge, localities 65 and 67 on Crabtree Ridge, locality 60 in Lower Velvet Canyon, locality 91 on Upper Holmes Ridge, the entire Pink Pits area, and finally, locality 35 on Lower Holmes Knoll at 5750 feet asl. With the exception of the Pink Pits area where it predominates, the pink material is less abundant than the white or cream colored opalite.

Material ranging from yellow through orange, red, and brown occurs at locality 77 on Rainbow Ridge. Brown and purple opalite is found at locality 81 on Bordes Ridge, and purple and white opalite was quarried at locality 31 on Lower Holmes Ridge. Opalite cobbles in many colors were obtained from colluvial or alluvial deposits at locality 31 and locality 10 at Station R.

There presently is no evidence that colored opalite was valued less or more than white material. Certainly, no greater effort was made to obtain colored opalite.

Given the time and energy required to secure a quantity of toolstone at the Tosawihi Quarries, quality probably was the major factor in deciding where to expend effort. In fact, assaying for quality probably is responsible for a sizable fraction of the debitage littering the surface of the ground in the District.

Several anthropologists have reported assaying behavior at Australian Aborigine quarries (Tindale 1965; Hayden 1979; Binford and O'Connell 1984). Binford and O'Connell (1984:410) observed that the first thing people did on arriving at the quarry area was to walk around, pick up chunks of rock and remove one or two flakes. Most of these assayed surface rocks were discarded because they were used merely to judge where good, unweathered buried material was likely. When the place was located, a large boulder was dug up, cracked open using a large hammerstone and fire, and chunks used as cores to produce blades and flakes. The description of Aborigine quarry features is reminiscent of Tosawihi:

> Between each rock exposure and clump of trees was a dense scatter of flaked and modified stone... Undulating depressions encircled by high densities of flake debris alternated with clusters of large blocks from which only a few flakes had been struck. Away from these clusters of 'big stuff' ... were small half-moon scatters of large flakes and a few chunks and blocks (Binford and O'Connell 1984:409).

Lithic Scatters

Undifferentiated lithic scatters are represented by a veneer of sparse-to-heavy density debitage overlying land surfaces throughout the District. Generally, moderate-to-heavy debitage scatters are associated directly with places where lithic raw materials were assayed, extracted, and initially processed, such as quarry pits, outcrop quarries, and surface cobble quarries. In the project area, geologic (sheet wash, frost heaving) and biotic (animal burrowing) processes move colluvium rapidly downhill on slopes greater than about 5%, so that these processes contribute to the widespread distribution of cultural materials across the landscape.

These relationships are perhaps clearest with regard to outcrop quarries and quarry pits. Typically, debitage density is highest along the foot of the outcrop or on the quarry pit berm, and perhaps the immediately surrounding area, but falls off with distance from source. Along outcrops and in complexes of closely adjacent quarry pits, debitage density may decrease significantly only outside the entire complex. Since material tends to move down hill, slope often has a strong influence on the shape and size of the debitage scatter surrounding pits and pit complexes. In this regard, consider the lobate (downslope) distribution of debitage at several localities shown in Figure 9.

An elongate, moderate density scatter associated with locality 47 (Upper Holmes Ridge) is also oriented downslope, but the processes just discussed are not primarily responsible. Instead, the moderate density scatter occurs among surface opalite boulders and cobbles in colluvium thinly covering a strip of bedrock. Here, much of the moderate density scatter has been generated by surface material assay.

The density plots from transect survey showed several small, isolated patches of moderate density scatter surrounded by areas of sparse-to-light density scatter, four of which were selected for intensive survey at 10 m intervals or less (see Figure 10).

Area M1 lies just outside the east boundary of the priority zone in Middle Little Antelope Canyon. Intensive survey showed that area M1 is actually a small outcrop-assay quarry on a narrow bench on the steep slope along the canyon. It was designated locality 98. Area M3 on Sagehen Ridge and area M5 on Rainbow Ridge were found to contain isolated quarry pit features, designated localities 100 and 105, respectively. Area M4 was found to be part of the moderate density scatter surrounding the quarry pit complexes on Crabtree Ridge.

Five areas in relatively flat terrain where density is sparse-to-light were examined (see Figure 10). Area L1 is a saddle in the Butte No. 2 Group above South Tosawihi Spring, containing an undifferentiated light-to-moderate density flake scatter representing many kinds and colors of opalite. Bifaces are abundant; they and the debitage reflect all stages of reduction, and by these features alone, the area, designated locality 107, resembles the large open residential sites around Tosawihi Springs to the north. Locality 107 also contained a feature comprised of seven biface fragments and an Elko Series projectile point.

Area L2, on a broad, open north slope of Crabtree Ridge, was found to contain no discrete archaeological features. However, an area just north on the crest of Rainbow Ridge, not purposely selected for study, was found to contain several discrete flaking stations. The group of features was designated locality 106.

Area L3 is a broad saddle on Upper Holmes Ridge. It was found to contain at least three discrete flaking stations, all associated with stands of big sage. Several obsidian flakes were noted in this area.

Area L4 is a small saddle north of Station R. It appears to have contained a discrete lithic scatter at one time, but this mostly was destroyed by historic mining.

These additional studies demonstrate a significant point: the transect survey density plots were made with data obtained at a resolution of 100 feet. While this level of observation serves to reveal large scale prehistoric patterns, there is more complexity than is indicated by the density map. Numerous areas plotted as moderate density contain "holes" of light or sparse density, while other areas plotted as sparse or light density may contain small artifact concentrations or quarry features.

Outcrop Quarries

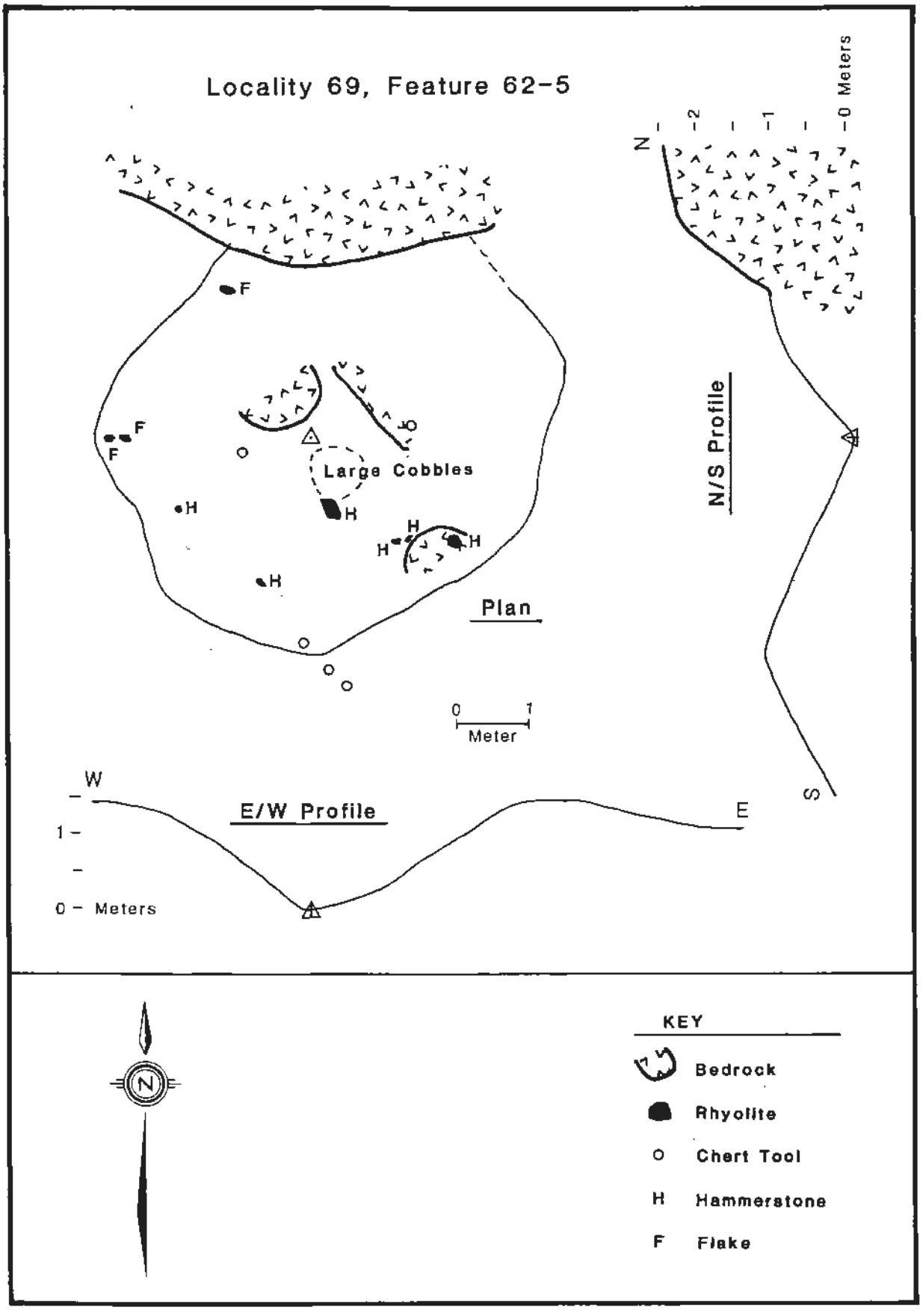
Outcrop quarries, places where the surface outcrop of toolstone was the major focus of prehistoric attention, account for only 11% of prehistoric localities in the District overall, and for 14% of prehistoric localities in the priority zone (see tables 11, 12). Five of the latter are small outcrop quarry/assay locations (localities 12, 50, 71, 98, and 113) and two each are small outcrop quarries (localities 13 and 59), outcrop quarry complexes (localities 68 and 69), and adits (localities 58 and 61).

Of all these, locality 69 was transit-mapped and feature 62-5 recorded in detail (Figure 12). Locality 69 is a component of a very large complex of outcrop quarries and quarry pits arrayed along the north side of Ledge Ravine and the south side of Crabtree Ridge, and feature 62-5 is a good example of blended extraction strategies. A talus of cultural and non-cultural lithic debris has accumulated at the base of a bedrock ledge, now about 1.3 m high. Much of this material appears to be debris from quarrying on the outcrop itself.

Feature 62-5 is a circular quarry pit 5.6 m in diameter and 1.5 m deep excavated into the colluvium at the base of the outcrop; a sizable berm of debitage and waste material has formed on the outside or down-slope side of the pit. The interior of the pit and the berm are littered with rhyolite hammerstones and hammerstone spalls.

The bottom of the pit contains an accumulation of what we termed "cobbles" as we were working in the field. However, while these are cobble-sized (between 8 and 15 cm) objects, most are artifacts: assayed cobbles, cores, flakes, biface fragments, and bifaces. "Cobble accumulations" occur in pits; "cobble patches" are found outside pits, usually at the base

Figure 12. Plan view and profiles, locality 69, feature 62-5.


Locality 69, Feature 62-5
N
-2
-1
-0 Meters
N/S Profile
S
F
F
F
Large Cobbles
H
H
H
H
H
H
Plan
0
1
Meter
W
E/W Profile
E
1 –
0 – Meters
N
KEY
Bedrock
Rhyolite
Chert Tool
H Hammerstone
F Flake

of berm slopes. Cobble patches and accumulations thus seem to be discarded material extracted and processed from an adjacent pit or outcrop. Sometimes cobble accumulations nearly fill pits.

A cobble accumulation in the bottom of feature 62-5 partially obscures the bedrock contact exposed there, but it appears possible that the bottom of the pit actually penetrated the bedrock, perhaps along a large crack. We have no clues as to how the bedrock was broken up or how deep the pit might actually be.

Quarry Pits

Quarry pits are places where toolstone in colluvium was the major focus of attention. Quarry pits are sometimes isolated features, but more often occur in complexes of 2 to more than 50. Two different kinds of place form the extremes of quarry pit location: in colluvium below bedrock outcrops (much like feature 62-5 in locality 69 described above), and in colluvium on open slopes. In the discussion below, quarry pits below bedrock outcrops are given more attention because they contain more structural complexity.

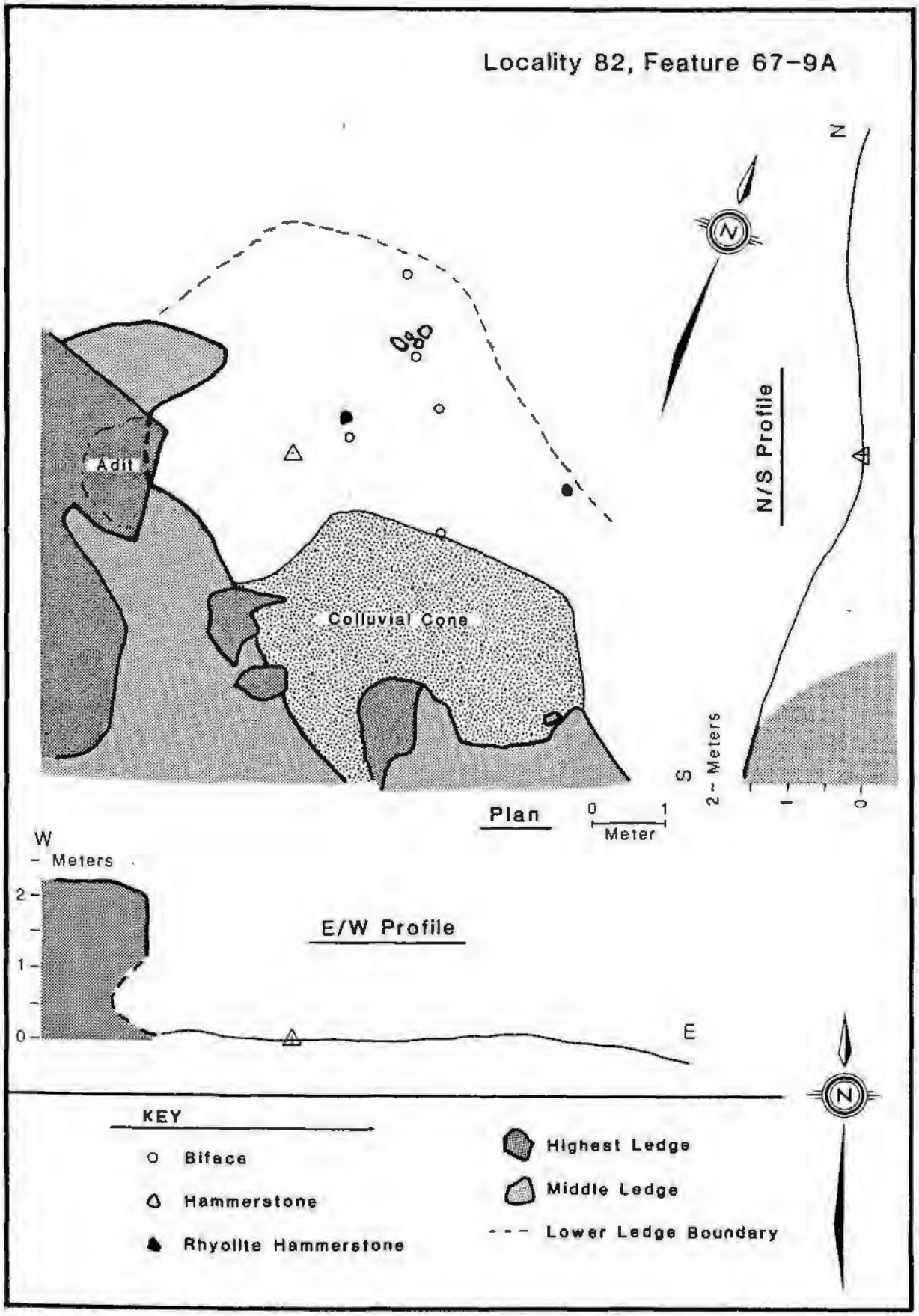
Quarry Pits Below Bedrock Outcrops

Of the localities with quarry pit features studied in the priority zone, only locality 69 seems to have been the focus of exploitation of the bedrock outcrop. However, several other localities have quarry pits in geomorphically similar situations at the base of bedrock outcrops.

Locality 82 is a complex of quarry pits in patches of colluvium in a bedrock outcrop about 20 meters above Velvet Creek in Upper Velvet Canyon. In most places, the bedrock is poor quality material that was not quarried; thus, the locality was classified as a quarry pit complex. However, one pit (feature 67-9a) has been excavated 85 cm into colluvium at the foot of a 2 m bedrock outcrop where toolstone quality was good (Figure 13). The pit, 6.5 m in diameter, is surrounded by a berm of debitage and waste rock and partially filled with colluvium washing down from above the outcrop. Opalite bifaces, along with rhyolite and tuff sandstone hammerstones were observed inside the pit.

In addition, a small adit, about 1 m wide and 1.5 m deep, has been excavated into the base of the bedrock. Flake scars are present on the opalite of the adit walls, so we assume

Figure 13. Plan view and profiles, locality 82, feature 67-9a.


Locality 82, Feature 67-9A
N
N/S Profile
Adit
Colluvial Cone
S
2 ~ Meters
1
0
Plan
0
1
Meter
W
- Meters
2
1
0
E/W Profile
E
N
KEY
Biface
Hammerstone
Rhyolite Hammerstone
Highest Ledge
Middle Ledge
Lower Ledge Boundary

that hammerstones were used in its excavation. Evidence of other extraction techniques, such as fire, is not apparent.

Locality 42 is a complex of four pits excavated into colluvium below a bedrock outcrop of partially silicified tuff, a very poor toolstone material. One of the four pits, feature 54-14, is 7.8 m in diameter and 60 cm deep (Figure 14) with a ledge of poor quality bedrock exposed in the bottom of the pit. A berm of debitage and waste rock rings the pit on the downslope side; concentrations of debitage were found on the crest of the berm in two places. Rhyolite and basalt hammerstones and hammerstone spalls lie on the outside slope of the berm.

In locality 65, feature 51-6 is one of five quarry pits excavated along a bedrock ledge. The feature is 6 m in diameter and 50 cm deep, but it (along with the other four pits in the group) is filled partially with an accumulation of cobbles (Figure 15). Cobble patches are found in the intervening spaces between pits. Basalt and rhyolite hammerstones and spalls are on the berm surrounding the pit; a rhyolite hammerstone spall rests on a boulder of the bedrock outcrop.

Other similar features are the isolated pit (no feature number assigned) in locality 41, feature 58-6 in locality 68, and feature 67-1 in locality 85.

Quarry Pits on Colluvial Slopes

Quarry pits on colluvial slopes are circular to oval in outline and basin-shaped to conical in profile. Isolated pits and pit complexes frequently are surrounded entirely by berms of soil, waste rock, and debitage. When pits are on slopes, the berms usually are higher on the downslope side.

Two isolated quarry pits were mapped in detail. Feature 63-5 in locality 38 is a shallow, basin-shaped depression 4.6 m in diameter and 25 cm deep, surrounded by a low berm (Figure 16). It was excavated in thin colluvium over bedrock, where good quality pink and cream-colored opalite was obtained. The pink flakes and waste rock in the pit, on the berm and surrounding area provide a striking contrast to the tan soil of the quarry area. Aside from the pink toolstone, this locality is interesting by the presence of two bifaces and a concentration of debitage made of material exotic to the material obtained from the pit. In addition, a possible rhyolite groundstone fragment is present just outside the

Figure 14. Plan view and profiles, locality 42, feature 54-14.

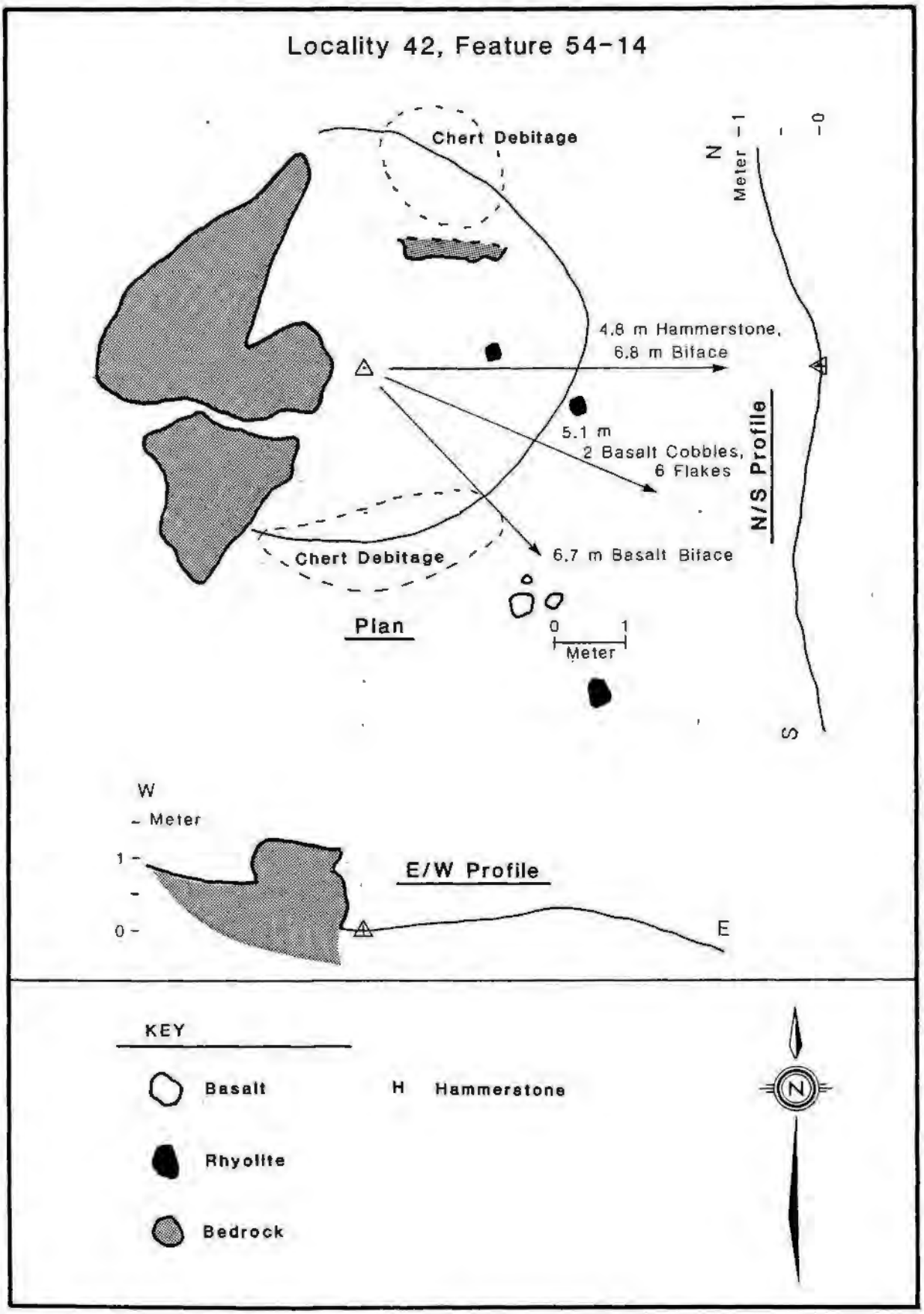

Locality 42, Feature 54-14
Chert Debitage
N
Meter -1
-
-0
4.8 m Hammerstone,
6.8 m Biface
5.1 m
2 Basalt Cobbles,
6 Flakes
N/S Profile
6.7 m Basalt Biface
Chert Debitage
Plan
0
1
Meter
S
W
- Meter
1 -
-
0 -
E/W Profile
E
KEY
Basalt
H Hammerstone
Rhyolite
Bedrock
N

Figure 15. Plan view and profiles, locality 65, feature 51-6.

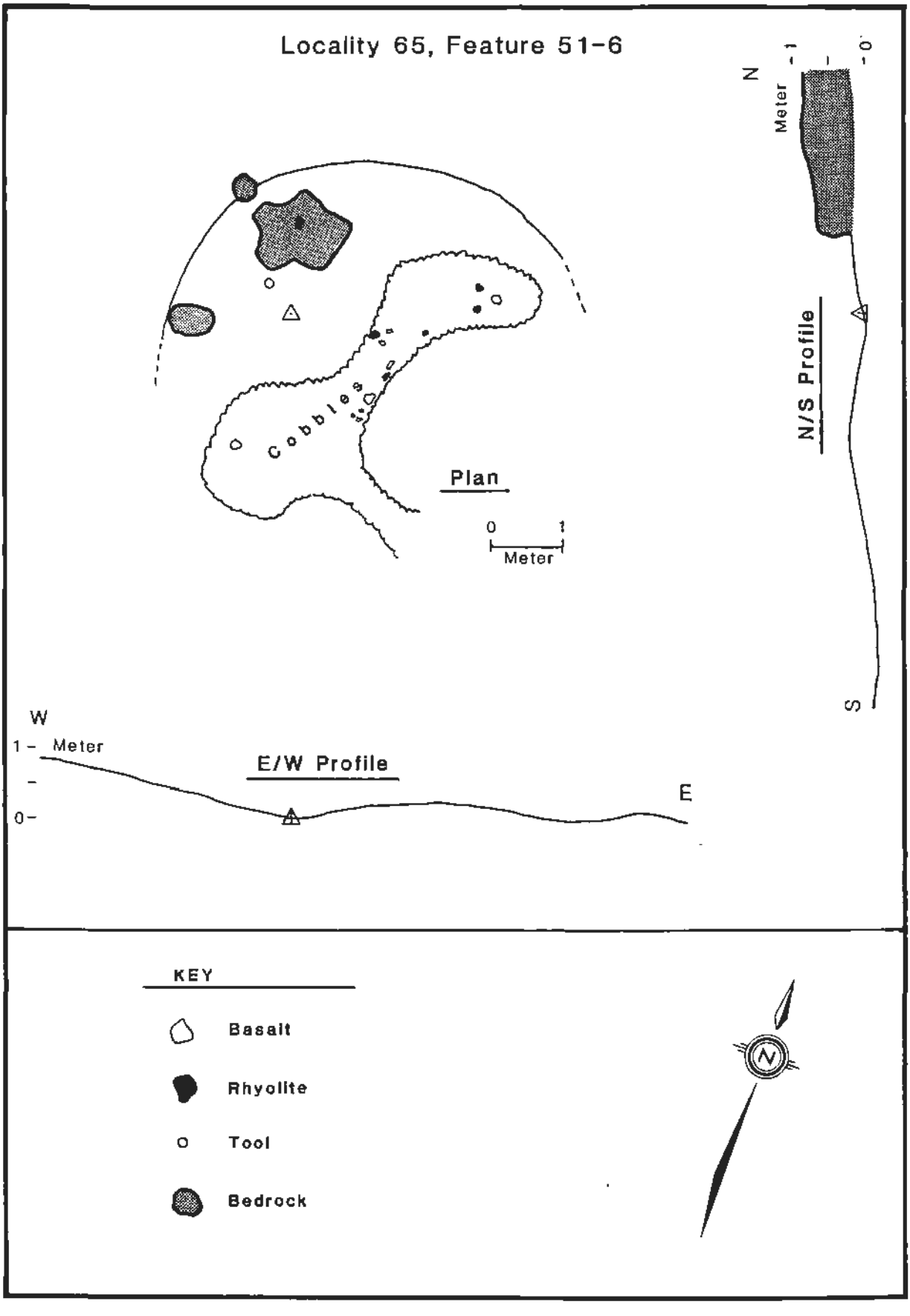
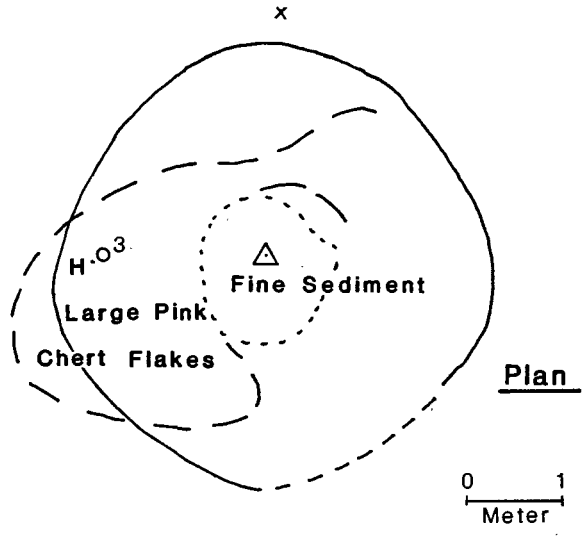
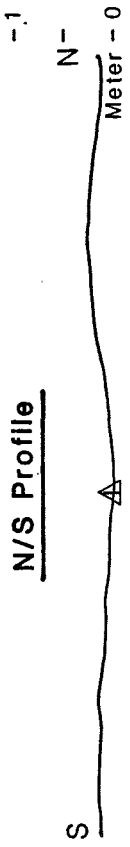
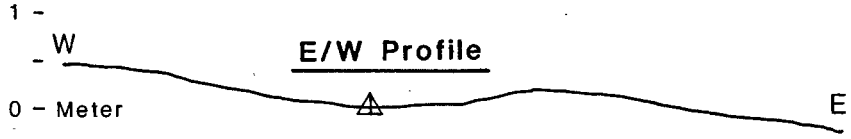

Locality 65, Feature 51-6
N
Meter
1
0
N/S Profile
S
Cobbles
Plan
0
1
Meter
W
1 – Meter
–
0 –
E/W Profile
E
KEY
Basalt
Rhyolite
Tool
Bedrock
N

Figure 16. Plan view and profiles, location 38, feature 63-5.

Locality 38, Feature 63-5









KEY

o Biface

x Groundstone

H Hammerstone

berm, making locality 38 one of the few quarry features in the District where a non-quarry related tool was found.

Feature 51-4 at locality 64 is an elongated pit 5.5 x 4.0 m, and 55 cm deep, with a low berm on the downslope side only. It was excavated into shallow colluvium upslope from a bedrock outcrop in order to obtain moderate-to-poor quality white and gray variegated opalite. The pit is filled partially by two cobble accumulations; two bifaces and a rhyolite hammerstone were observed inside the pit.

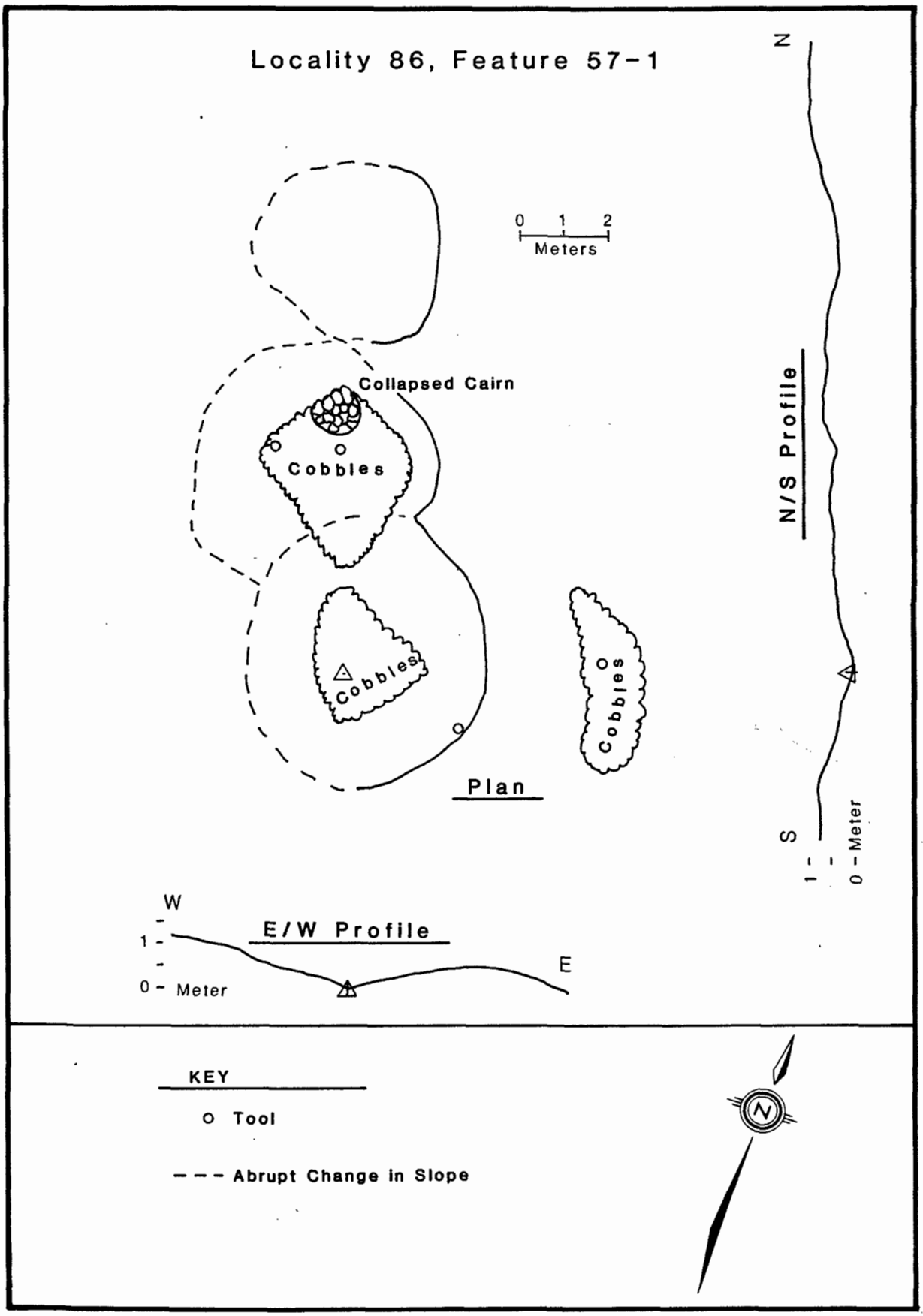
Other isolated quarry pits within the priority zone are feature 70-6 in locality 11 (where a distinctive blood-red toolstone was obtained), pit 1 in locality 206, the unnamed pit in locality 41 mentioned above, feature 57-5 in locality 101, feature 51-5 in locality 64, pit M3 in locality 100, feature 59-7 in locality 104, and feature 62-4A in locality 105.

There are few differences between isolated quarry pits and individual pits in quarry pit complexes. The closer pits are to each other, the more difficult it is to distinguish individual pit boundaries. This is due to the tendency for older pits to be filled with cobble accumulations and slope wash, and because of subsequent pit excavation in berms and pit floors. In places such as locality 36, with its complex of over 50 shallow pits in a relatively small area, the impression is of "lumpy" rather than "pitted" terrain.

In several instances, closely adjacent pits are arranged in a line, creating an elongated pit with low "compartments" formed by internal berms. These features suggest that toolstone was being obtained along a linear subsurface outcrop. They also suggest that at some point it became easier to excavate a new pit than to enlarge an old one. As with feature 57-1 in locality 86 (Figure 17), one sometimes can work out the order in which such pits were excavated by the ways berms overlap, and by the presence or absence of cobble accumulations in pit bottoms. Elongated pits and linear clusters of pits are present at localities 10, 36, 43, 47, 77, and 65.

Feature 66-23 in locality 10 is worth special mention. This is a very large (16 x 12 meters), shallow (50 cm) pit, excavated into sediments near the top of Station R hill on Holmes Ridge. The sediment is colluvium as we have defined it, but remarkable for the wide range of colors in the cobbles of opalite it contains. Relatively large amounts of tuff waste rock are present, and we suspect the underlying bedrock may be a tuff-opalite breccia.

Figure 17. Plan view and profiles, locality 86, feature 57-1.


Locality 86, Feature 57-1
0 1 2
Meters
Collapsed Cairn
Cobbles
Cobbles
Cobbles
Plan
N
N/S Profile
S
1 -
0 - Meter
W
E/W Profile
1 -
0 - Meter
E
KEY
o Tool
- - - Abrupt Change in Slope
N

Feature 66-23 is the largest pit recorded, but it probably is comprised of several closely adjacent pits without intervening berms. The low berm around the outside of the feature is composed mostly of tuff waste rock with opalite debitage. We assume that raw material size was small and concentrated in the upper half meter of colluvium. The feature lacks cobble patches or accumulations, hammerstones, bifaces, or obvious cores.

Variability in Quarry Pit Size and Depth

The length, width, and overall depth of mapped quarry pits in the priority zone is given in Table 13, and frequency distributions are shown in Figure 18. It occurred to us there might be some relationship between quarry pit size and depth, reflecting the optimum effort for the maximum return of toolstone. In order to test this hypothesis, the values for maximum pit dimension and depth in centimeters were log transformed and plotted (Figure 19). The plots are scattered and the correlation coefficient (using Pearson's r) is 0.09, about as uncorrelated as it is possible to get.

One alternative is that the relationship between pit size and depth is completely random. Another alternative is that the relationship is not simple; other factors (perhaps usable toolstone per unit volume of colluvium) are important, but we do not know what they are.

Variability in Basalt Hammerstone Distribution

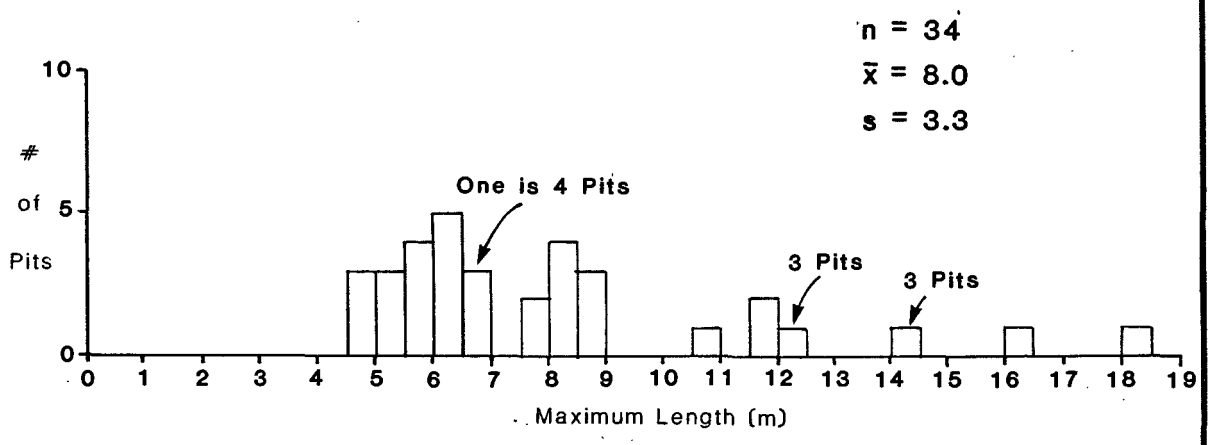
Heavy, dense hammerstones were required to quarry and process the tough Tosawihi opalite. Quartzite and rhyolite are available throughout the District, both as colluvial cobbles and in the beds of Velvet Canyon, Little Antelope Canyon and other stream courses, and tuff sandstone is present in smaller quantities. None of these rocks is particularly hard compared to opalite, although the hardness of rhyolite and sandstone sometimes is enhanced by partial silicification. Opalite is both hard and dense, but striking opalite against opalite is dangerous since one or both stones may shatter into shrapnel-like fragments. Basalt is hard, dense, and less shatter-prone than opalite, and seems to have been the hammerstone of choice.

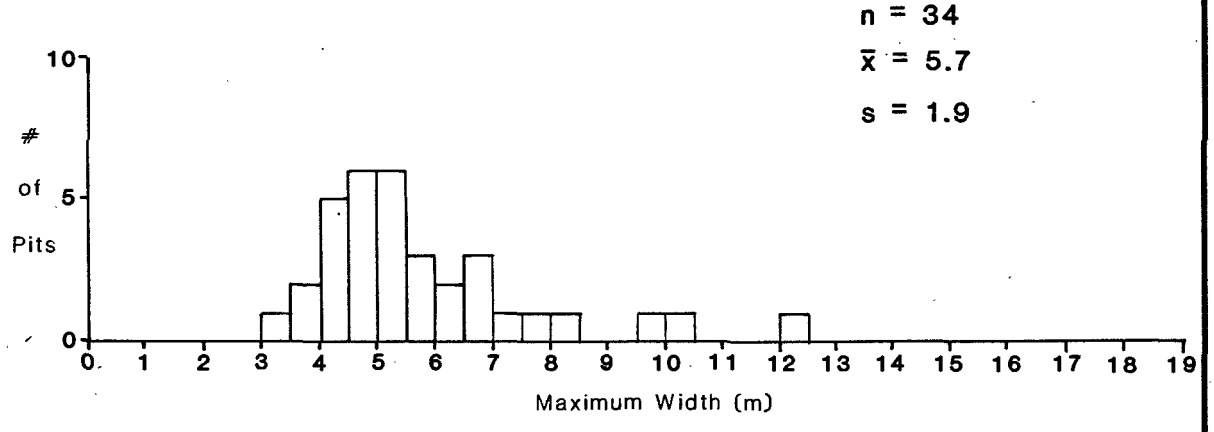
Table 13. Dimensions of Quarry Pit Features

Locality No.	Feature No.	Max. Length (m)	Max. Width (m)	Max. Depth (cm)		Locality Type
10	66-23	16.0	12.0	50		Quarry Pit Complex
24	67-16	4.5	5.1	25		Quarry Pit Complex
31	71-9	4.9	4.4	40		Quarry Pit Complex
35	64-9	8.4	7.5	30		Quarry Pit Complex
36a	60-4	18.0	9.5	60		Quarry Pit Complex
36b	60-5	5.1	4.1	40		Quarry Pit Complex
36c	61-4	5.0	4.0	30		Quarry Pit Complex
38	63-5	4.6	4.5	25		Isolated Quarry Pit
39	59-11	7.5	5.5	25		Quarry Pit Complex
42a	54-14	7.8	4.6	60		Quarry Pit Complex
42b	54-15	8.1	8.0	50		Quarry Pit Complex
43a	48-5	8.3	5.4	70		Quarry Pit Complex
43b	49-5	11.6	5.6	40		Quarry Pit Complex
44a	44-3	5.6	4.0	100		Quarry Pit Complex
44b	46-6A	6.2	5.4	50		Quarry Pit Complex
47	50-7	11.5	3.6	30		Quarry Pit Complex
48	59-4	8.7	6.9	50		Quarry Pit Complex
60	69-7	5.2	4.8	90		Quarry Pit Complex
62	66-17	5.7	4.9	30		Quarry Pit Complex
63	56-2	6.2	3.9	40		Quarry Pit Complex
64	51-5	5.5	4.0	55		Isolated Quarry Pit
65a	51-6	6.0	3.0	50		Quarry Pit Complex
65b	54-11	12.0	10.0	65	3 pits	Quarry Pit Complex
67	57-7	6.7	5.0	50	4 pits	Quarry Pit Complex
69	62-5	6.4	5.4	150		Outcrop Quarry Complex
75	64-5	5.6	5.6	50		Quarry Pit Complex
77	58-7	10.9	6.8	40		Quarry Pit Complex
78	53-4	8.5	4.6	25		Quarry Pit Complex
79	54-7	8.6	6.8	95		Quarry Pit Complex
81	59-8	6.7	5.2	60		Quarry Pit Complex
82	67-9a	6.5	6.0	85		Quarry Pit Complex
86	57-1	14.2	6.0	80	3 pits	Quarry Pit Complex
87	51-2	8.0	7.0	115		Quarry Pit Complex
91	55-3	6.0	4.7	60		Quarry Pit Complex
N=34		$\bar{x}$ = 8.0 s = 3.3	$\bar{x}$ = 5.7 s = 1.9	$\bar{x}$ = 56 s = 28		

Figure 18. Frequency distributions of quarry pit dimensions.

Tosawihi Quarry Pits





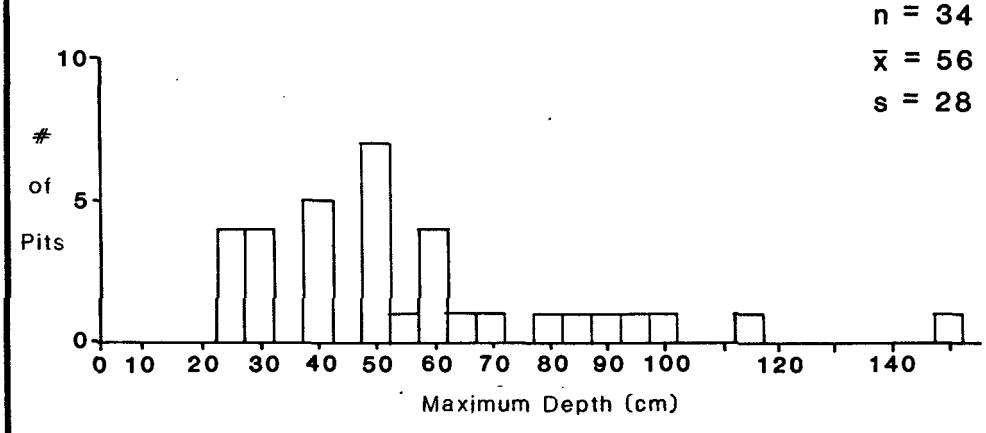
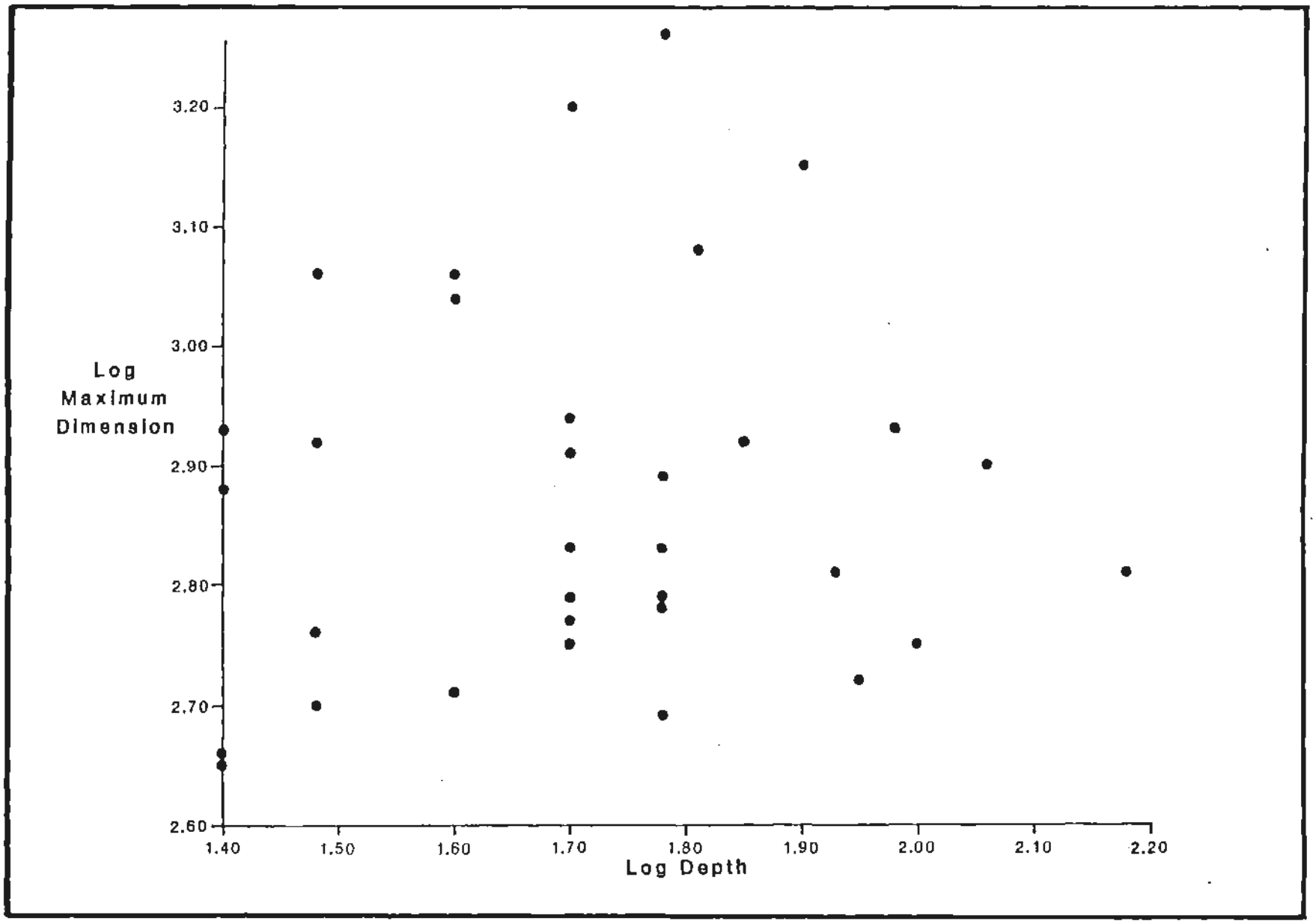


Figure 19. Plots of log transformed Quarry Pit depth and maximum dimensions.


Log
Maximum
Dimension
3.20
3.10
3.00
2.90
2.80
2.70
2.60
1.40
1.50
1.60
1.70
1.80
1.90
2.00
2.10
2.20
Log Depth

Basalt, however, is available only from talus and stream deposits in Basalt Canyon on the western margin of the Tosawihi District. Prehistoric people seem to have been willing to transport the material over rather long distances, since basalt hammerstones are found in quarry localities adjacent to Velvet Canyon, close to ample supplies of rhyolite and quartzite rock. Even so, there seemed to be an inverse relationship between the amounts and sizes of basalt hammers at quarry localities and the distance to the nearest source in Basalt Canyon. That is, basalt hammerstones become fewer and smaller the farther from Basalt Canyon they occur.

We measured the dimensions in centimeters of all basalt hammerstones observed during locality mapping in the priority zone. The frequency distributions of these data are graphed in Figure 20. A crude estimate of each hammerstone volume was obtained by multiplying length, times width, times thickness. The mean hammerstone volume for each locality then was calculated. The distance from Basalt Canyon to each locality was measured on the 1:6000 map in feet. The values for both mean volume and distance were log transformed.

The plot of these values shown in Figure 21 demonstrates the expected inverse relationship: mean basalt volume decreases with distance from source. However, the correlation coefficient calculated with these data is only 0.56, due in part to the vertical spread of the paired values. Notice that none of the 15 values lies on the regression line; 8 are well above it and 7 are below.

Field judgements of toolstone quality accompany the plot for each locality. Notice also that most plots above the line are localities at which toolstone is "good" or better, while most plots below the line are localities at which toolstone quality is less than "good", suggesting the possibility that people were willing to transport larger chunks of basalt to localities where toolstone quality made the effort worthwhile. Alternatively, this distribution may mean that extraction and processing of poorer quality opalite was harder on hammerstones, causing them to break into smaller pieces.

Biface Size

Bifaces were collected only when they seemed to represent reduction stages or processes outside the usual range for quarry areas. Dimensions and observations concerning collected bifaces are presented in Appendix B. Otherwise, bifaces observed during mapping of quarry features were

Figure 20. Frequency distributions of basalt hammerstone dimensions (in cm).

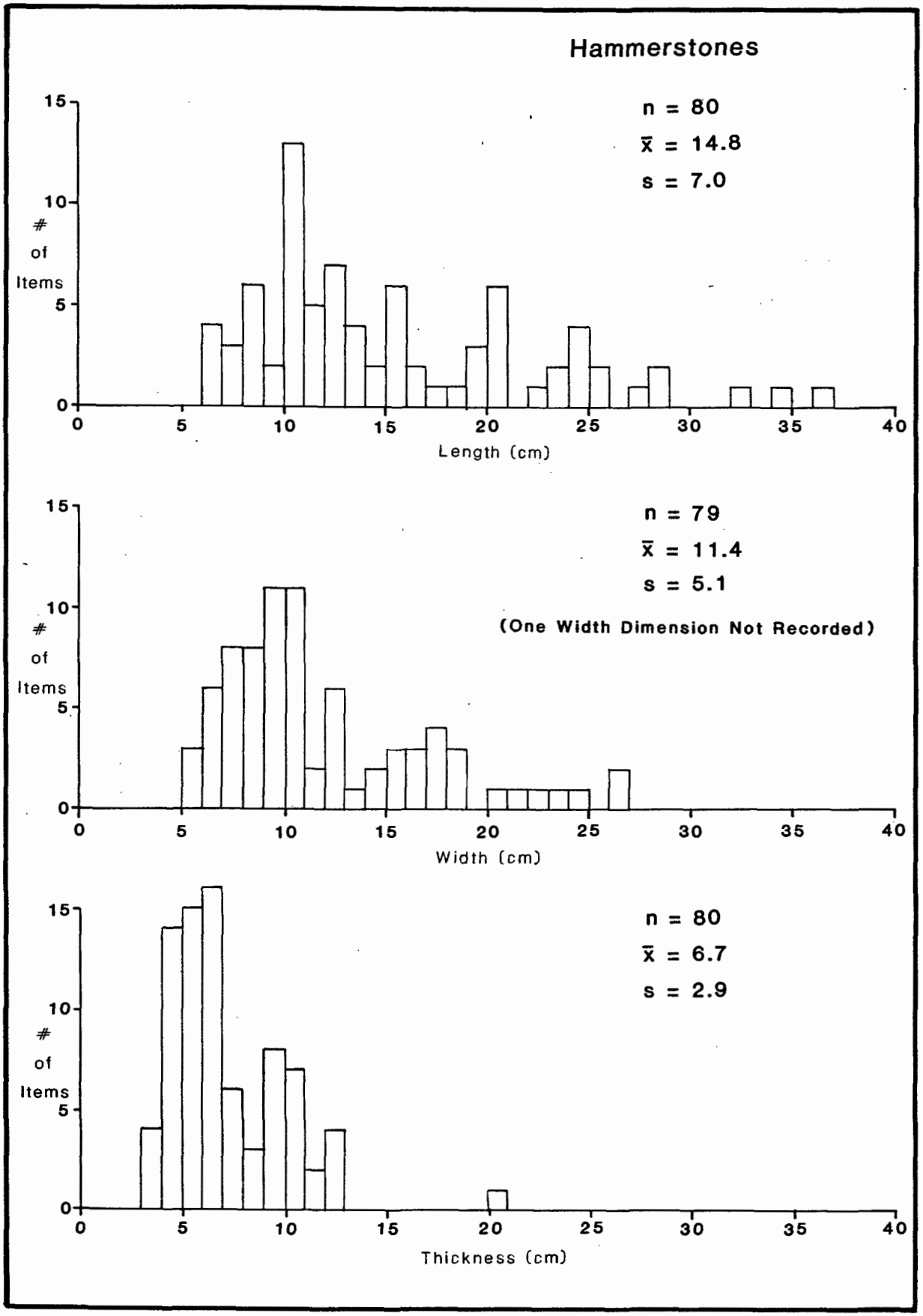
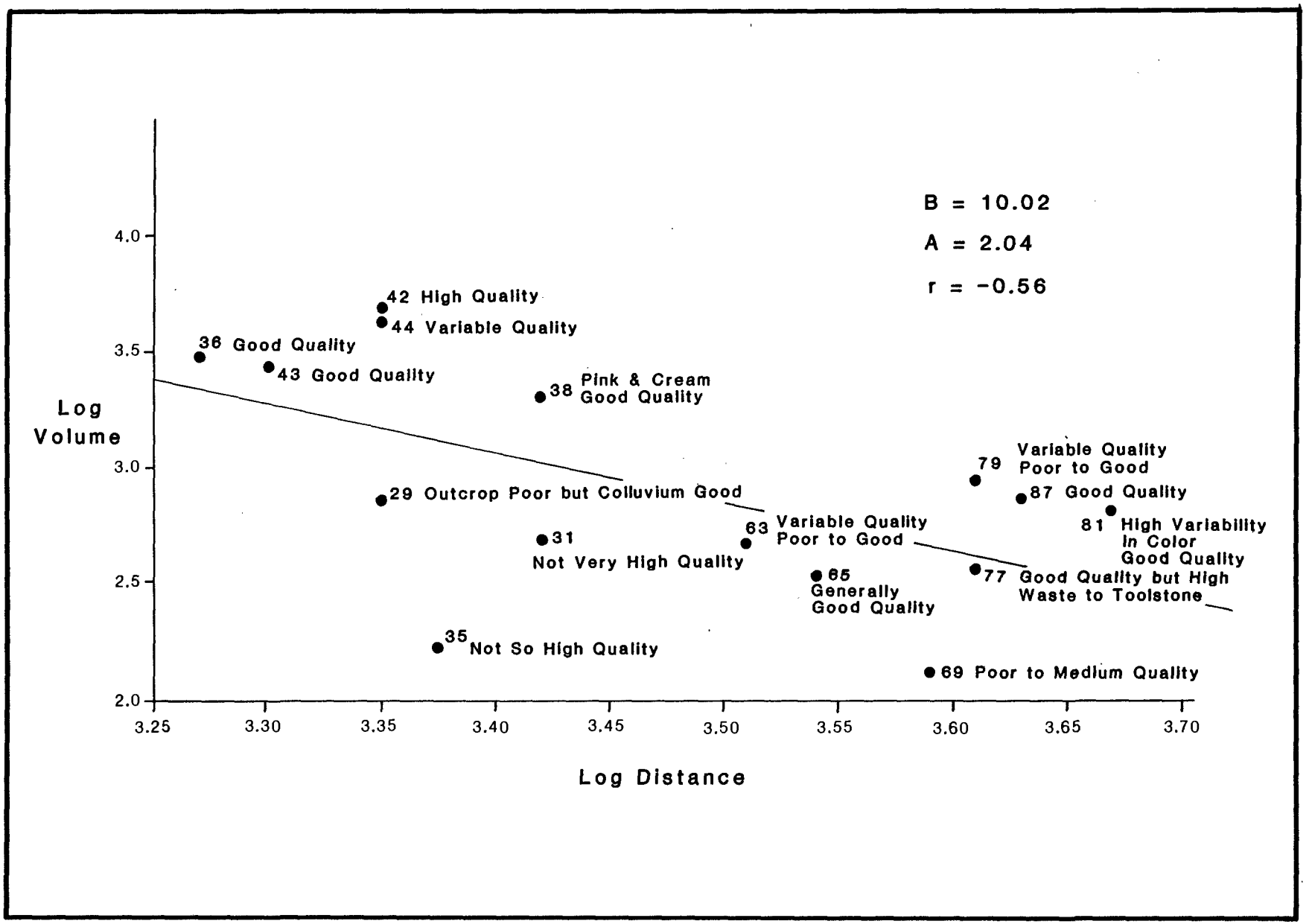

Hammerstones
n = 80
x̄ = 14.8
s = 7.0
of Items
Length (cm)
n = 79
x̄ = 11.4
s = 5.1
(One Width Dimension Not Recorded)
of Items
Width (cm)
n = 80
x̄ = 6.7
s = 2.9
of Items
Thickness (cm)

Figure 21. Basalt hammerstones: plots of log transformed mean volume (in cubic cm) by log transformed distance to source in feet. Comments are field observations of toolstone quality.


B = 10.02
A = 2.04
r = -0.56
42 High Quality
44 Variable Quality
36 Good Quality
43 Good Quality
38 Pink & Cream Good Quality
29 Outcrop Poor but Colluvium Good
31 Not Very High Quality
63 Variable Quality Poor to Good
79 Variable Quality Poor to Good
87 Good Quality
81 High Variability In Color Good Quality
65 Generally Good Quality
77 Good Quality but High Waste to Toolstone
35 Not So High Quality
69 Poor to Medium Quality
Log Volume
Log Distance
4.0
3.5
3.0
2.5
2.0
3.25
3.30
3.35
3.40
3.45
3.50
3.55
3.60
3.65
3.70

measured in the field and recorded. The frequency distributions of these measurements (in centimeters) are given in figures 22 and 23 (which also give mean and standard deviations).

Before continuing with the analysis of these data, let us consider the manufacture and maintenance of bifaces. First, the production of a flake blank and its bifacial reduction thoroughly tests the raw material and reduces unnecessary weight for transport away from the quarry. It also produces a symmetrical implement with sharp but relatively strong edges that can be used as is for a variety of cutting and scraping tasks. This symmetry also facilitates maintenance (resharpening) and further reduction of the tool. Indeed, the thin, sharp flakes typically produced from such maintenance ("biface thinning") are themselves useful as general purpose tools.

The optimizing strategy for biface thinning is to detach very thin, expanding flakes that cross the midline of the piece from narrow platforms. This results in least decrease in biface width while recreating a sharp edge and making the tool thinner.

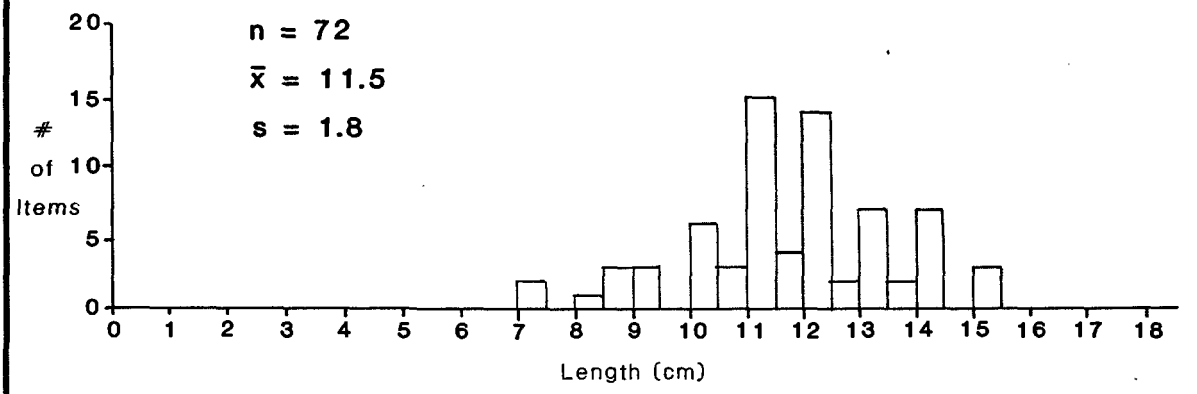
While thinning can occur in any stage of manufacture, it is emphasized in Stage II and later stages of reduction. However, successful (optimal) thinning in later stages requires that the proper core geometry be achieved in the earliest stage; particularly important is the thickness to width ratio. If this is too high, the curvature of one or both faces may be too great for flakes to cross the midline. In this case, each flake removal decreases the width of the piece but not its thickness, exacerbating the problem. Thus, early stage bifaces with high thickness to width ratios tend to be discarded.

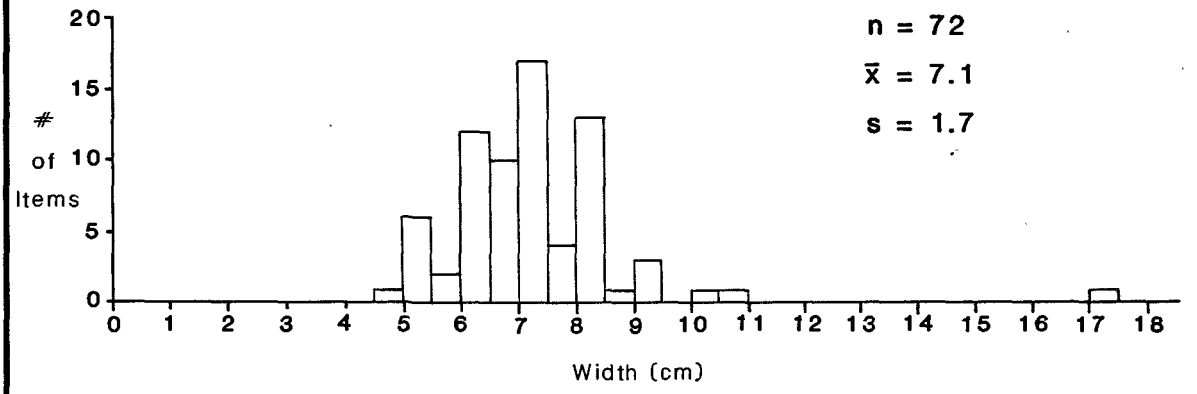
Returning now to measurements of bifaces observed at quarry features, the mean complete biface is 11.5 cm long, 7.1 cm wide, and 2.9 cm thick; the largest complete biface was 15.5 cm long. The mean width to thickness ratio of complete bifaces is .41. It is obvious that virtually all these artifacts were discarded because this value was too high and they could not be thinned any further.

The mean biface fragment was 9.9 cm long, 7.6 cm wide, and 2.8 cm thick. The mean width to thickness ratio for biface fragments is .37, and the largest biface fragment was 16.5 cm long. These artifacts broke while they were are being thinned, and thinning was progressing successfully until the break. This suggests that biface fragments were discarded

Figure 22. Frequency distributions of complete biface dimensions.

Complete Bifaces





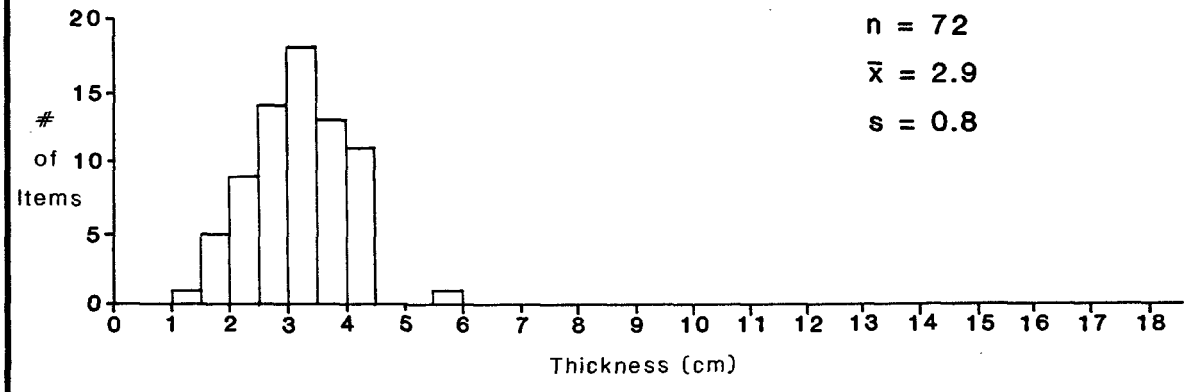
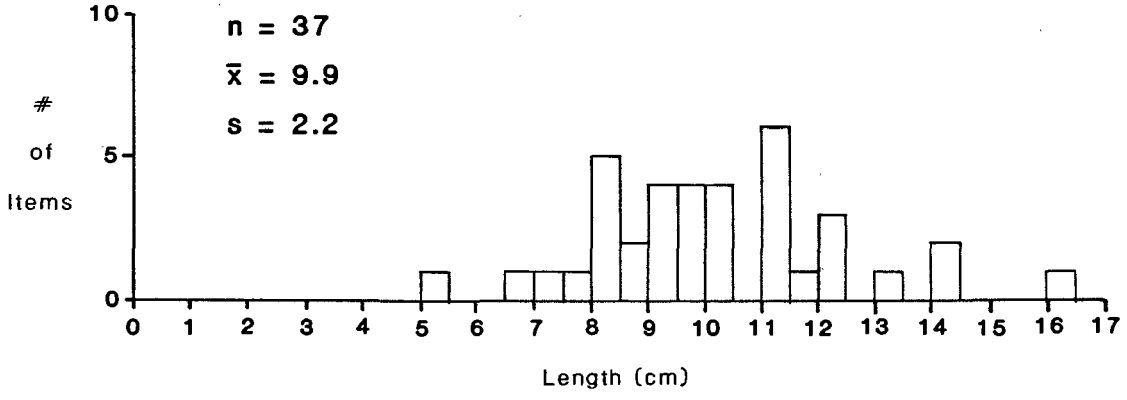
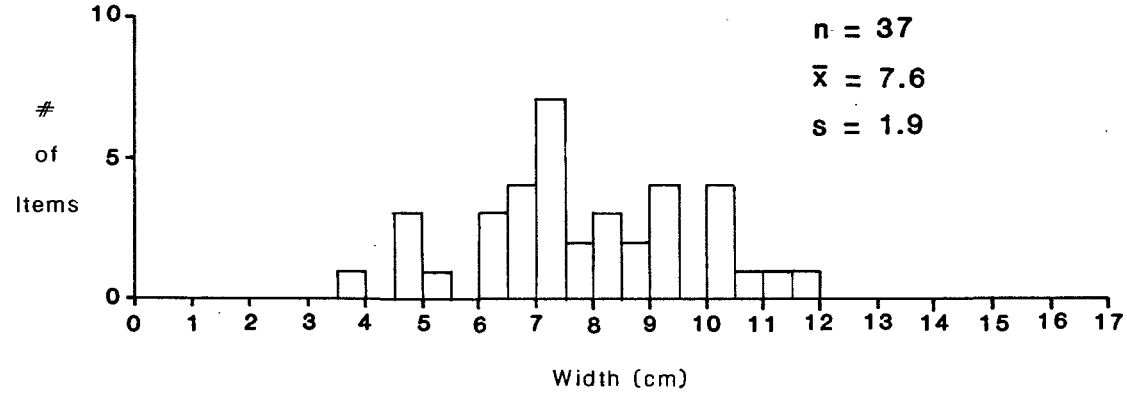
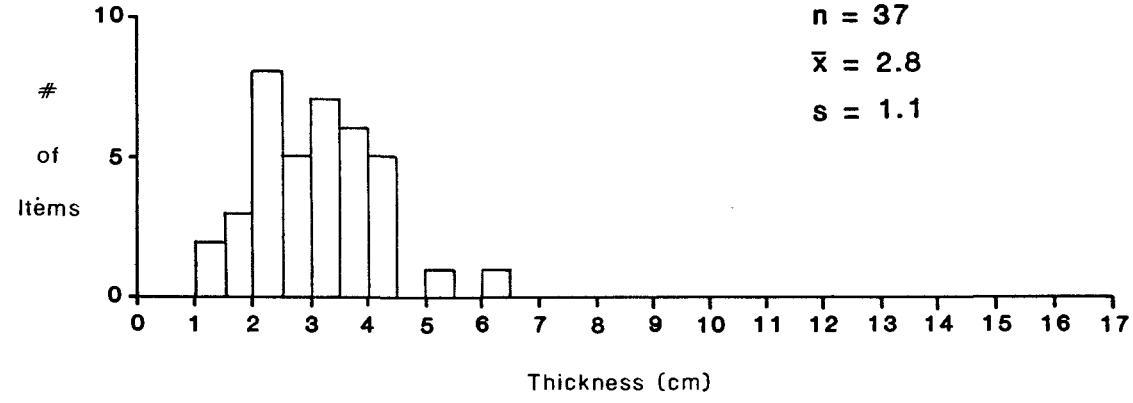


Figure 23. Frequency distributions of biface fragment dimensions.

Biface Fragments







precisely because they were too short to consider working further. Consider that the mean width of biface fragments is actually larger than the mean width of complete bifaces. The limiting factor appears to have been length: pieces 10 cm long or shorter tended to be discarded. Of course, longer pieces were discarded also (the longest biface fragment is longer than the longest complete biface), but they may have been flawed in other ways (we did not record such information).

What were the target dimensions of bifaces produced in the District? This can be estimated from discarded bifaces and biface fragment data: probably about 7.5 cm wide, longer than 11.5 cm, and thinner than 2.8 cm. To test this hypothesis, we have the six bifaces from a "cache" discovered in the District several years ago by Mary Rusco and her associates (figures 24-26). Unlike the bifaces we observed at the quarry features, most of which were discarded in Stage I or early Stage II because of major flaws and poor thickness to width ratios, the Rusco artifacts are "finished" stage two bifaces; that is, they have been shaped and thinned to a point at which they normally would have been transported from the quarry to another location for heat treatment and further thinning. However, each of these artifacts has a minor flaw or two, and they probably are also discards. Imagine the knapper sorting through a pile of bifaces after a day's work and taking only the perfect ones with him, leaving these six behind.

In any case, the Rusco artifacts probably reflect the target dimensions (Table 14) for bifaces produced in the quarry: the mean dimensions are 16.0 cm by 7.4cm by 1.8 cm, and the mean width/thickness ration is .24. Using Student's *t* distribution (Blalock 1979:190-195), the Rusco bifaces are significantly longer and thinner than the sample of observed bifaces, at the 0.05 level.

Table 14. Dimensions of Artifacts in Rusco's Biface Cache.

Item	Length (cm)	Width (cm)	Thickness (cm)
1	16.6	8.23	1.89
2	16.3	8.61	1.92
3	16.5	7.57	1.74
4	15.9	7.72	1.65
5	16.2	6.58	2.06
6	14.8	5.95	1.79

Figure 24a, b. Bifaces from the Rusco Cache.

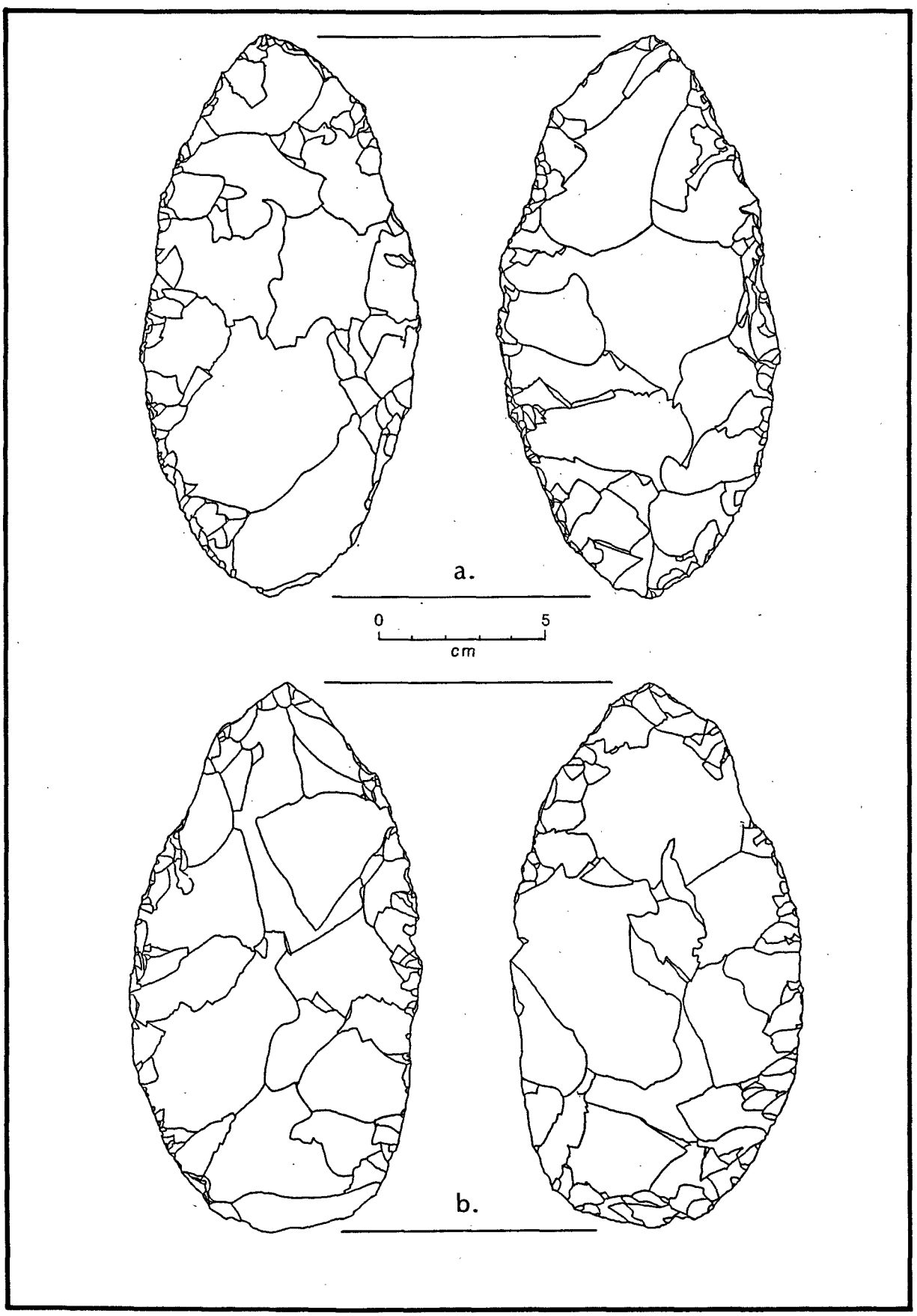

a.
0
5
cm
b.

Figure 25a, b. Bifaces from the Rusco Cache.

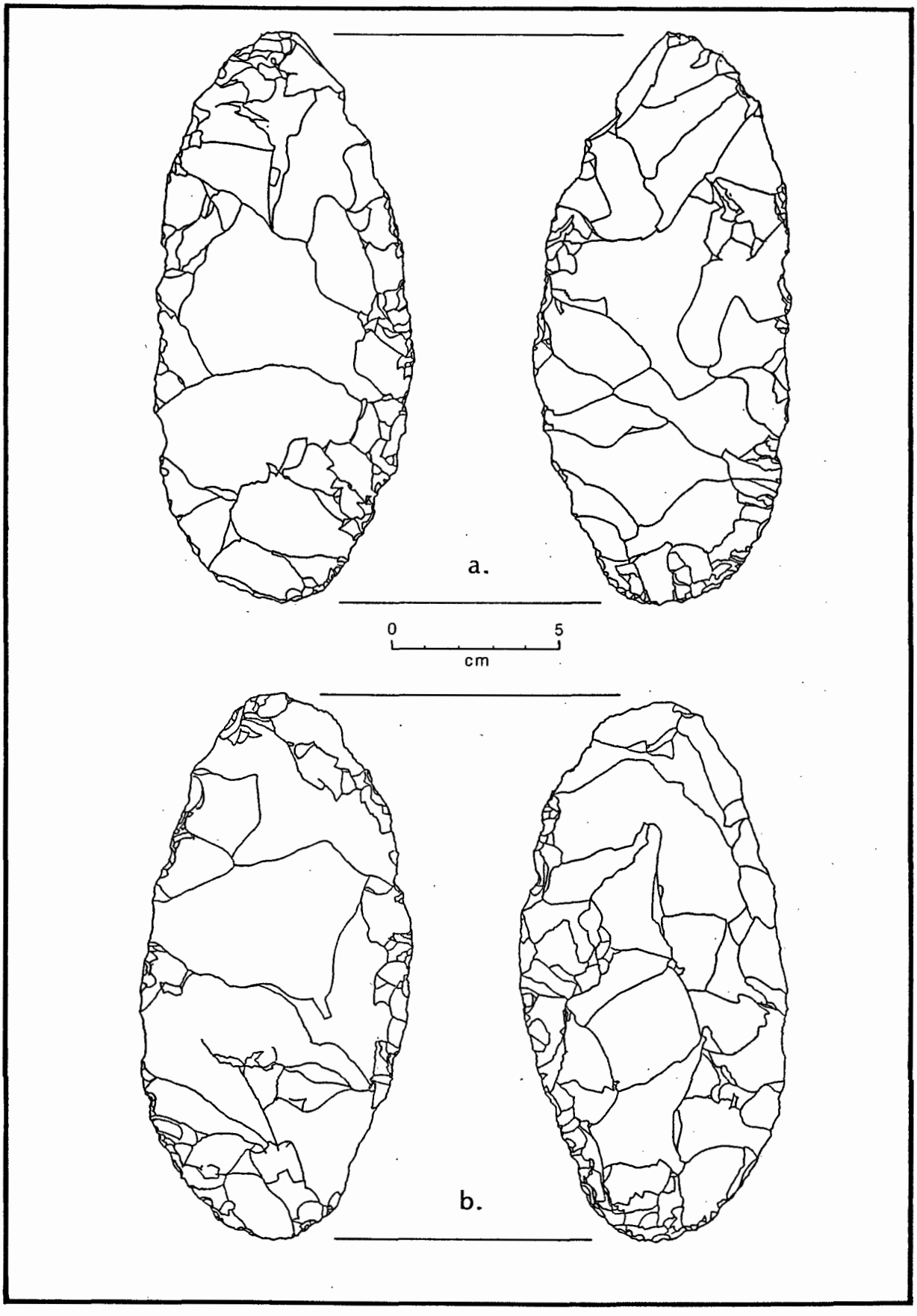
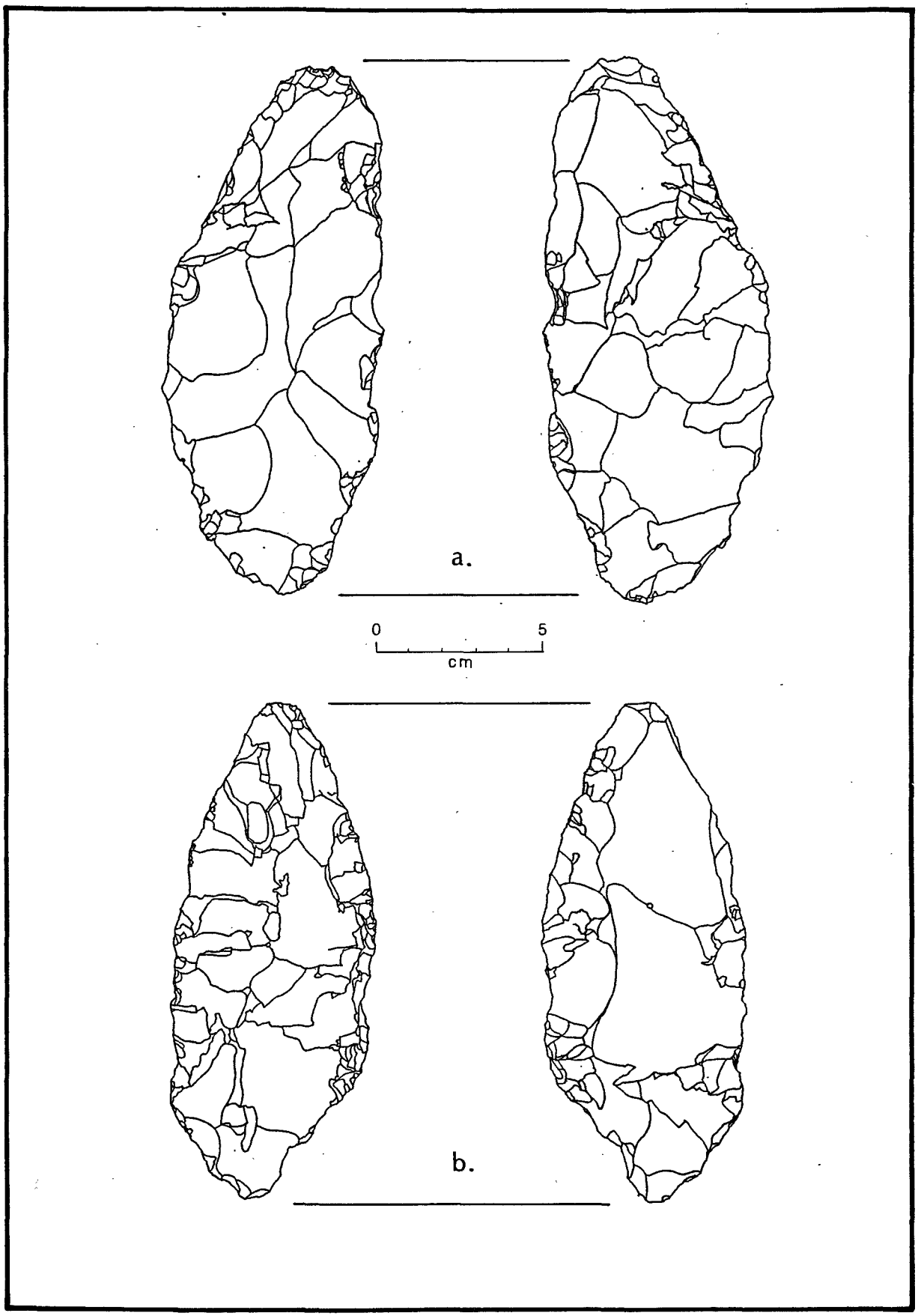

a.
0
5
cm
b.

Figure 26a, b. Bifaces from the Rusco Cache.


a.
0
5
cm
b.

Finally, the dimensions or early stage complete bifaces and biface fragments seem related to the size of objects in the cobble accumulations and cobble patches of discarded material in and around quarry pits. Cobble objects are well sorted in size, with most ranging between about 8 and 15 cm in maximum dimension. Consider that this is the size range at which pieces of tool stone are discarded. It appears that cores were discarded when they were too small to produce flake blanks of the correct size for large biface production. Little or no effort was expended on a piece of toolstone once it reached that size range. Consequently, there are few, if any (we observed none), well-developed cores in the quarry areas. The strategy was to handle the raw material as little as possible. Large pieces apparently were reduced to the size that one or two large flakes could be struck off the sides or ends, and then discarded.

Projectile Point Chronology

As previously mentioned, artifacts not directly related to opalite quarrying and processing are rare in quarry-related localities, and this includes temporally diagnostic projectile points. We observed only ten projectile points or projectile points preforms during the project; two of these were found, not in the Tosawihi District, but near our field camp at Hunting Blind Spring about two miles east of the project area in southeastern Big Butte Valley.

With one exception, points representative of all major periods in western Great Basin prehistory are present, from the Pre-Archaic between 6000 and 8000 B.C., through the Late Archaic between A.D. 500 and A.D. 1850 (Elston 1986). The exception is that no points key to the Rosegate Series, Late Archaic points used between A.D. 500 and A.D. 1100, although one specimen rejected by the Thomas (1979) key may well be a reworked Rosegate point. Projectile point observations appear in Appendix B.

Chapter 8. SUMMARY AND CONCLUSIONS

by Robert G. Elston

The Tosawihi Quarries are quite different from most Great Basin archaeological sites. The great extent of the quarry area, the density of surface artifacts, the complexes of quarry pits, outcrop quarries, rockshelters, and other cultural loci at first are bewildering. Underlying patterns are masked by the sheer abundance of archaeological material which, when viewed outside any frame of reference, suggest chaos.

Systematic survey of the Tosawihi District, followed by more intensive observation of quarry-related features and lithic scatters in the priority zone, was intended to provide such a framework, through description of the landscape and variation in the kinds and distribution of prehistoric localities across it. Data gathered thus will suggest where further evaluative studies are needed and provide a point of departure for planning and management of the District.

Certain findings and conclusions of the present study are summarized in the following discussions. Rather than statements of fact, many of these interpretations should be regarded as hypotheses to be tested in subsequent investigations.

Surface Debitage

Debitage scatters are most extensive and most dense in areas where opalite forms the bedrock; these scatters are related directly to toolstone procurement and initial processing at or adjacent to sources. Surface debitage density is highest at the source and tends to fall off with distance, although density also is affected by slope. Thus, areas of heavy-to-moderate density debitage (nearly always associated with quarry features) tend to be surrounded by areas of light density, with sparse density intervening. However, surface debitage scatters have more fine-grained structure than suggested by the 100 foot surface density plots presented in Figure 9. For instance, moderate density areas may contain smaller patches of heavy, light, or sparse density, and light density areas may contain patches of moderate density.

In areas where the bedrock is rhyolite or basalt (Owl Ridge, Red Hill Ridge), debitage is less extensive and dense; islands of sparse density, tending to occur on ridgetops and in saddles, are surrounded by expanses on slopes and drainage bottoms in which there are no cultural materials.

Discrete, light-to-moderate density flaking stations occur here and there throughout the District. These tend to occur on benches and saddles or overlooking drainages, are often associated with stands of big sage, and many probably are related to hunting. In opalite areas, such discrete scatters are masked by heavy-to-moderate density debitage in and around quarries, but can be distinguished where debitage is light-to-sparse.

Quarry-Related Localities

Prehistoric activities in quarry localities seem narrowly focused on just a few quarrying and processing activities; "residential" artifacts are rare at quarries. Still, some evidence of non-quarry-related land use exists within the quarry area, mainly in certain of the discrete debitage scatters recorded as flaking stations which, from their position in the landscape, appear related to hunting.

Most of the basic variation in quarry-related localities is a function of the nature of the opalite raw material: outcrop quarries and adits are found in surface exposures of bedrock; cobble quarries are associated with surface concentrations of opalite cobbles and boulders; quarry pits are excavated into colluvial deposits. Whether or not opalite was exploited at a particular spot in the landscape is likely a function of the interaction between raw material accessibility (given prehistoric technology) and quality.

There seems to be little technological variability among quarry pit features. Although pit size and depth do apparently not correlate, pits occur in a narrow range of sizes and depths. They usually are surrounded by berms of soil, waste rock, and the by-products of lithic assay and processing: flakes, shatter, assayed cobbles, cores, broken and rejected bifaces, and hammerstones.

These by-products tend to accumulate in pit bottoms and on pit berms. Size sorting in such accumulations appears to reflect a preferred size threshold for lithic products; material falling below that threshold was discarded.

Size sorting and lack of developed cores suggests an approach to toolstone procurement that minimized the time spent in processing and optimized the amount of toolstone processed. This apparently involved initial selection of pieces larger than a certain threshold; except to assay quality, smaller fragments were ignored. Boulders were broken into pieces within a size range such that removal of one to a few large flakes (suitable as biface blanks) reduced the core below the critical threshold and it then was discarded. This allowed a large amount of toolstone to be examined and the best material selected in the least amount of time. Such a strategy can pay off only when toolstone is as abundant as it is in the Tosawihi District.

Toolstone Diversity

Toolstone diversity (number of discrete toolstone sources represented) is least at quarries, where most toolstone is derived from the particular source. The occasional presence of color varieties of opalite at a source where they obviously had not been extracted suggests sequential exploitation of more than one source during a single visit to the quarry area.

Toolstone diversity is highest at residential sites (both open and in rockshelters), suggesting that material from numerous different sources was brought to such localities. Sources closest to a particular residential base were most likely to be exploited from that locality. While toolstone diversity is also high at localities 10, 31, and certain cobble quarries, this is due to variation in the raw material available at these localities and is not a cultural factor.

The incidence of exotic toolstone, such as obsidian, is highest in those small reduction stations that appear hunting related; such debitage probably is generated from maintenance of tools brought to the Tosawihi District from other areas.

Residential Sites

How people choose among quarry localities at any one time is not understood, but probably had something to do with the location of the residential base camp and duration of stay in the District vicinity. Our data suggest segmentation of toolstone procurement. Quarrying and initial processing were performed at or adjacent to the source, while subsequent processing took place at the residential base, most often located in relatively flat terrain near water.

The excavation of quarry pits and adits suggests a greater time investment and a longer duration of stay in the District vicinity than exploitation of surface cobbles, which could be accomplished by people who were merely passing through.

In turn, duration of stay probably was a function of scheduling demands, along with availability of local food resources and surface water. Seasonality of visits to the District, and the ways people supported themselves while there, are significant research problems. Fortunately, residential localities and discrete flaking stations associated with hunting have the potential to inform regarding subsistence, duration of occupation, seasonality, group size and composition, and a variety of other problem domains. The rockshelters containing dry deposits may contain well-preserved organic materials including bedding, cordage, and basketry, as well as wood, bone, and antler tools and weapons.

Technological Change and Cultural Chronology

Time diagnostic projectile points in the District suggest use of the area through 8,000 years or more. Whether or not the importance of opalite toolstone procurement has remained at the same level through that time is unknown, nor is it known if technological change in toolstone extraction and processing has occurred. It seems reasonable to expect that the first people to obtain toolstone from the District would have used the most cost-effective methods; high quality surface or near-surface material may have been "used up" before it became necessary to employ more intensive means of extraction.

Relative dates for quarry-related features may be obtained through stratigraphic superposition. Lichens are common on bedrock outcrops, debitage, and cobble objects throughout the District, and if basalt hammerstones have acquired desert varnish since their last use, cation dating may be possible. Whether or not lichenometry or cation analysis can provide relative dates will depend on a variety of technical factors not considered in the present study.

Absolute dates for quarry features are only possible if fire has been used in the quarrying process. Charcoal from campfires and heat treating ovens are likely to be present in both open residential localities and residential rockshelters. It may be possible to indirectly monitor changes in quarry

technology, and directly monitor changes in later stages of lithic reduction technology at these localities if stratified deposits are present.

Redundancy and Significance of Cultural Resources

As components of an archaeological district eligible for inclusion in the National Register of Historic Places, some cultural phenomena are absolutely essential to the significance of the District, while others are contributory to District significance to one degree or another. Greater redundancy does not equate with lesser significance. For instance, the Tosawihi District is significant precisely because it contains so many similar examples of quarry-related features and a vast multitude of artifacts representing relatively few categories.

In the same light, significance does not vary with artifact abundance. Thus, the debitage density map presented in Figure 9 is not in itself a map of archaeological significance as much as it is a planning aid and a qualitative indicator of potential significance.

Redundancy may vary with the level or intensity of investigation. Concentrating on gross distribution of surface debitage and variety in quarry pit features, there appears to be a great deal of technological uniformity and redundancy in the District. Whether this will hold at the level of lithic assemblages (the contents of localities), or through time, is not known.

What the demonstration and understanding of redundancy among cultural resources allows is their informed management and choice of representative samples for study and/or preservation. Redundancy <u>may</u> exist at every level throughout the District, yet be difficult to <u>demonstrate</u> because of the problem of adequately sampling the variety in a very large population with unknown parameters.

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APPENDIX A
(bound separately)

This appendix is comprised of an Intermountain Antiquities Computer System Site Form for site 26Ek3032, the Tosawihi Quarries Archaeological District. Included with the site form are descriptions and USGS topographic map plots for each of 219 prehistoric localities observed in June-July, 1987.

APPENDIX B

Table 1. Projectile Point Attribute List.

Table 2. Measurements and Observations on Collected Bifaces.

Table 1. Projectile Point Attribute List.

* Collected from Hunting Blind Spring

Catalog No.	Type	Material	LS	LT	LA	LM	WM	WB	NW	TH	Wt.	Est. Wt.	DSA	PSA	NOI	(BIR)	LT/WM	WB/WM	LM/LT	Comments
35-4	DSN	Obsidian	17.0	(21.5)	(20.5)	-	10.9	7.9	5.4	2.2	.4	.4	192	170	22	.95	1.97	.72	-	Complete point, tip broken but re-worked. Minimal reduction of lateral margins, minimal thinning.
*HBS-LOC R	CWT	Obsidian	17.2	17.2	16.4	16.7	9.7	9.7	-	2.7	.4	.4	-	-	-	.95	1.77	1.00	.97	Complete, fully reduced.
219-1	ECN	Obsidian	27.3	27.3	26.9	-	15.6	14.0	9.1	4.4	1.5	1.5	179	145	34	.99	1.75	.90	-	One tang broken, base too large for Rosegate, may be re-worked Elko Eared.
107-1A-1	ECN	White/Tan Opalite	25.4	(40.3)	(38.8)	-	19.9	16.5	11.4	4.4	2.5	4.5	154	143	11	.96	2.02	.83	-	Tip missing, one lateral margin re-sharpened.
	ECN	White Opalite	52.3	(91.8)	(91.8)	-	29.0	22.5	14.9	8.3	15.4	22.5	203	140	63	1.00	3.17	.78	-	Tip broken, poorly reduced, re-sharpened, keys to ECN, but very large, PSA too small for large Side-notched.
53-1A	EE	Basalt	19.9	(40.6)	(37.8)	-	19.4	14.6	12.7	6.1	2.6	5.0	221	113	108	.93	2.09	.75	-	Tip broken, margins re-sharpened.
81-1A	GSS	White Opalite	21.1	(53.1)	(50.0)	-	36.0	14.6	15.0	5.9	3.6	7.2	168	95	73	.94	1.48	.41	-	Tip broken, one lateral margin re-sharpened. PSA variable, 110o-95o. Could also key to Elko Eared.
*HBS-mapped	GBS	Basalt	31.0	(70.0)	(70.0)	(46.2)	23.5	16.4	15.6	6.2	4.8	9.0	216	92	124	1.00	2.98	.70	.66	Blade broken above shoulders. Stem is edge ground. Not keyed by Thomas 1981.
138-53-1B	GBS	Obsidian	35.9	-	-	-	-	18.5	-	(7.7)	7.5	15.0	-	-	-	-	-	-	-	Stem only, broken below shoulders. Heavily edge ground. Made on brown obsidian. Not complete enough for measurement of all attributes.
40-56-3	Out of Key	Obsidian	22.6	22.6	22.6	-	17.9	5.1	7.3	3.7	1.3	1.4	160	95	65	1.0	1.26	.28	-	Complete, tip and base re-worked. Extensively re-sharpened. Remnant notching suggests it originally keyed to Rosegate Series.
4-69-12	Preform	Obsidian	33.2	(34.9)	(34.9)	(34.1)	18.1	18.1	-	3.2	1.7	1.7	-	-	-	1.0	1.93	1.00	3.84	Small portion of tip missing. Too large (wt.) 1.5 gr.) for Cottonwood Triangular.

Measurements are in millimeters and grams; numbers in parentheses are estimated.

Abbreviations:

CWT - Cottonwood Triangular
DSN - Desert Side-notched
ECN - Elko Corner-notched
EE - Elko Eared
GBS - Great Basin Stemmed
GSS - Gatecliff Split Stem

LS - Actual Length
LT - Total Length
LA - Length of Longitudinal Axis
LM - Length from Proximal End of Point of the Maximum Width
WM - Maximum Width
NW - Neck Width
WB - Basal Width
TH - Thickness

Wt. - Weight in Grams
DSA - Distal Shoulder Angle, between 90o-270o
PSA - Proximal Shoulder Angle, between 0o-270o
NOI - Notch Opening Index
BIR - Basal Indentation Ratio, LA/LT

Table 2. Measurements and Observations on Collected Bifaces

Catalog Number	Type	Material	Length	Width	Thickness	Comments
188-12	Stage II	Slightly waxy surface, translucent, "butterscotch" opalite; dusky yellow (5Y 6/4) by reflected light; dark yellowish-orange (10YR 6/6) by transmitted light; with opaque, very pale orange (10YR 8/2) angular inclusions 6 mm max. dimension - these do not appear to affect workability, which appears to be very good.	8.96	5.16	1.24	This artifact is intact but appears to be a reworked fragment of a larger biface. It may have been discarded because of its relatively small size in combination with hinge terminated flake scars at either end. It was probably not heat treated.
44-01	Stage II	Matte surface, opaque, very light gray opalite (N8) with opaque white (N9), slightly grainy banding; internal fracture planes interfere with flaking and quality is medium.	8.54	5.89	1.54	This artifact is intact but appears to be a reworked fragment of a larger biface. It may have been discarded because of its size and the presence of fracture planes. It apparently has not been heat treated.
102-01	Early Stage III	"Opaque white (N9) opalite with opaque light gray (N7) inclusion; quality is good.	5.34	3.15	0.99	This artifact is a fragment, apparently truncated by end shock. The edges of the piece taper from the truncation to an irregularly blunt "base". Flaking tends toward collateral but is marred by many terminations; platforms on margins are created by unifacial scrubbing. This could be a Great Basin Stemmed point preform. It apparently has not been heat treated.

Table 2. Measurements and Observations on Collected Bifaces, continued.

Catalog Number	Type	Material	Length	Width	Thickness	Comments
107-L1A-02	Stage I	Waxy, opaque with translucent edges bluish-white (5B 9/1) opalite with faint opaque white banding; contains a few small (to 1 mm) crystal-filled vugs; quality is good.	8.67	6.05	1.48	This artifact is an end fragment. It was made on a flake with longitudinal curvature; one edge has not been fully reduced. The artifact was apparently heat treated as a flake blank and seems to have been smash truncated. It is one of 7 bifaces found together.
107-L1A-03	Stage III	Waxy, opaque, pinkish-gray (5YR 8/1) opalite with quartz grain inclusions and small vugs, both to 1 mm. Quality is medium.	5.68	2.99	0.86	This artifact is leaf-shaped with truncations at both tip and base. The basal truncation has not been reduced and a small graver-like projection created. The edges have been retouched and the margins are crushed. It is one of 7 bifaces found together.
107-L1A-04	Stage III	Waxy, opaque but translucent on edges, very pale orange (10YR 8/2) with waxy, opaque white and matte moderate orange-pink (5YR 8/4) banding; quality is very good.	5.68	2.70	0.85	This artifact is a fragment, truncated on both ends. The margins taper from one end to the other; the artifact was heat treated as a flake blank or early stage biface and reduced to its present form. The edges have been retouched and the edges are crushed; a red mineral (ochre ?) is embedded in cracks and flake scars. It is one of 7 bifaces found together.
107-L1A-05	Stage I	Waxy, opaque, yellowish-gray (5Y 7/2) on flake scars; some surfaces are matte; vugs to 3 mm and some quartz inclusions. Quality is poor to medium.	8.94	5.05	1.02	This artifact is a fragment, with end shock truncation. It was apparently heat treated as an earlier Stage 1 biface: most flake scar surfaces have a waxy texture, a few flake scars and one unreduced margin have matte surfaces. It is one of 7 bifaces found together.

Table 2. Measurements and Observations on Collected Bifaces, continued.

Catalog Number	Type	Material	Length	Width	Thickness	Comments
107-L1A-06	Stage II	Waxy, opaque, yellowish-gray (5Y 8/1) opalite with fine gray bands; some flake scar surfaces are matte; open vugs to 3 mm and some fracture planes; quality is poor to medium.	8.37	4.74	2.05	This artifact is a fragment, truncated on both ends; the truncation on one end has been partially reduced unifacially. This piece was apparently heat treated as an early Stage I biface. This is one of 7 bifaces found together.
107-L1A-07	Stage II	Waxy, opaque, bluish-white (5B 9/1) opalite with faint gray bands and large (to 8 mm open vugs); quality is poor to good.	8.04	5.34	1.21	This artifact is a fragment with one end truncated. It was apparently heat treated as a Stage I biface. This is one of 7 bifaces found together.
107-L1A-08	Late Stage I	Matte, opaque, pinkish-gray (5YR 8/1) opalite with open vugs to 4 mm. Quality is poor to medium.	8.12	5.45	1.32	This artifact is a fragment, with one end truncated. The piece has apparently been heat treated; recent flake scars from trampling have a waxy texture. The truncation has a matte surface and must have occurred prior to or during heat treatment.

AN ARCHAEOLOGICAL SURVEY

OF THE

U.S. STEEL PROJECT AREA

by
Elizabeth E. Budy, Ph.D.

Intermountain Research Project No. 631
Intermountain Research Cultural Resources Use Permit N-39918
Bureau of Land Management Cultural Resources Report No.1-1124(P)

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January 1988

INTERMOUNTAIN RESEARCH
REPORTS

MANAGEMENT SUMMARY

In November 1987, Intermountain Research performed a Class III cultural resources inventory (BLM 1985) of the U.S. Steel Project Area for Galactic Services, Inc. The U.S. Steel Project Area encompasses proposed mining development to be located adjacent (southwest) to the Tosawihi Quarries (26Ek3032), a prehistoric opalite quarry complex recommended for nomination to the National Register of Historic Places.

The project area includes about 120 previously surveyed acres in what has come to be called the Tosawihi Quarries Study Area; 28 prehistoric site localities, previously recorded as components of site 26Ek3032 (Elston et al. 1987), occur in the north and east portions of the proposed U.S. Steel Project Area. Previously recorded localities include 13 quarries, 12 lithic reduction sites, 2 rockshelters, and 1 isolated groundstone artifact.

The project area includes an additional 480 acres surveyed during present investigations which recorded 124 new prehistoric sites. These include 9 quarries, 71 lithic reduction sites, 16 small sites, 19 isolated artifacts, and 9 complex sites that may have seen short term residential use.

Most newly recorded sites are spacially discrete lithic reduction stations, or lithic reduction complexes, composed largely of the reduction debris of opalite transported from the nearby Tosawihi Quarries. In the U.S. Steel Project Area, quarry sites are limited to a few small opalite exposures. Nine sites contain small numbers of specialized tools (such as drills, scrapers, projectile points, groundstone), small quantities of obsidian, and a range of reduction stages and opalite materials that suggest short term residential use concurrent with opalite reduction. Collected projectile points include Gatecliff Split Stem, Elko Corner-notched, Large Side-notched, and Rosegate series, suggesting cultural use of the area for at least 5000 years.

Results of investigations suggest 37 sites will be affected by the proposed development, as presently designed: 8 are thought to be ineligible for National Register consideration, 3 are eligible, and 26 are potentially eligible. Recommendations include no further action on behalf of the ineligible sites, avoidance and protection of the 3 eligible sites, and testing and further evaluation of the 26 sites whose eligibility remains to be addressed.

Areal/Intensity Data:

Project study area is about 600 acres.
About 120 acres were previously surveyed (Elston et al. 1987).
About 480 acres were surveyed during present investigations.

Transect Interval/Number/Type	30 meters/44/linear
	30 meters/22/ contour

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Survey of the U.S. Steel Project Area was supervised by Elizabeth E. Budy, and assisted by Kenneth E. Juell, and Laurie A. Walsh. Michael P. Drews classified projectile points; Robert G. Elston provided supplementary artifact descriptions. Report graphics were produced by Michael P. Drews (text figures), Cardan Corporation (pocket maps), and Elizabeth E. Budy (artifact photos). Cashion Callaway edited the report. Data entry, word processing and report production were accomplished by Katherine Nickerson.

Susan Stornetta assisted the compilation of Intermountain Antiquities Computer System (IMACS) records for 124 sites.

Chapter 1. INTRODUCTION

Intermountain Research was contracted by Galactic Services, Inc. to conduct an archaeological inventory of their U.S. Steel Project Area, located about 45 air miles north of the town of Battle Mountain (Figure 1). The U.S. Steel Project is a proposed mining development to be located southwest of the Tosawihi Quarries (26Ek3032), a prehistoric quarry complex that has been recommended for nomination to the National Register of Historic Places (Figure 2). The project area includes about 120 acres (previously surveyed) in the Tosawihi Quarries Study Area defined by Elston et al. (1987) as well as about 480 acres surveyed during present investigations.

The Class III cultural resources survey (BLM 1985) was conducted to identify and evaluate cultural resources in the project area and to provide recommendations for their management. The work was undertaken in compliance with Executive Order 11593 and the National Historic Preservation Act of 1966, as amended, and as implemented by Advisory Council Procedures 36 CFR, Part 800.

Field work was conducted between November 10 and November 22, 1987. Mr. Stanley Jaynes of the BLM Elko Resource Area office was consulted by telephone on November 9 regarding the pending survey, and was advised of the preliminary results on November 23, 1987.

Figure 1. Project vicinity map.

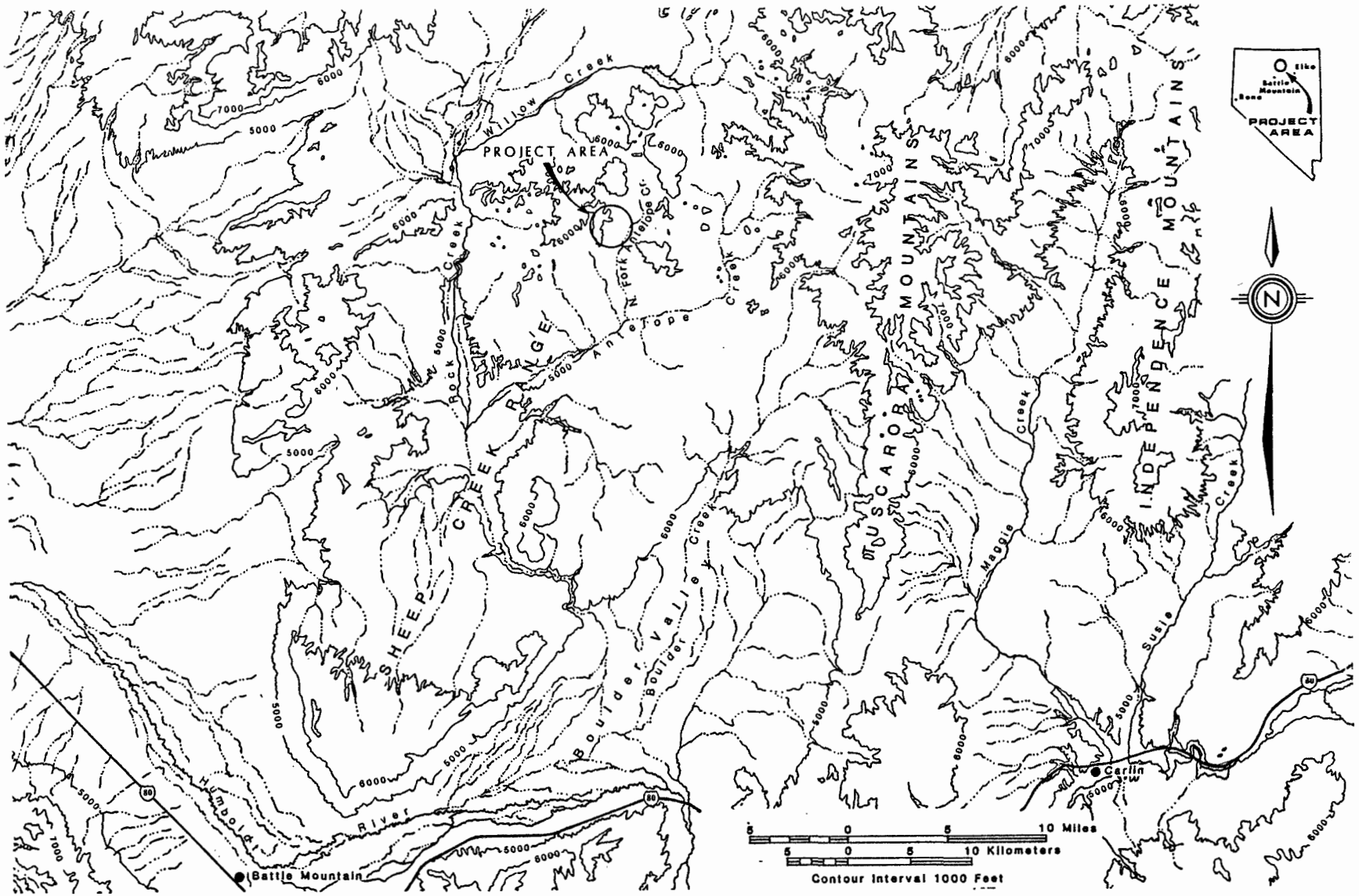
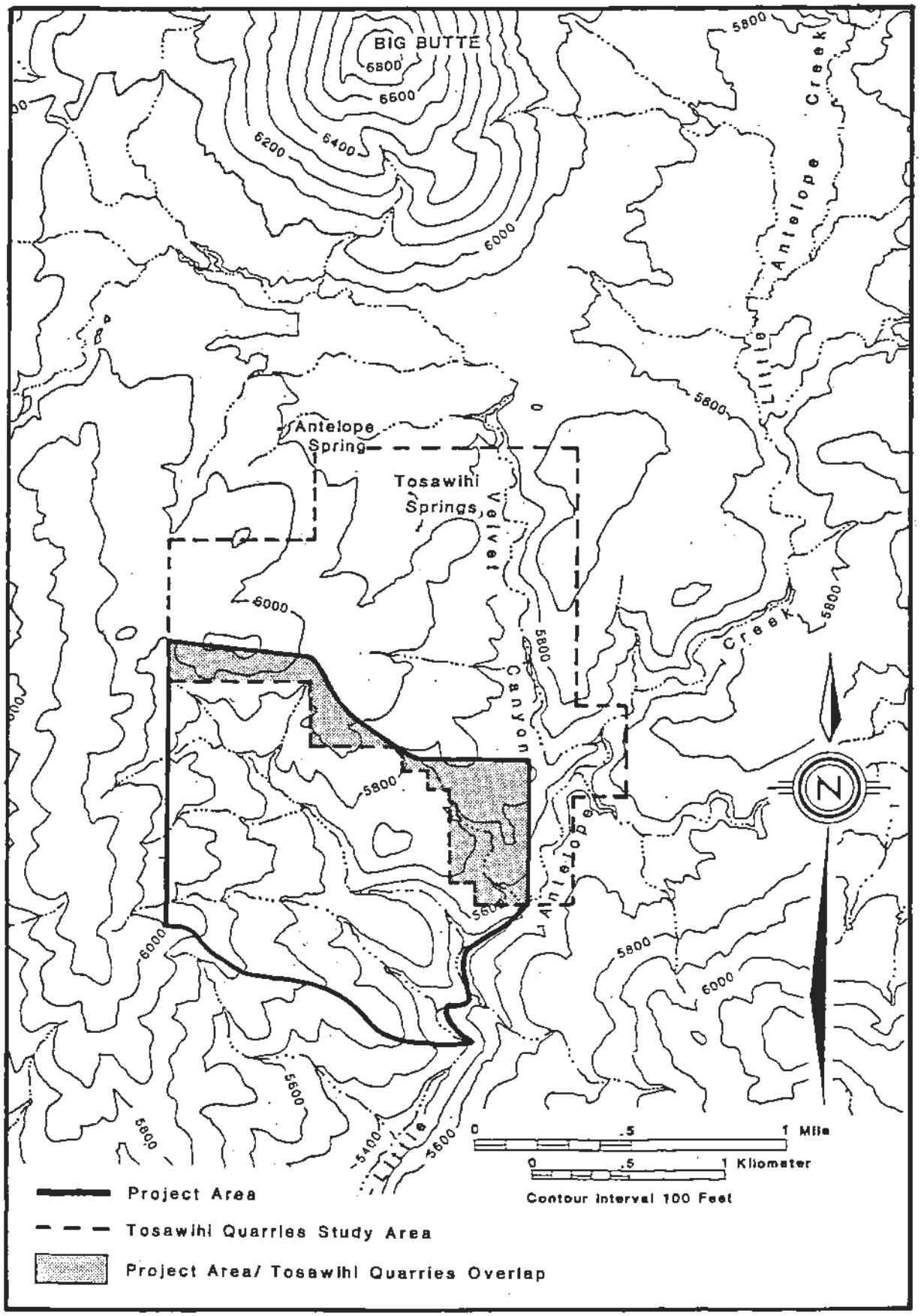

PROJECT AREA
Willow Creek
Rock Creek
North Fork Antelope Cr.
Antelope Cr.
SHEEP CREEK RANGE
Boulder Valley
Boulder Creek
MUSCAROA MOUNTAINS
INDEPENDENCE MOUNTAINS
Maggie Creek
Susie Creek
Humboldt River
Battle Mountain
Carlin
80
5000
6000
7000
8000
Elko
Battle Mountain
Reno
PROJECT AREA
N
5 0 5 10 Miles
5 0 5 10 Kilometers
Contour Interval 1000 Feet

Figure 2. Project location map, showing relationship of the U.S. Steel Project Area to the Tosawihi Quarries Study Area (Elston et al. 1987).


BIG BUTTE
6800
6600
6400
6200
6000
5800
Little Antelope Creek
Antelope Spring
Tosawihi Springs
Tosawihi Valley
Canyon
Creek
Little Antelope
N
0 .5 1 Mile
0 .5 1 Kilometer
Contour Interval 100 Feet
Project Area
Tosawihi Quarries Study Area
Project Area/ Tosawihi Quarries Overlap

Project Description

Galactic Services proposes to develop a gold mine at their U.S. Steel Property. Ore extraction will be by open pit method, and reduction will employ the cyanide heap leaching process. Thus, the mine development will be comprised of pit, haul roads, waste dumps, leach pad, ore piles, topsoil storage, mill site, equipment yard, and other support facilities. Legal descriptions of the project area, based on the U.S.G.S. Willow Creek Reservoir SE Quad, 7.5', (1965), are as follow:

SW 1/4 of SW 1/4 of Section 4, T37N, R48E
W1/2 of NW 1/4 of SW 1/4 of Section 4, T37N, R48E
Portions of SW 1/4 of NE 1/4 of SW 1/4 of Section 4, T37N, R48E
Portions of NW 1/4 of SW 1/4 of SW 1/4 of Section 4, T37N, R48E
Portions of SW 1/4 of SW 1/4 of SW 1/4 of Section 4, T37N, R48E

SE 1/4 of Section 5, T37N, R48E
W 1/2 of SE 1/4 of NE 1/4 of Section 5, T37N, R48E
SW 1/4 of NE 1/4 of Section 5, T37N, R48E
E 1/2 of SE 1/4 of NW 1/4 of Section 5, T37N, R48E
E 1/2 of NE 1/4 of SW 1/4 of Section 5, T37N, R48E
E 1/2 of SE 1/4 of SW 1/4 of Section 5, T37N, R48E

NE 1/4 of NE 1/4 of Section 8, T37N, R48E
NE 1/4 of NE 1/4 of NW 1/4 of Section 8, T37N, R48E
E 1/2 of NW 1/4 of NE 1/4 of Section 8, T37N, R48E
Portions of NE 1/4 of SE 1/4 of NE 1/4 of Section 8, T37N, R48E
Portions of W 1/2 of NW 1/4 of NE 1/4 of Section 8, T37N, R48E

NW 1/4 of NW 1/4 of Section 9, T37N, R48E
N 1/2 of SW 1/4 of NW 1/4 of Section 9, T37N, R48E
SE 1/4 of SW 1/4 of NW 1/4 of Section 9, T37N, R48E
Portions of NW 1/4 of NE 1/4 of NW 1/4 of Section 9, T37N, R48E
Portions of SW 1/4 of NE 1/4 of NW 1/4 of Section 9, T37N, R48E
Portions of NW 1/4 of SE 1/4 of NW 1/4 of Section 9, T37N, R48E
Portions of SW 1/4 of SE 1/4 of NW 1/4 of Section 9, T37N, R48E

While the project area encompasses some 600 acres, proposed developments are planned for the southern portion of the project area. The pit is to be located on Red Hill in an area where intensive minerals exploration has occurred intermittently since 1963 (Hollister 1986:4-6). Red Hill is circumscribed by roads and drill pads from this exploration activity (Figure 3). Support facilities are to be located on ridges and in canyons southwest of Red Hill (Figure 4). A proposed plan of operation for the mine development is detailed in Chapter 8.

Report Organization

The following discussions report the archaeological inventory and evaluation work undertaken on behalf of the U.S. Steel Project. The physical environment of the project area is described in Chapter 2 and the cultural setting is described in Chapter 3. Field and laboratory methods are detailed in Chapter 4. Chapter 5 presents the results of survey and artifact observations are discussed in Chapter 6. The two concluding chapters discuss site significance evaluations (Chapter 7), assess project effects and offer cultural resource management recommendations (Chapter 8).

Figure 3. Overview (north) of Red Hill, site of proposed pit.

Figure 4. Overview (north) of area proposed for ancillary development.



Figure 3.



Figure 4.

Chapter 2. PHYSICAL SETTING

The reader is referred to Elston et al. (1987) for a detailed description of the study region. Here, description is confined to the project area and its immediate surrounds.

The project area is located along moderately steep, dissected terrain that forms tributaries to Little Antelope Creek (Figure 5). On the west, a series of southeast-trending finger ridges, cut by narrow ephemeral drainages, descend (10% slope) to the canyon of Little Antelope Creek which forms the east boundary of the project area (figures 5 and 6). On the north, the project area boundary extends from Twin Butte (also known locally as Crow's Nest) on the northwest, along Boundary Ravine, to Little Antelope Canyon near Confusion Gorge. The south boundary of the project area follows the crest of a ridgeline. Basalt Canyon, an important but ephemeral tributary to Little Antelope Creek, bisects the project area, forming a divide between Red Hill and Prospector Point, and providing road access through the area (figures 5 and 7).

Elevations range from 5425 feet amsl on the southeast in Little Antelope Creek, to 6125 feet amsl on the northwest at the summit of Twin Butte. Slopes range from strongly sloping (10%) ridgelines broken by numerous small flats, terraced knoll tops, and saddles, to moderately steep drainage slopes (15-30%), with steep to very steep slopes (33-50%) along the south side of Red Hill, around Prospector Point, and along the north side of Sunday Peak (see Figure 5).

Geology

The geology of the project area has been mapped as Tertiary basalt (Coats 1987: Plate 1), but has not been described in detail. Basalt occurs as talus stripes on ridge slopes and as scattered surface cobbles on ridge tops. On the northwest, talus is composed of large basalt cobbles; on the southwest, thin, tabular pieces of rhyolite are characteristic. Large basalt cobbles were transported prehistorically from the area to the Tosawihi Quarries where they served as hammerstones and provided raw material for projectiles and digging tools; similarly, tabular rhyolite pieces provided seed grinding surfaces and abraders for percussion tools (Elston et al. 1987:6, 94-98).

The Tosawihi Quarries, north of the project area, encompass an extensive opalite zone that was quarried intensively for prehistoric toolstone (Elston et al. 1987).

Figure 5. Topography of the project area.

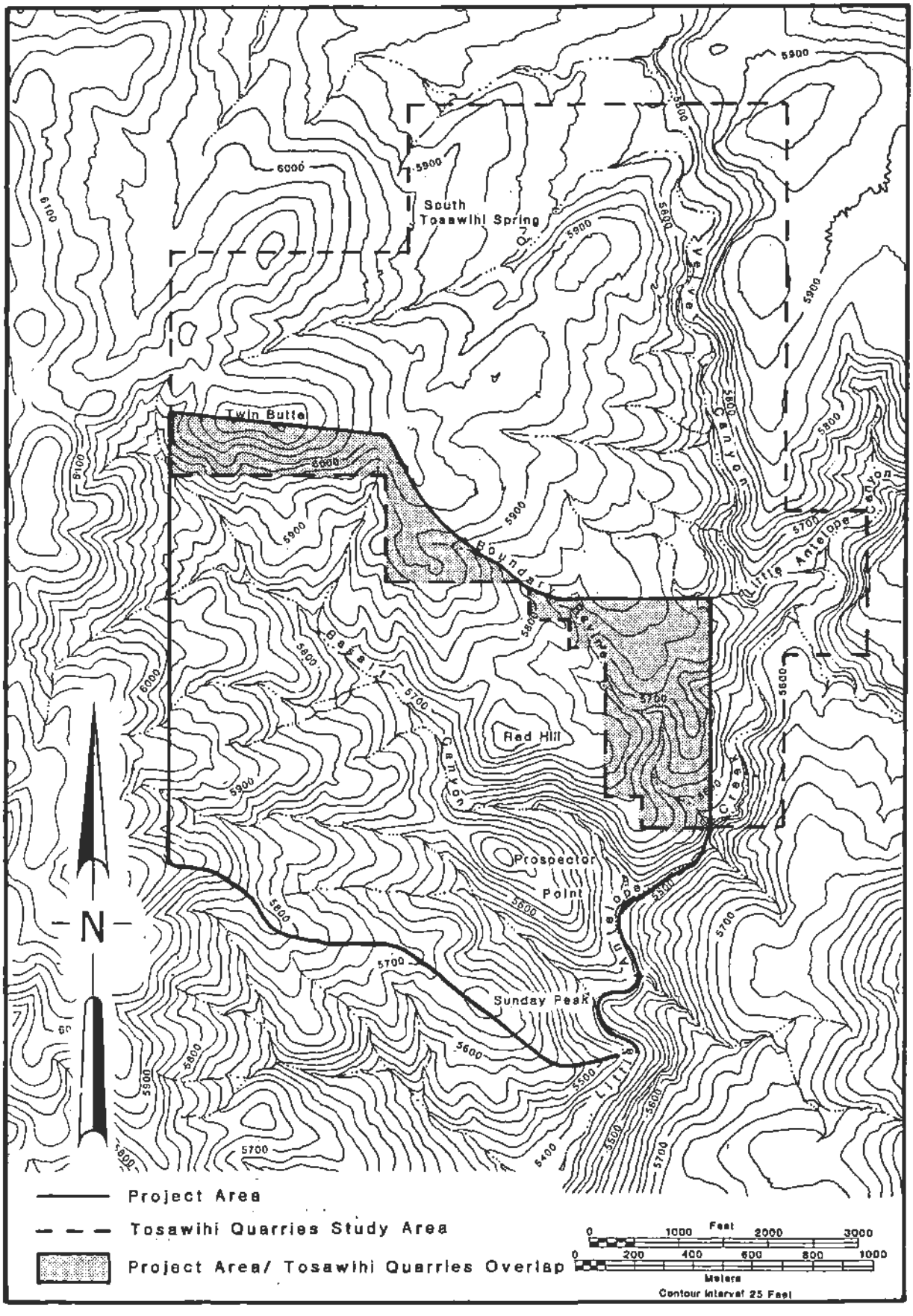

South
Tosawihi Spring
Twin Butte
Red Hill
Prospector
Point
Sunday Peak
Little Antelope Creek
Project Area
Tosawihi Quarries Study Area
Project Area/ Tosawihi Quarries Overlap
0 1000 Feet 2000 3000
0 200 400 600 800 1000
Meters
Contour Interval 25 Feet

Figure 6. Overview (north) of eastern project boundary, along Little Antelope Canyon. Confusion Gorge can be seen in upper center.

Figure 7. Overview (north) of western project boundary. Twin Butte on western horizon, Red Hill on eastern horizon, Basalt Canyon at photo center, and Big Butte in background.



Figure 6.



Figure 7.

Opalite formation is the product of late Miocene or early Pliocene silicification of volcanic rocks and sediments (rhyolitic ash, tuffs, obsidian, and rhyolite) induced by a series of hydrothermal episodes. Permeation of the matrices by silica-rich solutions along fissures and bedding planes resulted in localized deposits of opalite that subsequent millenia of dehydration and crystallization have transformed into a chert-like group of cryptocrystallines (Bailey and Phoenix 1944:17-21).

The surface and near surface deposits of opalite which outcrop in the Tosawihi Quarries are rare in the U.S. Steel Project Area. Boundary Ridge defines the southern limit of the zone of opalite mineralization, although a few small outcrops are located along the southern crest of Red Hill in the project area. Opalite cobbles occur as occasional components of alluvial gravels in the bottom of Basalt Canyon.

Soils deriving from basalts and rhyolites on the western ridges are characteristically red in color. Each of the prominent knolls on the southeast above Little Antelope Creek is a different formation with distinct surficial deposits: Prospector Point and Sunday Peak have dark brown soil with large surface areas covered by gravel-to-pebble-sized pieces of fractured opalite and occasional boulder-sized outcrops of nonsiliceous opalite materials unsuitable for toolstone. Soil color on Red Hill is variable, ranging from light orange to red; nonsiliceous opalite is present on the surface, ranging from gravel-to-cobble-sized pieces, with rare boulders. Siliceous opalite, of variable toolstone quality, occurs as small, near surface outcrops along the south crest of Red Hill and on the extreme northeast margin of the project area along Boundary Ravine. A description of the stratigraphy, processes of alteration, and rock types is being developed (Don Hruska, personal communication 1987).

Hydrology

No perennial water sources are located in the project area. Little Antelope Creek channels seasonal runoff from a sizable watershed. Persistent (but ephemeral) seeps form in Velvet Canyon, a significant tributary to the north. The many small drainages tributary to Basalt Canyon, and thence to Little Antelope Creek, are active only briefly during storm episodes. Two springs occur north of the project area, one at the confluence of Velvet and Little Antelope canyons and one (Tosawihi Spring) in the flats south of Big Butte; both were moribund by mid-August, 1987 (Elston et al. 1987:6).

The fugitive nature of water resources in the vicinity of the Tosawihi Quarries may have constrained prehistoric habitation to short term and/or seasonal use (Elston et al. 1987:111-112).

Vegetation

The study area is an expression of the Artemesian biotic province characteristic of the high desert valleys and lower foothills of the northern Great Basin (Billings 1951:110-113; Cronquist et al. 1972:122-125). Three communities of this sagebrush-grass zone are found in the project area. A low sage community forms open cover on the basalt ridges with their thin soil mantle; species include low sage (Artemesia arbuscula), phlox (Phlox sp.), snakeweed (Gutierrezia sarothrae), green rabbitbrush (Chrysothamnus viscidiflorus), with occasional grasses such as squirreltail (Sitanion hystrix) and Idaho fescue (Festuca idahoensis). Big sage (Artemesia tridentata) mixed with small amounts of rubber rabbitbrush (Chrysothamnus nauseosus), Great Basin wildrye (Elgmus cinereus), and bluebunch wheatgrass (Agropyron spicatum) is limited to steep north-facing slopes, drainage bottoms, and occasional low soil mounds on ridge tops; however, where present, big sage forms a rather dense cover with some nearly impenetrable thickets, especially along drainage bottoms. Grasses and snakeweed compose the third community; grasses form notably thick cover on the top and upper slopes of Prospector Point, but compose small island communities on Red Hill and Sunday Peak.

Fauna

Animals noted during survey were limited to occasional coyote (Canis latrans), cottontail rabbit (Sylvilagus spp.), and chipmunk (Eutamias spp.). Big sagebrush thickets were woven by fresh trails of coyote and cottontail spoor, often overlapping. Badger (Taxidea taxus) burrows and rodent turbated slopes signal the presence of some common, but seldom observed, residents. Antelope (Antilocapra americana) were noted during an earlier survey (Elston et al. 1987:8), and mule deer (Odocoileus hemionus) are likely seasonal visitors.

Chapter 3. CULTURAL SETTING

A cogent summary of ethnographic patterns, cultural chronology, and previous archaeological research is provided in a survey report for the adjacent Tosawihi Quarries (Elston et al. 1987). The discussions which follow highlight selected cultural background information and guide the reader to relevant literature sources.

Ethnography

The project area constitutes a portion of the foraging territory used by the ethnographic Tosawihi, or "White Knife," Shoshoni whose winter settlements were centered along the Humboldt River in the vicinity of present day Battle Mountain (Steward 1938). The group name refers to a locally available white toolstone (Steward 1938:162), most certainly the Tosawihi Quarries opalite. Ethnographic sources include Steward (1937, 1938, 1939, 1941), Harris (1940), and Powell and Ingalls (1874), but they record little ethnographic data concerning the mechanisms of opalite procurement, transport and trade, or relationships to Shoshoni settlement and subsistence. These questions are the focus of previous archaeological studies in the vicinity, as described below.

Previous Research

The archaeology of the project area is tied closely to inquiry into the exploitation and manipulation of opalite toolstone from the Tosawihi Quarries. Though the significance of the quarries has been known for some time (cf. Steward 1938), research has been limited and present understanding is preliminary.

An intensive reconnaissance of the 823 acre Tosawihi Quarries Study Area recently was conducted by Elston et al. (1987). The study recorded 219 prehistoric localities: isolated artifacts, discrete clusters of artifacts, rockshelters, open residential localities, and quarry-related localities (isolated quarry pits, quarry pit complexes, outcrop quarries, adits, and surface cobble quarries).

Investigation of the Tosawihi Quarries was initiated by Mary Rusco in the 1970s. Initial research focused on chemical as well as macroscopic physical characterization of Tosawihi opalites and on the distribution of apparent Tosawihi material in sites outside the quarry source, in light of gravity models

and ethnic boundaries (Rusco 1976a, 1976b, 1978, 1979, 1983). X-ray fluorescence methods for chemical characterization so far have proven equivocal (Duffe' 1976a, 1976b), but other approaches are being contemplated (Mary Rusco, personal communication 1987).

Identification of the nature and distribution of lithic materials derived from the Tosawihi Quarries has been addressed by subsequent research at archaeological sites 70 to 90 km east of the quarry source: at South Fork Shelter (Heizer et al. 1968; Spencer et al. 1987:72), at James Creek Shelter (Elston and Budy 1989), and at sites near Carlin (Rusco and Jensen 1979) and along Susie Creek (Armentrout and Hanes 1987).

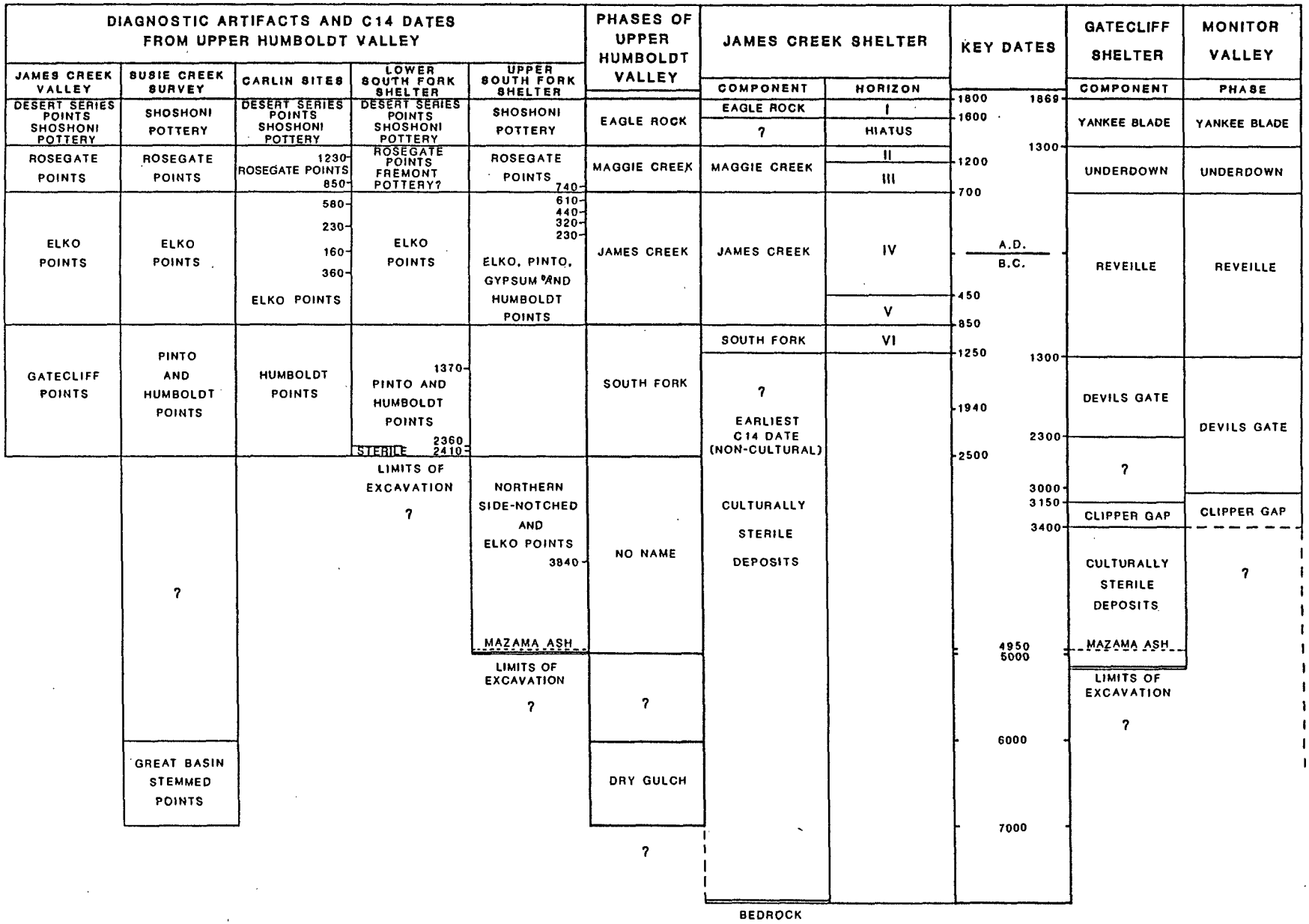
Investigations at five late prehistoric sites at the proposed Rock Creek Dam location, about 30 km southwest of the project area, indicate that reduction of Tosawihi opalite bifaces was a primary activity there; it has been inferred that the material was taken to the sites in the form of Stage II or Stage III bifaces (Clay and Hemphill 1986). Tosawihi opalite was also the dominant toolstone material present at seven sites investigated near the Rossi Mines, located about 10 km east of the Tosawihi Quarries (Rusco 1982); there, projectile points suggest a possible time depth of 8500 years.

The most intensive archaeological investigations to have been undertaken in the region were in connection with development of the Valmy power plant some 50 km southwest of the Tosawihi Quarries; studies included preliminary surveys (Bard 1980; Busby and Bard 1979; Rusco and Seelinger 1974) and intensive surface collections and test excavations at several sites near Treaty Hill (Davis et al. 1976; Rusco and Davis 1979; Elston et al. 1981). These investigations indicate human use of the area over the past 7000 years, with Tosawihi opalite composing the dominant toolstone at the sites studied.

Cultural Chronology

Syntheses of the regional cultural chronology are available in James (1981), Rusco (1982), Smith et al. (1983), and Elston (1986); Figure 8 compares regional cultural sequences. A sequence proposed for the upper Humboldt, based on recent excavations at James Creek Shelter (Elston and Budy 1989), 50 km southeast of the project area, is outlined below.

Figure 8. Prehistoric chronology for the upper Humboldt Valley, Nevada (after Elston et al. 1987:Figure 4).


DIAGNOSTIC ARTIFACTS AND C14 DATES FROM UPPER HUMBOLDT VALLEY
JAMES CREEK VALLEY
SUSIE CREEK SURVEY
CARLIN SITES
LOWER SOUTH FORK SHELTER
UPPER SOUTH FORK SHELTER
PHASES OF UPPER HUMBOLDT VALLEY
JAMES CREEK SHELTER
COMPONENT
HORIZON
KEY DATES
GATECLIFF SHELTER
COMPONENT
MONITOR VALLEY
PHASE
DESERT SERIES POINTS SHOSHONI POTTERY
SHOSHONI POTTERY
DESERT SERIES POINTS SHOSHONI POTTERY
DESERT SERIES POINTS SHOSHONI POTTERY
SHOSHONI POTTERY
EAGLE ROCK
EAGLE ROCK
I
1800
1869
YANKEE BLADE
YANKEE BLADE
?
HIATUS
1600
1300
ROSEGATE POINTS
ROSEGATE POINTS
1230
ROSEGATE POINTS
850
ROSEGATE POINTS FREMONT POTTERY?
ROSEGATE POINTS
740
MAGGIE CREEK
MAGGIE CREEK
II
III
1200
700
UNDERDOWN
UNDERDOWN
ELKO POINTS
ELKO POINTS
580
230
160
360
ELKO POINTS
ELKO POINTS
610
440
320
230
ELKO, PINTO, GYPSUM AND HUMBOLDT POINTS
JAMES CREEK
JAMES CREEK
IV
A.D.
B.C.
REVEILLE
REVEILLE
450
V
850
GATECLIFF POINTS
PINTO AND HUMBOLDT POINTS
HUMBOLDT POINTS
1370
PINTO AND HUMBOLDT POINTS
2360
STERILE
2410
SOUTH FORK
SOUTH FORK
VI
1250
1300
DEVILS GATE
DEVILS GATE
?
EARLIEST C14 DATE (NON-CULTURAL)
1940
2300
2500
?
3000
3150
CLIPPER GAP
CLIPPER GAP
3400
LIMITS OF EXCAVATION
?
NORTHERN SIDE-NOTCHED AND ELKO POINTS
3840
NO NAME
CULTURALLY STERILE DEPOSITS
CULTURALLY STERILE DEPOSITS
?
MAZAMA ASH
MAZAMA ASH
4950
5000
LIMITS OF EXCAVATION
?
?
?
6000
GREAT BASIN STEMMED POINTS
DRY GULCH
7000
?
BEDROCK

Dry Gulch Phase: ? - 6000 B.C.

Diagnostic artifacts for the earliest known phase for the upper Humboldt include large, concave-base projectile points, Great Basin Stemmed points, flaked stone crescents, heavy core tools, scrapers, and choppers. Originally defined as a lacustrine adaptation, or the Western Pluvial Lakes Tradition (Bedwell 1973), presently it is recognized in riparian and upland settings as well. Regarded as pre-Archaic in the broader sequence of Great Basin adaptations (Elston 1982), the phase is characterized by a distinctive lithic technology, lack of seed grinding implements, and a high degree of residential mobility. Artifacts diagnostic of the phase have been noted at Valmy (Elston et al. 1981), Susie Creek (Armentrout and Hanes 1987), Rye Patch Reservoir (Rusco and Davis 1982), and at the Tosawihi Quarries (Elston et al. 1987).

No Name Phase: 5000-2500 B.C.

The emergence of the Early Archaic adaptation in the upper Humboldt River drainage is marked by Northern Side-notched and Humboldt Series projectile points (Heizer and Hester 1973; Thomas 1981, 1983). Elsewhere in the Great Basin, early Archaic adaptations reflect the inception of intensified seed use, increased locational diversity in land-use patterns, probable increase in breadth of diet, and logistical structuring of subsistence pursuits. In the upper Humboldt, few sites of this time period have been observed (Elston and Budy 1989).

South Fork Phase: 2500-850 B.C.

The Middle Archaic adaptation on the upper Humboldt is not well characterized by existing data; however, Humboldt and Gatecliff Series projectile points are considered diagnostic (Elston and Budy 1989).

James Creek Phase: 850 B.C.-A.D. 700

This phase marks the full expression of the Archaic adaptation. Elko Series projectile points are the principal phase-markers, and their distribution indicates the exploitation of an extremely wide range of settings and resources, a marked broadening of the prey-base, and a more eclectic use of the environment.

Maggie Creek Phase: A.D. 700-1300

At James Creek Shelter, this phase is characterized by further intensification of plant exploitation, increased pursuit of small game, and introduction of the bow and arrow. Rosegate Series projectile points (and Fremont Grayware ceramics in the eastern Great Basin) are diagnostic.

Eagle Rock Phase: A.D. 1300 to protohistoric times

The phase apparently represents the archaeological record of the Numic peoples who occupied the area at historic contact. Along the upper Humboldt, the phase is marked by Desert Series projectile points (Desert Side-notched and Cottonwood), and by Shoshone Brownware ceramics (Elston and Budy 1989).

History

The project area is located in the historic Ivanhoe Mining District (Bailey and Phoenix 1944:17-21). Mercury ore was discovered in 1911, but development, north of the project area at the Clementine, Butte, and Velvet workings, dates from about 1929 (Zeier 1987:6). Mining continued intermittently through the 1940s, with most production generated by the Butte Quicksilver Mine. Mercury mining increased with the advent of World War II and lasted (at least intermittently) until 1947. Mining saw a brief resurgence between 1957 and 1962, and again in 1966, likely in response to increased international mercury prices (Zeier 1987:6). In 1979, exploratory drilling for other mineral resources was initiated in the area. Gold was found associated with the local opalite formation and deposits at Red Hill, initially located by U.S. Steel (Hollister 1986), motivate the present proposed mining developments.

Chapter 4. STUDY METHODS

Field work was accomplished in two field sessions in November, 1987. Session I surveyed 250 acres and recorded 62 sites. Session II surveyed 230 acres and recorded an additional 62 sites.

Two periods of snowfall imposed constraints on field work, interrupting and delaying survey which resumed when snow cover diminished to less than 30% coverage. Finally, a few small areas on north-facing slopes and small narrow drainages remained with 30-60% snow cover (Figure 9); it should be noted that these areas were inspected casually but were not accorded the systematic coverage received by the remainder of the project area. The potential for the occurrence of cultural remains in these areas is considered negligible.

Survey Methods

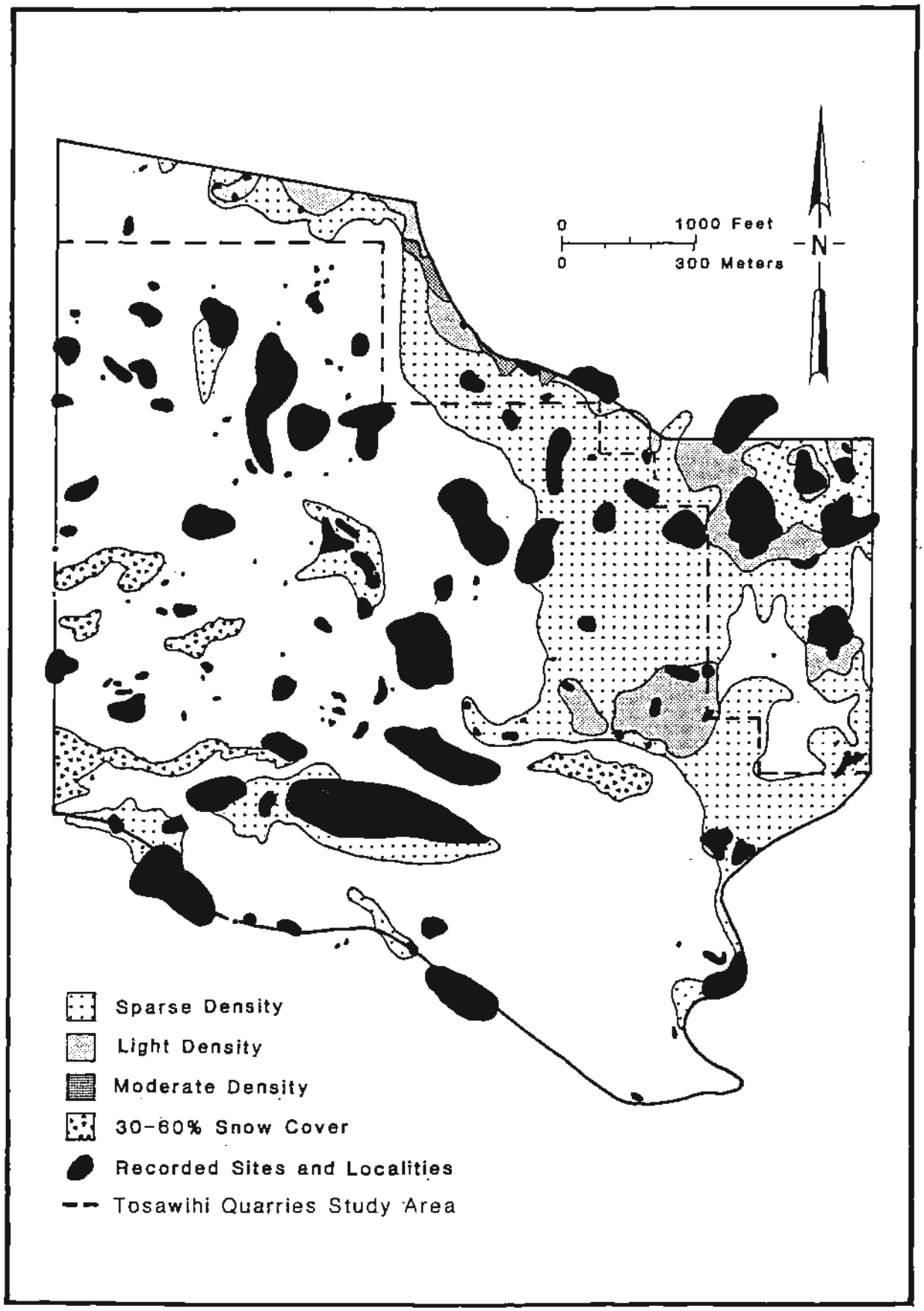
Except for minor adjustments dictated by snow cover and terrain, survey was conducted at the same level of intensity and used the same reconnaissance strategies implemented during the earlier survey of the Tosawihi Quarries Study Area (Elston et al. 1987). Galactic Services, Inc. provided 1:6000 (1 in. = 500 ft.) topographic maps (5 feet contour intervals) of the project area; these were used to orient transects, maintain geographic control, and plot archaeological sites. Survey was facilitated by an existing survey grid staked at 400-foot intervals over most of the project area.

Survey transect interval was established at 30 meters, using both cardinal direction and contour transects. Forty-four cardinal direction transects, some oriented north-south, others oriented east-west, were established over the western and northern portions of the project area. The steep slopes of Red Hill, Prospector Point, and Sunday Peak were surveyed along 22 transects oriented parallel to slope contours.

Recording

Each field party member was responsible for recording all cultural observations made along each transect that he/she walked. Each spacially discrete observation was assigned a temporary site number; data were recorded on field transect records. Intermountain Antiquities Computer System (IMACS) site forms then were completed for each of the 124 prehistoric sites recorded.

Figure 9. Project area map showing zones of snow cover relative to recorded sites and localities.


0
1000 Feet
0
300 Meters
N
Sparse Density
Light Density
Moderate Density
30-60% Snow Cover
Recorded Sites and Localities
Tosawihi Quarries Study Area

Consistent with methods used by Elston et al. (1987), debitage density over the project area was recorded at 100-foot intervals along survey transects. The estimation and recording of debitage density observed the following conventions:

0:	No debitage noted over 100 transect-feet.
Sparse:	Average density of less than 1 flake/m^2.
Light:	Average density of 1-100 flakes/m^2.
Moderate:	Greater than 100 flakes/m^2; bare ground visible.
Heavy:	Unbroken pavement of debitage; bare ground not visible.

Unlike the primary quarry zone to the north, where debitage forms a variable density, but ubiquitous, scatter, sites in the project area tend to be spacially discrete and zones between sites are characterized by zero or sparse amounts of debitage (see Figure 9). Light density scatters were recorded as discrete sites. Exceptions are noted only in the few places where local opalite sources were quarried for toolstone, and where debitage materials have been dispersed down steep slopes (see Figure 9).

Collection

Due to the scarcity of temporal indicators in the vicinity, all projectile points observed (n=11) were collected. In addition, one exceptionally large biface was collected from a disturbed context at site 631-38. Similarly, an unmodified obsidian pebble was collected along Little Antelope Creek, outside the project area.

Following field work, collected artifacts were cleaned, numbered, cataloged, and bagged for storage. Catalog numbers, comprised of temporary site number and specimen number, were applied directly to individual items with china white or black india ink coated with clear lacquer. Field and laboratory notes and logs, mapping notes, photo logs and negatives, artifact assemblage and catalog, and this report will be accessioned by the Museum of Anthropology, University of Nevada, Reno, where they will be available to future

teaching and research endeavors. Intermountain Antiquities Computer System (IMACS) site forms have been filed with the BLM Elko Resource Area office.

Lithics Analysis

Prior to their collection, artifacts were plotted on field maps and proveniences were recorded with compass bearings and survey coordinates. Classification of projectile points is based on morphological criteria specified by Thomas (1981). In addition to length, width, thickness, and weight attributes, notching or shoulder angles are measured and various ratios between attributes calculated. Bifaces recorded during survey were classified according to the three stage reduction scheme developed by Muto (1971), and as further described by Elston et al. (1987) for bifaces examined in the Tosawihi Quarries.

Chapter 5. RESULTS OF SURVEY

A total of 152 sites occur in the project area (Figure 10, pocket map); 28 are localities recorded during survey of the Tosawihi Quarries Study Area (Elston et al. 1987); 124 are new sites recorded during present survey. New sites include two sites observed previously by BLM personnel, but not fully recorded until the present study: site 631-35 (CRNV-01-2009) and site 631-45 (CRNV-01-2008).

Previously Recorded Localities

Previously recorded localities are represented by isolated artifacts, and discrete features and feature clusters originally recorded as components of the Tosawihi Quarries Site (26Ek3032) (Elston et al. 1987). Previously recorded locality numbers discussed here are prefaced by a 611- designator to set them apart from temporary numbers (prefaced by a 631- designator) assigned to sites recorded by the present survey.

Relative percentages of localities by type, as defined in Elston et al. (1987:53-66), are listed in Table 1, below. Summary descriptions follow.

Table 1. Summary of Previously Recorded Locality Types in the Project Area.

Locality Type	Number	%
Outcrop Quarry	3	10.7
Isolated Quarry Pit	3	10.7
Quarry Pit Complex	7	25.0
Small Reduction Station	8	28.5
Reduction Station Complex	4	14.3
Rockshelter/Reduction Station	1	3.6
Rockshelter/Undetermined	1	3.6
Isolated Artifact	1	3.6
Total	28	100.0

Quarry Localities

Quarry localities are classified according to the nature of the related opalite exposure (e.g., bedrock outcrop, cobbles in colluvium) and, consequently, by presence or

absence of extraction pit features at each. Thirteen previously recorded quarry localities are summarized by type in Table 2, below.

Table 2. Previously Recorded Quarry Locality Types.

Type	Reference Number	Max. Area (sq. m.)	Exotic Materials/ Specialized Tools
Outcrop Quarry			
	611-1	900	None noted
	611-12	150	None noted
	611-13	375	Basalt hammerstones
Isolated Quarry Pit			
	611-2	15	Rhyolite hammerstone
	611-206	2,280	None noted
	611-207	30	Basalt cobble spalls
Quarry Pit Complex			
	611-10	10,000	None noted
	611-24	9,000	Rhyolite hammerstones
	611-35	2,700	Rhyolite hammerstones
	611-36	21,600	None noted
	611-39	24,000	None noted
	611-43	7,200	None noted
	611-45	2,700	None noted

The three outcrop quarries are located along the rimrock edging Red Hill; all are described as very localized, poor-to-medium quality toolstone sources (Elston et al. 1987).

In general, quarry pit features are associated with abundant, good quality toolstone sources. The seven quarry pit complexes reflect fairly intensive exploitation of rather large opalite source areas. They range in area from 2,700 to 24,000 square meters; all evidence thick accumulations of quarrying debris, including variable amounts of reduction flakes, shatter, cores, and bifaces. The only exotic lithic materials (i.e., other than local opalite) noted were rhyolite and basalt hammerstones and basalt cobble spalls.

Of the three isolated quarry pits recorded, two (611-2 and 611-207) evidence only light flake scatters and are located well outside the primary opalite outcrop zone; both

contained rhyolite and basalt hammerstones. Locality 611-206 is a small pit in a large diffuse lithic scatter dominated by historically produced mining shatter and natural angular fragments.

Reduction Localities

Reduction stations contain concentrations of lithic debitage, usually reflecting core reduction and/or biface thinning. Little or no on-site quarrying is evident at these localities, but opalite sources and quarry features may be present nearby. Reduction localities are further segregated by size and complexity. Small reduction stations encompass areas of no more than 350 square meters each and evidence only one flaking concentration. Reduction station complexes vary in area from 600 to 2250 square meters and evidence more than one flaking concentration or overlapping accumulations of reduction debitage. Reduction station localities are summarized in Table 3, below.

Table 3. Previously Recorded Reduction Locality Types.

Type	Reference Number	Max. Area (sq. m.)	Exotic Materials/ Specialized Tools
Small Reduction Station			
	611-34	345	None noted
	611-37	10	None noted
	611-181	20	None noted
	611-184	4	Obsidian flakes
	611-185	10	None noted
	611-186	1	None noted
	611-200	25	None noted
	611-216	20	None noted
Reduction Station Complex			
	611-25	2,250	None noted
	611-46	600	Basalt cobbles/ reduction flakes
	611-180	1,000	Obsidian flakes
	611-203	1,400	None noted

Reduction localities are thought to represent brief, isolated episodes of tool reduction, or overlapping accumulations of several brief episodes. However, tool reduction often is embedded in other activities (such as hunting) that leave less visible archaeological records (Elston et al. 1987:59). In this regard, it is interesting to observe that unmodified flakes of imported obsidian were noted at two reduction localities (611-46 and 611-180) and that basalt apparently was reduced at one of these localities (611-46).

Rockshelter Localities

Rockshelters are natural overhangs at the bases of cliffs, in cliff faces, or rock outcrops, which provide protection from the elements and can serve a variety of cultural uses. Two previously recorded rockshelters are located in the project area (Table 4).

Table 4. Previously Recorded Rockshelter Localities.

Type	Reference Number	Max. Area (sq. m.)	Exotic Materials/ Specialized Tools
Rockshelter/ Reduction Station	611-3	50	None noted
Rockshelter/ Undetermined	611-164	25	None noted

Rockshelter locality 611-3, classified as a reduction station, consists of a scatter of about 200 secondary flakes in a small alcove in the rimrock above Little Antelope Canyon. Rockshelter locality 611-164, called Prospect Shelter, is enigmatic. It is located in an overhang formed by a poor quality opalite ledge; quarry pits (locality 611-24) are apparent in the colluvial mantle above the outcrop that forms the shelter. Reduction debitage was visible at the surface and to a depth of about one meter (in a historic pit in the shelter).

Isolated Artifact Locality

One isolated artifact was recorded previously in the project area. Locality 611-93 is a metate fragment found face (i.e., grinding surface) down on a steep (33%) slope in an area otherwise devoid of cultural materials. The metate is split near the center down its long axis, but only one section was found. High polish and a well developed basin on the grinding surface indicate heavy use wear prior to the split (Elston et al. 1987: Appendix A).

Newly Recorded Sites

Newly recorded sites were classified into general functional types based on debitage density, spacial distribution, and tool and/or debitage categories (Table 5). For the most part, site type definitions follow Elston et al. 1987:53-66; differences reflect a smaller number of quarry types, a larger number of discrete reduction areas, and the presence of what may be short term residential sites.

Table 5. Summary of Newly Recorded Site Types.

Site Type	Total Recorded	Percent of New Sites
Outcrop Quarry	3	2.4
Talus Quarry	2	1.6
Cobble Quarry	4	3.2
Reduction Station	33	26.6
Reduction Complex	38	30.7
Reduction Complex/ Residential Site	9	7.3
Small Site	16	12.9
Isolated Artifact	19	15.3
Total	124	100.0

Quarry Sites

Quarry sites are classified according to the kind of opalite exposure available for toolstone extraction, including outcrop quarries (opalite bedrock outcrop), talus quarries (opalite cobbles accumulated as talus), and cobble quarries (occasional surface opalite cobbles). Table 6 provides a summary of newly recorded quarries.

Table 6. Newly Recorded Quarry Sites.

Site Number	Max. Area (sq. m.)	Toolstone Source Description
Cobble Quarry		
631-14	24	Occasional large cobbles; white; poor to medium quality.
631-40	1,800	Occasional small cobbles; milky white; poor to medium quality.
631-67	6,750	Occasional large cobbles; white-yellow; poor to medium quality.
631-102	900	Very sparse cobbles; overall poor quality; white-grey.
Talus Quarry		
631-35	1,200	Thick talus cobbles; good quality; white-grey.
631-38	800	Thick talus cobbles; good quality; red-blue-white.
Outcrop Quarry		
631-37	400	Bedrock outcrop; medium quality; red-white.
631-39	1,500	Bedrock outcrop; poor to good quality; white.
631-59	600	Bedrock outcrop; poor quality; grey-white.

All quarry types combined account for only 7.3% of the newly recorded sites. Opalite is exposed as bedrock only in the vicinity of Red Hill (sites 631-37, 631-39, and 631-59), and toolstone quality appears to be highly variable. Talus cobble accumulations are also present on Red Hill (sites 631-35 and 631-38), and associated reduction debitage suggests intensive prehistoric use of high quality toolstone; however, modern minerals exploration has obscured prehistoric patterns at site 631-35. Occasional surface opalite cobbles are available along the lower reaches of Basalt Canyon and four sites (631-14, 631-40, 631-67, and 631-102) evidence on-site cobble assay and/or reduction. Naturally occurring opalite

suitable for use as toolstone is absent elsewhere on the southwest periphery of the Tosawihi Quarries.

Reduction Sites

Reduction sites, classified as reduction stations (n=33) and reduction complexes (n=38), are the most numerous site types encountered in the project area.

Reduction stations, ranging from 4 square meters to 1,200 square meters in area, include as few as 20 to as many as 3000 items; in each case, sites are thought to reflect brief, isolated episodes of lithic reduction. Table 7 summarizes small reduction stations.

Table 7. Summary of Reduction Stations.

Site No.	Max. Area (sq. m)	Total Debitage Items	Relative Abundance PF	SH	SE	BFT	Absolute Counts C	B1	B2	
631-1	225	300	-	2	2	-	-	1	-	
631-2	25	500	-	-	2	3	-	-	-	*
631-3	24	200	-	-	3	-	2	4	-	
631-4	400	27	-	-	2	1	-	-	-	
631-5	288	500	-	1	3	1	1	1	-	
631-11	4	100	-	-	2	-	-	-	-	
631-17	40	20	-	-	2	-	-	-	-	
631-19	240	30	-	-	2	2	-	-	-	
631-22	30	100	-	-	2	1	1	1	-	
631-23	5	500	-	-	2	3	-	-	-	
631-24	165	25	-	1	2	1	-	1	-	
631-27	36	25	1	-	-	2	-	-	-	
631-31	450	100	-	-	3	-	-	1	-	
631-32	105	250	-	-	3	-	-	-	-	
631-36	70	200	-	-	3	-	2	-	-	
631-41	45	200	-	2	2	-	-	-	-	
631-42	150	50	-	2	2	2	2	2	-	
631-43	36	20	-	-	2	2	-	-	-	
631-44	450	25	-	2	2	-	2	1	-	
631-46	70	500	-	-	3	2	1	2	-	
631-47	150	200	-	-	3	1	-	1	-	
631-54	300	500	-	-	3	2	-	-	1	
631-61	9	3000	-	2	3	2	-	1	-	
631-65	50	200	-	-	3	-	-	-	-	
631-69	100	2000	-	-	3	2	1	1	2	
631-70	90	1000	-	-	3	1	-	2	-	**
631-71	200	500	-	-	2	3	1	1	-	**

Table 7. Continued.

Site No.	Max. Area (sq. m)	Total Debitage Items	Relative Abundance PF	SH	SE	BFT	Absolute Counts C	B1	B2	
631-81	150	25	-	-	2	1	-	-	-	
631-82	1,200	25	-	-	2	-	1	-	-	
631-88	225	2000	-	-	2	3	3	1	1	
631-96	450	150	-	2	2	-	-	-	-	
631-100	50	50	-	-	3	-	-	-	-	
631-119	900	200	-	-	3	-	-	-	-	**

Debitage Categories

PF = primary flakes
SH = shatter
SE = secondary flakes
BFT = biface thinning flakes

Relative Abundance

- = not recorded
1 = rare
2 = common
3 = dominant

* specialized tool present
** obsidian present

Debitage at reduction stations is dominated by secondary interior and biface thinning flakes. Secondary flakes were conspicuous (common or abundant) at 96% of reduction stations; biface thinning flakes were noted at 57% of these sites (Table 8). Large, early Stage I bifaces are the most common modified artifact found at reduction stations (present in 45.5% of these sites) (Table 9). Most were fragments, likely reflecting manufacture breaks; others apparently were rejected because of material flaws. A number of cores (n=17) were observed, present at 33.3% of reduction stations. Cores generally are trimmed, chunky pieces with some areas of cortex; however, several appear to be small prepared cores.

Obsidian was observed at three sites: a small obsidian biface (with remnant cortex) was noted at site 631-70, one unmodified obsidian flake was recorded at site 631-71, and two were noted at site 631-119. In addition, an opalite flake tool, bifacially modified on one edge, unifacially modified on the other, was recorded at site 631-2.

Table 8. Debitage Abundance at Reduction Stations.

	Primary Flakes	Shatter	Secondary Flakes	Biface Thinning Flakes
	No. of Sites (%)	No. of Sites (%)	No. of Sites (%)	No. of Sites (%)
Rare	1 (3%)	2 (16%)	--	7 (21%)
Common	--	6 (18%)	18 (54%)	8 (24%)
Dominant	--	--	14 (42%)	4 (12%)
Present	1 (3%)	8 (24%)	32 (96%)	19 (57%)

Table 9. Artifact Types at Reduction Stations.

Artifact Type	No. of Sites	% of Sites
Core	11	33.3
Biface I	15	45.5
Biface II	3	9.0
Exotic Obsidian	3	9.0
Opalite Flake Tool	1	3.0

In summary, reduction stations reflect primarily Stage I or Stage II biface reduction. Though opalite sometimes was transported to the sites as trimmed, chunky pieces, the prevalence of secondary flakes, especially biface thinning flakes, suggests most artifacts left the sites as Stage II bifaces. The presence of obsidian, and two specialized tools, suggests other functions (e.g., hunting, tool repair), at four sites.

Reduction complexes reflect a range of artifacts and debitage similar to reduction stations, but consist of extensive lithic scatters which are thought to represent overlapping accumulations resulting from many episodes of use. Comparative data from reduction complexes is presented in Table 10.

Table 10. Summary of Newly Recorded Reduction Complexes.

Temporary Site No.	Maximum Area (sq. m)	Debitage Density Range (items per sq. m) Low	High	No. of Flaking Loci	No. of Artifacts C	B1	B2	B3	
631-6	3,150	1.0	25	2	-	6	-	-	
631-8	6,300	1.0	100	5	1	-	2	-	
631-10	1,200	1.0	300	3	4	1	-	-	
631-13	1,350	0.2	100	1	-	-	-	-	
631-15	22,875	1.0	100	4	X	1	-	-	
631-18	2,700	0.2	50	1	-	1	-	-	
631-20	1,500	0.03	2	-	1	1	-	-	
631-25	13,000	1.0	200	2	-	1	-	-	
631-26	5,400	50.0	150	1	1	X	X	-	
631-29	1,500	1.0	2	-	1	-	-	1	
631-30	1,125	1.0	10	-	-	-	-	-	
631-48	1,875	0.1	200	7	X	X	-	-	*
631-51	14,250	1.0	200	3	-	3	-	-	
631-52	2,100	2.0	200	2	4	3	-	-	
631-55	5,850	1.0	200	1	-	-	-	-	
631-56	11,250	1.0	15	1	-	-	-	-	
631-57	2,400	1.0	100	X	-	2	-	-	
631-58	1,200	1.0	250	1	-	-	-	-	
631-60	3,000	2.0	3	1	-	1	-	-	
631-62	6,750	0.1	15	-	-	1	-	-	
631-63	2,400	1.0	100	11	-	-	-	-	
631-64	2,700	2.0	5	-	-	-	-	-	
631-66	1,200	0.1	15	-	1	-	-	-	
631-68	1,350	0.1	15	4	-	1	-	-	
631-72	1,950	1.0	5	-	-	-	-	-	
631-86	3,750	0.3	20	-	3	-	-	1	
631-87	400	1.0	500	3	-	-	-	-	
631-89	525	1.0	20	2	-	-	-	-	**
631-90	4,500	0.1	50	1	2	-	1	-	
631-93	2,700	0.1	5	-	-	-	-	-	
631-95	7,875	4.0	25	-	-	2	-	-	
631-101	6,300	0.2	20	-	-	1	-	-	
631-106	1,800	0.1	20	1	-	-	-	-	
631-108	1,800	1.0	50	-	-	-	1	-	
631-112	1,800	20.0	150	-	-	-	1	-	
631-113	400	15.0	100	X	-	-	-	-	
631-114	2,100	1.0	15	-	-	1	-	-	
631-122	1,200	0.1	6	-	-	-	-	-	

C = Core
B1 = Stage I Biface
B2 = Stage II Biface
B3 = Stage III Biface

* = basalt hammerstone present
** = quartzite hammerstone present
X = several present, not counted

Many reduction complexes evidence numerous, spacially discrete, flaking stations; these stations are small, 5 to 10 meters in diameter, and often contain up to 5000 debitage items, several bifaces and/or cores, and occasionally a basalt hammerstone (site 631-48, for example). Notably, large numbers of Stage II bifaces are present at site 631-26, similar to observations at reduction complexes with residential components (see discussion below). Other reduction complexes evidence no concentrated flaking stations, but rather, consist of widely dispersed flakes that vary in size and color (accumulations of numerous brief uses over time?).

Reduction Complex/Residential Sites

Nine reduction complexes/residential sites were recorded. Artifact variety, abundance, and potential for shallow subsurface features (hearths, camping refuse pits) suggests these sites were used as short term camps (Thomas 1983, 1984). Selected data is summarized in Table 11.

Table 11. Summary of Reduction Complex Residential Sites.

Temporary Site No.	Max. Area (sq. m)	Debitage Density Range (items per (sq. m) Low	High	No. of Flaking Loci	No. of Cores/Bifaces C	B1	B2	B3	Other Artifacts OF	BF	ST	GS	HS
631-21	1,800	1	50	-	1	-	-	3	-	X	-	-	
631-45	19,500	25	500	+15	X	X	X	X	X	X	X	-	X
631-50	18,500	25	200	8	-	X	X	-	X	X	X	X	X
631-103	4,950	1	15	-	-	2	3	-	-	-	X	-	-
631-104	3,600	15	25	-	-	-	-	-	-	-	X	-	-
631-109	21,500	50	500	6	-	X	X	-	X	X	X	-	X
631-111	8,400	1	500	+3	-	1	-	-	X	X	-	-	X
631-115	69,000	1	150	X	-	X	X	-	X	-	X	-	-
631-120	10,500	5	100	3	-	-	-	-	-	-	X	-	-

C = Core
B1 = Stage I Biface
B2 = Stage II Biface
B3 = Stage III Biface

OF = Obsidian Flakes
BF = Basalt Flakes
ST = Specialized Flake Tool
GS = Groundstone
HS = Hammerstone
X = Many present, not counted

Reduction complex/residential sites are dominated by opalite reduction debitage, but obsidian and basalt (tools and debitage) are present in small amounts. Residential and reduction components compose overlapping activity areas at the smaller sites (especially sites 631-21, 631-103, 631-104, 631-111) while several larger sites (e.g., 631-45, 631-50, 631-115) evidence a central residential locus surrounded by numerous discrete flaking stations. Stage II bifaces are abundant at four of these sites; this is consistent with Elston's hypothesis (Elston et al. 1987:111) that Stage II bifaces are target forms and were produced most often at residential sites near the quarries. Sites also include small numbers of specialized tools (e.g., projectile points, drills, scrapers, knives) common to short term campsites. Groundstone is a common component at residential sites in the Great Basin; however, it is quite rare at sites in the project vicinity. Of the newly recorded sites, only site 631-50 contained groundstone (several small fragments from one heavily used metate).

Small Sites

The remaining sites recorded in the project area by the present survey are small sites (n=16) and isolated artifacts (n=19).

Sites with fewer than 20 items are included, for convenience, into the small site category; however, these are quite variable in artifact content (and probable function) (Table 12).

Table 12. Artifact Observations at Newly Recorded Small Sites.

Temporary Site No.	Max. Area (sq. m)	Artifact Counts ST	C	B1	B2	B3	PF	SH	SE	BFT	Total Items
631-16	1,200	-	-	-	-	-	-	-	-	11	11
631-75	1	-	-	-	-	-	-	-	5	-	5
631-76	5	1	-	-	-	-	-	-	2	-	3
631-77	2	-	1	-	-	-	-	1	3	-	5
631-79	15	-	-	2	-	1	-	-	2	-	5
631-84	3	-	-	3	-	-	-	-	3	-	6
631-85	10	-	-	2	-	1	-	-	3	-	6
631-94	25	-	-	-	-	-	2	-	-	-	2
631-98	30	-	-	-	-	-	-	-	12	-	12
631-105	3	-	-	-	-	-	-	-	-	3	3

Table 12. Continued.

Temporary Site No.	Max. Area (sq. m)	Artifact Counts ST	C	B1	B2	B3	PF	SH	SE	BFT	Total Items
631-116	36	-	1	-	-	-	-	-	4	1	6
631-117	3	1	-	-	-	-	1	-	1	-	3
631-118	3	-	-	1	-	-	-	1	2	-	4
631-121	24	-	-	-	-	-	-	-	-	4	4
631-123	60	-	-	1	-	-	-	-	5	-	6
631-124	4	-	-	-	-	-	3	-	-	-	3
Total		2	2	9	0	2	6	2	42	19	84

ST = Specialized Flake Tool
C = Core
B1 = Stage I Biface
B2 = Stage II Biface
B3 = Stage III Biface
PF = Primary Flake
SH = Shatter
SE = Secondary Flake
BFT = Biface Thinning Flake

Most small sites encompass areas of from 1 to 60 square meters; an exception, site 631-16, is a scatter of eleven biface thinning flakes over a small saddle covering 1,200 square meters in area. Several small sites exhibit an assemblage diversity that is not expected considering small assemblage size. For example, the five items comprising site 631-79 include two Stage I bifaces of white opalite (both broken), one Stage III biface of butterscotch-colored opalite with a developed haft element (carefully made, waxy material, but broken along the base), and two unmodified secondary flakes of white opalite. Site 631-117, with three items total, includes one untypeable projectile point of heat-treated opalite, resharpened along one edge (perhaps for use as a knife); one large, chunky (7cm x 5 cm x 1cm) core reduction flake with cortex; and one small secondary flake - all of different colored opalite materials. At the other extreme, site 631-124 consists only of three primary flakes of grey-white opalite. It is of interest primarily because of its location on the steep eastern slopes of Prospector Point where no other cultural materials were recorded.

Formed artifacts such as cores, bifaces, and projectile points, observed in isolated contexts, were recorded as discrete phenomena and assigned separate site numbers. Newly recorded isolated artifact sites are summarized in Table 13, below.

Table 13. Newly Recorded Isolated Artifacts.

Temporary Site No.	Artifact Type	Description
631-7	Stage I Biface	White opalite, broken
631-9	Stage I Biface	White opalite, broken
631-12	Core	White-yellow opalite; unidirectional
631-28	Projectile Point	Rosegate Series, tip broken
631-33	Stage I Biface	White opalite; very crude
631-34	Stage I Biface	White-tan opalite; complete
631-49	Stage I Biface	White opalite; shock break
631-53	Core	Purple opalite; bidirectional
631-73	Stage I Biface	Stage Grey opalite; roughly bifacial
631-74	Stage I Biface	Grey-white opalite; large
631-78	Projectile Point	Elko Corner-notched
631-80	Projectile Point	Untypeable fragment
631-83	Core	White opalite, fragment
631-91	Stage I Biface	White opalite, broken
631-92	Stage II Biface	White opalite, broken
631-97	Projectile Point	Gatecliff Split Stem
631-99	Projectile Point	Untypeable, midsection fragment
631-107	Stage I Biface	Yellow-white opalite, complete
631-110	Projectile Point	Untypeable, resharpened to drill

It is interesting to observe that isolated artifacts and small sites reflect a range of reduction activities similar to reduction stations and reduction complexes. Debitage is dominated by early stage bifaces and secondary and biface thinning flakes. Projectile points and small specialized tools may suggest hunting and other subsistence related activities.

In summary, sites located in the U.S. Steel Project Area primarily relate to the reduction of opalite derived from the nearby Tosawihi Quarries; local quarries are few in number and quite limited in size. Compare the low relative percentage of quarries in the U.S. Steel Project Area (7% of new sites, or 22% of combined new and previously recorded sites) to the high percentage (48%) of quarries in the Tosawihi Quarries Study Area (Elston et al. 1987:64-65). On the other hand, reduction sites compose the largest category of sites in the U.S. Steel Project Area (57% of new sites, 55% of combined new and previously recorded sites), but compose a small percentage (22%) of localities in the Tosawihi Quarries Study Area (Elston et al. 1987:64-65).

The production of large, thin Stage II bifaces seem to be a primary focus of site activities on the periphery of the Tosawihi Quarries, and is especially noticeable at short term residential camps in the project area. Subsistence activities are reflected in hunting related artifacts (projectile points) and seed grinding tools (groundstone), as well as in drills, knives, and scrapers of more general utility. Data present at sites in the U.S. Steel Project Area can contribute to a number of identified regional and local research issues (cf. Elston 1987; see Chapter 7).

Chapter 6. ARTIFACT DESCRIPTIONS

Artifacts collected during field survey include 11 projectile points and 1 large biface. An unmodified obsidian pebble was collected outside the project area as well. The following discussion describes and illustrates the collected artifacts, and discusses artifact observations made in the field.

Bifaces

As noted earlier, most bifaces found at reduction sites are Stage I or Stage II forms rejected due to material flaws or because they broke during manufacture.

Specimen 631-38-1 is an early Stage I biface similar to those reduced at Tosawihi Quarries localities north of the present project area (Figure 11b). The opalite at site 631-38 is unique in the project area, both for its abundance and its high toolstone quality; it includes an unusual range of material colors, dark red to blue to yellow.

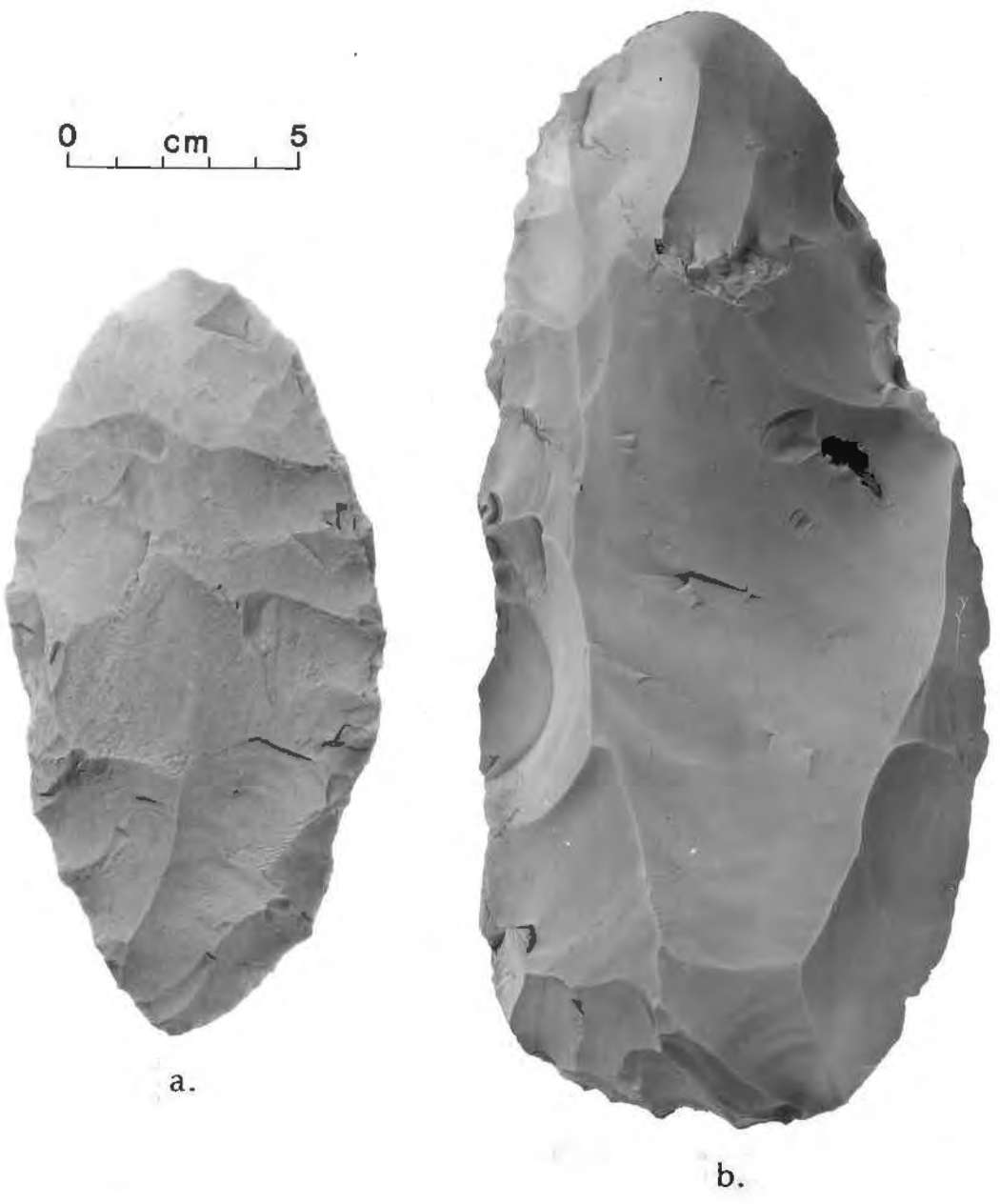
The dark red, yellow banded biface is one of the largest complete bifaces observed in the project area, measuring 23.5 cm long by 11 cm wide by 4.3 cm thick. The artifact may have been discarded after removal of a large flake from one surface exposed stress fractures and a large vug. It is interesting to note that the removed flake approximates the dimensions of Stage II bifaces from a Tosawihi Quarries cache collected by Rusco (Elston et al. 1987:104) (Figure 11a). The flake scar measures 15 cm long by 9 cm wide; the Rusco biface measures 16.2 cm long by 8.2 cm wide by 1.8 cm thick. Similar Stage II bifaces are thought to represent target artifacts, that is, forms ordinarily produced for transport elsewhere (Elston et al. 1987:104).

Projectile Points

Four of the 11 collected projectile points are typologically distinct and serve as chronological markers. They include one Gatecliff Split Stem (specimen 631-97-1), one Elko Corner-notched (specimen 631-78-1), one Large Side-notched (specimen 631-115-1), and one Rosegate series (631-28-1). Projectile point attributes are given in Table 14.

Figure 11a. Stage II biface from a Tosawihi Quarries cache (Elston et al. 1987:104).

Figure 11b. Large, Stage I biface from quarry site 631-38.



a.

b.

Table 14. Attribute List for Projectile Points Collected from Sites on the Southwest Periphery of the Tosawihi Quarries.

Catalog No.	Type	Material	Ls	Lt	La	Lm	Wm	Wb	Nw	Th	Wt.	Est. Wt.	DSA	PSA	NOI	(BIR)	Lt/Wm	Wb/Wm	Lm/Lt	HT
631-28-1	RSG	*White Chert	13.6	28.4	28.4	-	20.1	7.5	6.2	3.6	1.0	2.0	127	101	26	1.0	1.41	.37	-	Yes
631-45-1	UN	Basalt	11.8	-	-	-	-	(15.1)	11.4	4.7	.8	3.0	220	140	60	-	-	-		No
631-78-1	ECN	*Pink-white chert	25.4	(40.6)	(40.6)	-	22.1	(12.3)	10.9	4.9	2.2	3.0	151	118	33	1.0	1.84	.56	-	Yes
631-80-1	UN	*White Chert	16.7	-	-	-	-	-	-	-	.6	-	-	-	-	-	-	-	-	Yes
631-97-1	GSS	*White Chert	42.0	53.4	51.0	-	24.0	13.9	12.8	5.3	5.1	5.6	131	96	35	.96	2.23	.58	-	?
631-99-1	UN	*White Chert	12.8	-	-	-	-	-	-	-	5.6	-	-	-	-	-	-	-	-	Yes
631-103-1	Out of Key	Obsidian	28.5	48.6	44.0	-	16.1	16.1	0	4.6	2.2	4.0	-	-	-	.90	3.00	1.00	-	No
631-109-1	UN	Obsidian	30.1	-	-	-	-	-	-	4.7	2.2	-	-	-	-	-	-	-	-	No
631-110-1	Preform	*Pink Chert	35.0	-	-	-	-	-	-	4.0	2.4	-	-	-	-	-	-	-	-	Yes
631-115-1	LSN	Obsidian	28.6	(38.2)	(36.2)		(17.1)	(17.1)	7.0	3.8	1.7	2.0	182	178	4	.94	2.23	1.00	-	No
631-117-1	Preform	*White Chert	27.3	-	-	-	-	-	-	3.3	1.2	-	-	-	-	-	-	-	-	Yes

Measurements are in millimeters and grams; numbers in parentheses are estimated.

Abbreviations:

ECN - Elko Corner-notched
GSS - Gatecliff Split Stem
LSN - Large Side Notch
RSG - Rosegate Series
UN - Untypeable

Ls - Actual Length
Lt - Total Length
La - Length of Longitudinal End
Lm - Length from Proximal End of point of Maximum Width

Wm - Maximum Width
Nw - Neck Width
Wb - Basal Width
Th - Thickness

Wt - Weight in Grams
DSA - Distal Shoulder Angle, between 90-270o
PSA - Proximal Shoulder Angle, between 0-270o
NOI - Notch Opening Index
BIR - Basal Indentation Ration, La/Lt
HT - Heat Treated

* All chert likely are Tosawihi opalite

Gatecliff Split Stem points are dated between 3000 B.C. and 1300 B.C. at Gatecliff Shelter (Thomas 1983:185-186) and mark the South Fork Phase on the upper Humboldt (Elston and Budy 1989). In the central Great Basin, Elko Corner-notched points span the interval between 1300 B.C. and A.D. 700 (Thomas 1983:182), but these points may have greater antiquity and have persisted longer in the northern Great Basin (Aikens 1970). At James Creek Shelter on the upper Humboldt, the type dates between 850 B.C. and A.D. 700 (Elston and Budy 1989). Large Side-notched points like specimen 631-115-1 are poorly dated. Specimens larger than Desert Side-notched points, but smaller than Northern Side-notched points, occur in numerous contexts dated prior to A.D. 1300 (Thomas 1981:19). Rosegate points are confined to the period between A.D. 700 and A.D. 1300 (Thomas 1983:179-180), and mark the Maggie Creek phase on the upper Humboldt (Elston and Budy 1989).

Specimen 631-28-1 (Figure 12b) keys to the Rosegate Series, resembling the Eastgate subtype (Heizer and Baumhoff (1961:123-124). The point is made from white, heat treated chert (probably Tosawihi opalite). The tip and one tang are broken; no attempt was made to repair the truncations. The isolated context of the find, and the nature of the breaks, suggest the point broke on impact.

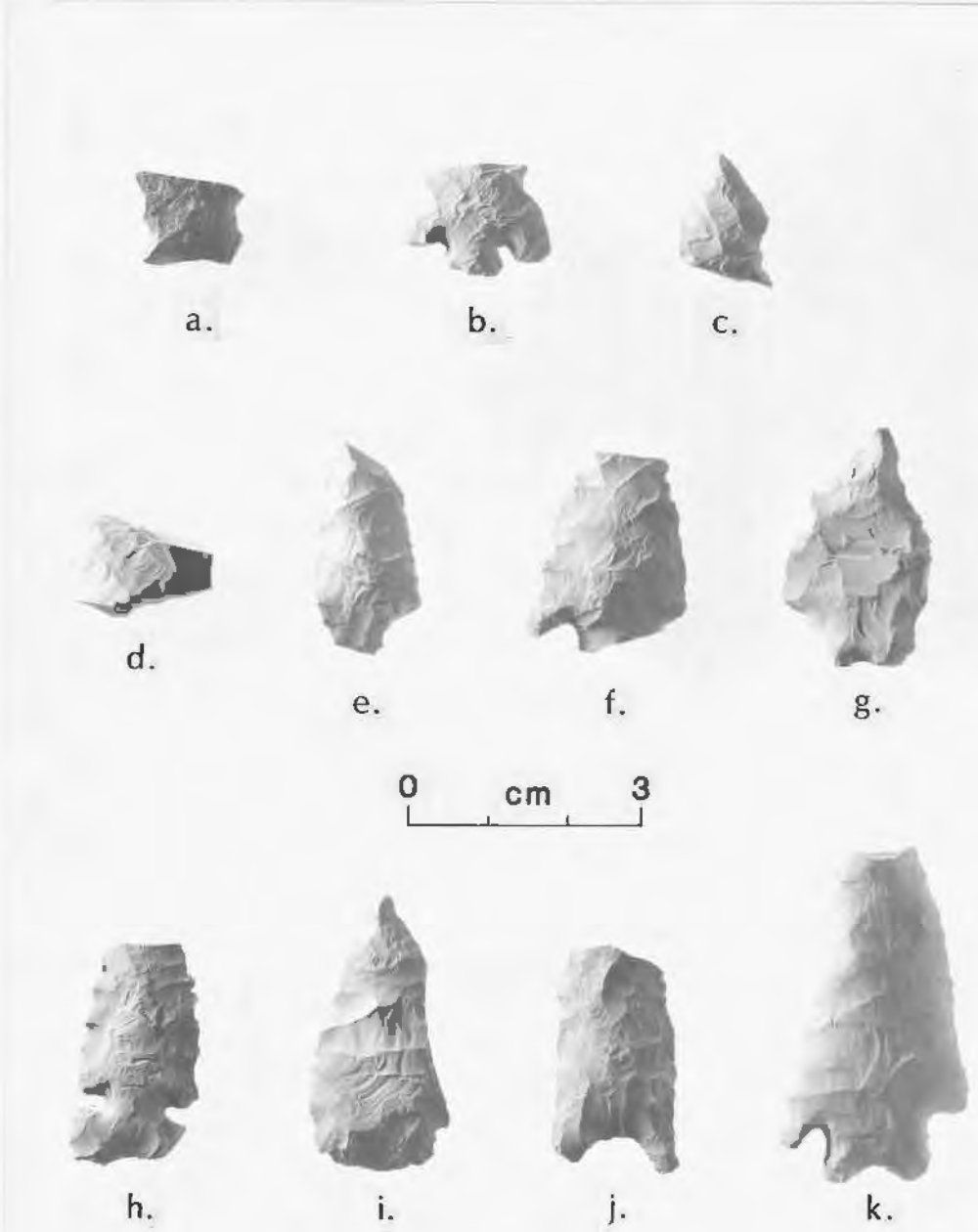
Specimen 631-45-1 (from Locus D at reduction complex/ residential site 631-45) is a small basal point fragment made from fine-grained, black basalt (Figure 12a). Both shoulders and base appear to be reworked, but it is difficult to be certain given the nature of the material and small size of the fragment. Though untypeable, the item may represent a portion of a reworked Humboldt or Elko Eared point.

Specimen 631-78-1, an isolated artifact, keys to the Elko Corner-notched type, but break patterns and extensive reworking suggest a complex history for this small artifact (Figure 12f). The base broke, apparently a result of notching failure. The tip also broke, but this looks like a bending fracture, and reworking attempted repair. In other words, the artifact looks like a failed point preform which was used as a knife until the tip broke off. One last attempt was made to salvage the tool (fix the tip) before it finally was abandoned. The material is a creamy white chalcedonous chert with red-orange inclusions and waxy luster indicating heat treatment.

Specimen 631-80-1, an isolated artifact, is a very small, untypeable point fragment of opaque white, heat treated chert (likely Tosawihi opalite). It has a single notch and appears to be either an expedient point that broke on impact along the

Figure 12. Collected projectile points.

a. Specimen 631-45-1
b. Specimen 631-28-1
c. Specimen 631-80-1
d. Specimen 631-99-1
e. Specimen 631-117-1
f. Specimen 631-78-1
g. Specimen 631-109-1
h. Specimen 631-115-1
i. Specimen 631-110-1
j. Specimen 631-103-1
k. Specimen 631-97-1


a.
b.
c.
d.
e.
f.
g.
0 cm 3
h.
i.
j.
k.

basal haft or a reworked point fragment that was discarded before necessary modifications were completed (Figure 12c). The presence of the extensively modified (and expended) tool in an area of great toolstone abundance suggests it arrived in a hunters tool kit. Perhaps the artifact was a nearly used up tool fired before the hunter had a chance to make a better projectile or perhaps it was not fired at all but merely discarded because better materials were at hand.

Isolate 631-97-1 keys to the Gatecliff Split Stem type. The point is made from opaque white, heat treated chert (likely Tosawihi opalite). The tip is missing and both lateral edges have been resharpened extensively on one face. The left margin (as illustrated in Figure 12k) has been reduced to the extent that it is concave in outline. The tip was truncated by a bending break after resharpening. Ring cracks on the truncation surface near one corner may indicate an attempt to rejuvenate the edge with burin technique (cf. Vaughan 1985). Traces of an unidentified bright red substance are present along one truncation corner.

Isolate 631-99-1 is an untypeable midsection fragment (Figure 12d) of opaque white, heat treated chert (likely Tosawihi opalite). A ring crack on the lower truncation, and linear cracks on the upper (opposite face), suggest smash truncation (a bipolar technique), a method used to recycle tool fragments (cf. Budy and Elston 1986).

Specimen 631-103-1, from reduction complex/residential site 631-103, is a small, concave-based obsidian projectile point (Figure 12j). Though it broadly resembles one of the Humboldt Series, it is not lanceolate in outline (basal width/maximum with ratio exceeds 0.90) and it falls out of Thomas's (1981) key. The tip broke upon impact, and the resulting hinge fracture extends along most of one surface.

Specimen 631-109-1, from Locus A at reduction complex/ residential site 631-109, is an untypeable, reworked obsidian projectile point (Figure 12g). A longitudinal flake scar with hinge termination on one face is similar to the impact scar on specimen 631-103-1 described above. Exhibiting drill-like use wear, the point apparently broke on impact and was refashioned for use as a drill.

Isolate 631-110-1 is a reworked point preform made of creamy pink, heat treat chert (possibly Tosawihi opalite). The margin of the ventral flake surface was prepared (roughened by grinding) but not thinned. A lateral fracture

may have occurred as a notching failure. The tip was resharpened (prior to the lateral break) as if for use as a drill (Figure 12i).

Specimen 631-115-1, from Locus A at reduction complex/ residential site 631-115, is a Large Side-notched obsidian projectile point (Figure 12h). Its edges are serrated but are not noticeably reworked. The tip and portion of one tang are broken, probably as a result of impact fracture.

Specimen 631-117-1, from very small scatter site 631-117, seems to be a failed point reworked for use as a cutting tool (Figure 12e). It is made from white, heat treated chert. Both tangs are snapped off, perhaps as a result of notching failures. Only the dorsal surface of the original flake is fully reduced, but both margins have been resharpened bifacially. The tool apparently was abandoned after the tip broke.

Obsidian

Sites in the project area are notable for the presence of small amounts of imported obsidian. Debitage (and one small core) observed in the field included pieces of obsidian shatter bearing cortex, indicating on-site core or natural pebble reduction, as well as small controlled thinning flakes, reflecting small biface and/or tool manufacturing. Small obsidian tools (projectile points and bifaces) were also observed at several sites. Though obsidian is not available in the project area, debitage size and tool forms suggest a nearby source characterized by rounded, pebble-sized nodules.

At site 631-109, the largest piece of obsidian shatter (with cortex) measured 30mm x 15mm x 10mm. A split core observed at site 631-50 measured 60mm x 40mm x 30mm. All obsidian tools are small (see for example Figure 12g, h, j). The largest tool noted in the field was a biface retouched along two edges (illustrated from a field drawing in Figure 13). The artifact measures 45 mm wide by 36 mm long and 14mm thick; cortex along the proximal edge retains the rounded shape of the original pebble.

One unmodified obsidian pebble (55mm x 61mm x 47mm) was collected (purely fortuitously) along Little Antelope Creek about 5 miles south/southwest of the project area (Figure 14); this area may be a source of obsidian for artifacts found at sites in the project area. The prevalence and distribution of obsidian in Tosawihi Quarries vicinity is unknown at present.

Figure 13. Obsidian biface with cortex (from field drawing, site 631-70).

Figure 14. Obsidian pebble collected along Little Antelope Creek.

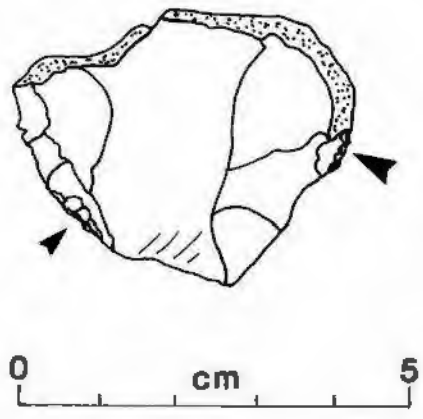


Figure 13.

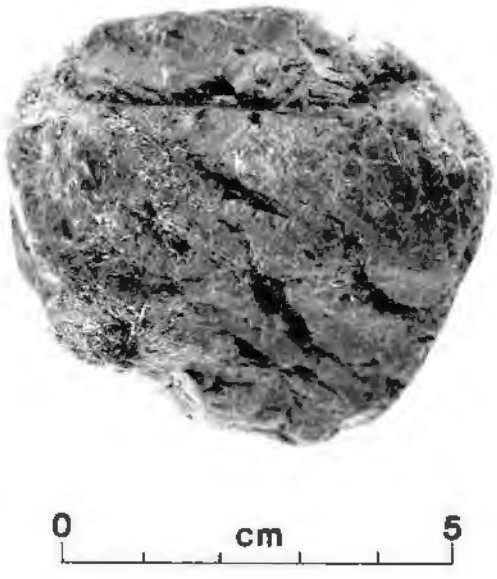


Figure 14.

Chapter 7. SIGNIFICANCE EVALUATIONS

The 152 sites and localities occurring in the U.S. Steel Project Area were evaluated in terms of their eligibility for nomination to the National Register of Historic Places. The National Register of Historic Places was developed by the Department of the Interior to serve as a means of isolating properties worthy of cultural resource management consideration. In order for a property to be eligible for nomination to the Register, it must possess integrity and satisfy at least one of four criteria of significance as outlined in 36 CFR 800.60 (NPS 1982). Integrity and significance are discussed below, followed by eligibility assessment of sites in the U. S. Steel Project Area.

Integrity Standards

To possess integrity, a property must retain sufficient physical character to convey its association with past patterns, persons, designs, technology, or events. Although designed primarily for use in the evaluation of standing structures, the following National Park Service evaluation standards (NPS 1982:44) can be applied to prehistoric sites:

LOCATION	Is the site in its original location or has it been moved or redeposited (i.e., by stream action, road grading)?
SETTING	Is the surrounding physical environment the same as it was during the period of occupation? Is the relationship between the site and its physical surroundings the same as when it was occupied?
DESIGN	Is the design of the resource intact or have any patterns been destroyed or altered by human or other processes?
MATERIAL/ WORKMAN-SHIP	Is the material at the site authentic or has original material been removed or additional material introduced?
FEELING	Do the resource and its setting convey a sense of time and place appropriate to the period of occupancy?

All sites recorded in the U.S. Steel Project Area convey a similar sense of setting and feeling associated with the Tosawihi Quarries. Site integrity has been effected by environmental forces (e.g., slopewash, rodent turbation) and by modern minerals exploration activities (e.g., roads, drill sites, blading). The integrity of each site was rated according to the degree of surface disturbance it has sustained, as summarized in Table 15. Results of the integrity rating exercise appear in Appendix B.

Table 15. Integrity Rating Scheme.

Score	Scoring Standards
1	Severely disturbed over more than 50% of site area. Disturbance may be a result of extensive erosion, numerous roads, drill pads, minerals exploration features, bulldozer cuts, or of artifact collection.
2	Moderately to heavily disturbed over less than 50 of total site area. Disturbance may be a result of erosion, roads, or minerals exploration, but significant portions of the site remain intact.
3	Discrete, areal disturbance restricted to less than 25% of total site area. Disturbance may include a road or mining exploration feature as well as slopewash and rodent turbation.
4	Essentially undisturbed. Minor disturbance may be a result of slopewash, trampling or bioturbation.

Sites with low integrity (that is, a score of 1) are considered ineligible for nomination to the National Register of Historic Places. Sites with moderate (2) to high (4) integrity may be eligible, depending upon their research significance. Significance standards are applied to all sites demonstrating moderate to high integrity, as described below.

Significance Standards

Of the four criteria of significance given in 36 CFR Part 60.6, one is most relevant to the prehistoric archaeological resources under consideration here: does the site contribute to an understanding of prehistory? Four standards developed by Glassow (1977) were employed to assess the ability of sites to contribute to an understanding of prehistory:

VARIETY	How many different classes of information are present?
QUANTITY	How much information is present?
CLARITY	Are human behavioral components discrete (especially temporal and spatial components), i.e., not inextricably mixed? Is the pattern of organization clear and straightforward?
RESEARCH POTENTIAL	Does the resource have the potential to address identified local or regional data gaps, research goals, or methodological problems?

The four standards are closely interrelated and, together, form the basis on which to quantify relative site significance (cf. Zeier 1981). The potential for yielding scientifically valuable data is measured in terms of the existing data base, that is, site significance is considered relative to ability of the site to contribute to identified regional and local research issues. Elston (1987) has analyzed major issues relevant to the Tosawihi Quarries and vicinity; those research problems bearing on present project area are summarized below. A discussion of the quantification system devised to measure site significance in National Register terms follows.

Research Issues

Research issues identified by Elston (1987) concern regional chronology and settlement, as well as site specific problems such as understanding site formation and site function. Problems specific to the Tosawihi Quarries, such as toolstone characterization and variability, also can be addressed to some degree by certain sites in the U.S. Steel Project Area. Eight identified issues are relevant to the sites in the U. S. Steel Project Area.

1. Cultural Chronology. A cultural chronology describes the dates and sequence of phases in the culture history of a locality or region (Willey and Phillips 1958:22). Local chronological questions include the earliest use of Tosawihi chert, the inception of intensive extraction techniques, and the inception of rockshelter and open site occupation.

> Construction of a local cultural chronology for Tosawihi that can be fitted into, or even expand, the regional sequence, requires a series of radiocarbon dates from stratified or otherwise discrete cultural deposits.... Datable charcoal may be present in quarry pits or in waste dumps at outcrop quarries. Moreover, hearths have been used for warming and/or cooking in quarry areas, and hearths may also be present in some of the small, discrete surface lithic scatters designated as Reduction Stations (Elston 1987:14).
>
> Other dating methods, such as obsidian hydration, may be applicable to establishing a chronology.... Stratigraphic superposition will allow the relative dating of artifacts within stratified deposits.... The presence of temporally diagnostic artifacts, such as projectile points, help constrain the age of the deposits in which they are found.... It is remotely possible that rock varnish on basalt hammerstones ... can be dated directly using either the cation-ratio method, or radiocarbon dating using a linear accelerator... (Elston 1987:15).

2. Place of the Quarries in the Regional Economy. Sites in the vicinity of the Tosawihi Quarries may be excellent places to address the issue of "embeddedness" of lithic procurement (Binford 1979, 1985a, 1985b; Binford and Stone 1985; Gould 1980, 1985; Gould and Saggers 1985). Did people go to Tosawihi to get toolstone, or did they get toolstone while they were there doing something else?

> In order to know whether assemblages representing non-quarrying activities at Tosawihi are unique or similar to assemblages from non-quarry sites elsewhere, comparative data must be gathered from sites in the surrounding region. A stratified archaeological sample of the landscape bounded by Rock Creek, Willow Creek, the crest of the Tuscaroras, and middle Boulder Valley would be sufficient to characterize the distribution and

variability among sites reflecting regional subsistence and settlement systems and provide the necessary comparative data (Elston 1987:12).

3. Site Formation Processes. Interpretation of the archaeological record depends upon an understanding of how archaeological sites were formed and how they have been transformed (Binford 1979, 1980; Schiffer 1976).

> People create archaeological sites by living and working on them. Use of space is differentiated as people sleep in one place, work in another, and dispose of refuse in yet another. Erosion, deposition, soil formation, bioturbation, chemical change, and human activity all affect archaeological deposits as they are created and for as long as they exist thereafter. Understanding how archaeological localities were formed ... is central to their functional interpretation (Elston 1987:13)

4. Site Function, Site Structure, and the Organization of Production. Quarry localities, workshops, rockshelters, and open habitation sites should all exhibit different site structures because each was used for a different set of activities over different periods of time by different sized groups. The ethnographic literature regarding stone tool manufacture should provide models for the structure of quarry and base camp workshops (Binford and O'Connell 1984, 1986; Gould 1977, 1980; Hayden 1979; O'Connell 1974, n.d.; Tindale 1965).

> A strong formal characterization of the differences in debitage (stage, size, raw material type, presence or absence of heat treatment) observable at quarry pits and at habitation sites ... will help evaluate whether the reduction carried on there was simply pre-transport lightening of the load or whether folks were staying in place long enough to make the production of finished tools worthwhile (Elston 1987:18).

> Changes in the function and structure of various Tosawihi localities, and the organization of lithic production through time, would signal changes in use of the quarry district as a whole, possibly related to large scale subsistence and settlement patterns (Elston 1987:18).

Of particular interest are the functions of "Flaking Stations", that is, small, discrete lithic scatters, usually on ridges or in small rockshelters. Do these represent hunting stations, procurement of lithic material by groups just passing through the quarry area on their way elsewhere, or places where specialized reduction tasks were carried out (Elston 1987:17)?

5. Geologic Context of Tosawihi Toolstone. Opalite toolstone sources occur as bedrock outcrops, thinly mantled bedrock, talus deposits, and colluvium containing opalite clasts. Each source area varies through a particular range of quality and may require different methods of extraction and processing.

The geologic context of Tosawihi chert or "opalite" thus determined its accessibility to prehistoric people and strongly affected the strategies they used to extract it (Elston et al. 1987:110). Additional information is required in order to fully understand these strategies (Elston 1987:6).

6. Variability in Toolstone Quality. Particular opalite exploitation strategies likely are related to differences in toolstone quality (workability and durability) among various quarry sources.

If exploitation of a particular deposit of toolstone depended on its quality, it would be very useful to know how toolstone quality varies across the quarries and between bedrock outcrops, talus deposits, and colluvial soils (Elston 1987:7).

7. Chemical Identification of Tosawihi Toolstone. The spacial distribution of Tosawihi chert can tell much about trade, toolstone economics, and settlement and subsistence throughout the western Great Basin.

The question of chemical identification of Tosawihi chert, and its segregation from other, more local, materials is a pressing issue, inhibiting all attempts at a broader view of Tosawihi; a realistic evaluation of the importance of the place depends upon an ability to determine how far and in what volumes Tosawihi chert actually travelled.

> Renfrew's (1977) decay, or inverse gravity model, can be used to predict fall-off (both in terms of volume and reduction state) with increasing distance from the quarries (Elston 1987:7).

8. Quantity of Toolstone Processed and Removed From Tosawihi. In conjunction with studies of chronology, and settlement and subsistence, estimates of the quantity of toolstone processed and removed from Tosawihi can allow assessment of the importance of that toolstone resource and the total human investment of time and energy devoted to obtaining it (Ahler 1986:18).

> The amount of material processed at quarry pits and discarded at workshops could be estimated from yield of debitage in pit berms and workshop site deposits...(Elston 1987:9).

Sites in the U.S. Steel Project Area contain data that can address the issues summarized above, but how can individual sites be evaluated for their relative research value? To address this question, a systematic method of quantifying site significance (after Zeier 1981) was applied to sites in the project area.

To measure site significance, selected classes of information relevant to identified research questions were listed and a numerical score assigned to each class present at a given site (Table 16). Each site in the project area was evaluated for relative artifact abundance (maximum artifact density per square meter), clarity of site organization (number of spacially discrete activity areas and/or possible residential features), and variety of data classes present (quarry features, reduction stage forms, specialized tools, potentially dateable basalt and obsidian).

Significance scores are comparable and provide an objective measure of relative site significance; scores range from a low of 3 (lowest possible score = 3) to a high of 16 (highest possible score = 19). Sites scoring 10 or higher appear to have significant research potential and suggest National Register eligibility. Intensive evaluation (testing) is necessary at these sites to verify their National Register eligibility and to define data recovery strategies appropriate to each. Although all sites contain some research information, those with low research value, that is, scoring 4 or lower, are considered ineligible for National Register consideration. Sites with moderate research potential (scoring from 5 through 9) require additional assessment (data

recording, collection and analysis, or testing) in order to clarify their National Register eligibility status. Results of the significance rating exercise for each site in the project area are provided in Appendix B. Eligibility assessments are summarized below.

Table 16. Research Significance Rating Scheme.

RESEARCH CRITERIA	SCORE
Quantity Measures	
1-10 items/sq. m.	1
>10-100 items/sq. m.	2
>100 items/sq. m.	3
Clarity Measures	
Isolated artifact	1
Undifferentiated spacially	2
Single activity locus	3
Multiple activity loci	4
Multiple activity loci/ Possible residential features	5
Variety Measures	
Quarry Categories	
On-site opalite source	1
Quarry feature	1
Reduction Categories	
Cores	1
Stage I bifaces	1
Stage II bifaces	1
Stage III bifaces	1
Specialized Activity Measures	
Groundstone	1
Hammerstones/cobble spalls	1
Basalt Biface Reduction Debitage	1
Obsidian	1
Specialized Tools	1
	Total Score

National Register Eligibility Assessments

The following discussion separates significance evaluations for newly recorded sites and localities recorded previously (Elston et al. 1987).

Newly Recorded Sites

Of the 124 newly recorded sites, 9 (7.3%) appear eligible for National Register consideration, 45 (36.3%) sites are considered ineligible, and the eligibility of 70 (56.4%) sites is uncertain from the present level of information.

As shown in Table 17, two of the nine (22.2%) recorded quarries are considered ineligible to the National Register, one because of extensive disturbance, the other because of low research potential. The remaining quarries (77.8%) have moderate research potential, but eligibility assessments require additional information.

Table 17. National Register Assessment of Newly Recorded Quarry Sites.

Site Number	Integrity Score	Significance Score	National Register Status
Cobble Quarry			
631-14	4	4	Not eligible
631-40	4	6	Unclear
631-67	4	5	Unclear
631-102	3	6	Unclear
Talus Quarry			
631-35	1	N/A	Not eligible
631-38	2	9	Unclear
Outcrop Quarry			
631-37	3	7	Unclear
631-39	3	9	Unclear
631-59	4	6	Unclear

Site 631-35 may have been a good quality toolstone source, likely with quarry pit features, but road construction, blading, and drilling have trenched through the opalite talus source, rendering it difficult to segregate prehistoric reduction debris from opalite shattered and fractured by minerals exploration. The site is not eligible to the National Register due to lack of integrity. Site 631-14 is a small cobble quarry associated with a sparse flake scatter; low research potential renders it ineligible to the National Register.

Portions of sites 631-38 and 631-39 are disturbed by roads, but intact sections preserve significant prehistoric quarry data. These quarry sites, and others of uncertain National Register status, are strategically located on the periphery of the primary opalite zone to the north. These quarries contain data appropriate to understanding variability in toolstone sources and associated variability in procurement strategies and may contribute to chemical and geologic investigations at the Tosawihi Quarries.

The National Register eligibility of reduction stations is, for the most part, unclear. Six (18%) have limited research potential and are considered ineligible; 27 (82%) have moderate research value and require additional assessment (Table 18).

Table 18. National Register Assessment of Newly Recorded Reduction Stations.

Site No.	Integrity Score	Significance Score	National Register Status
631-1	4	6	Unclear
631-2	4	7	Unclear
631-3	4	7	Unclear
631-4	4	5	Unclear
631-5	4	9	Unclear
631-11	4	5	Unclear
631-17	4	4	Not eligible
631-19	4	4	Not eligible
631-22	4	6	Unclear
631-23	4	6	Unclear
631-24	4	5	Unclear
631-27	4	4	Not eligible
631-31	4	5	Unclear
631-32	4	5	Unclear
631-36	2	6	Unclear
631-41	4	5	Unclear
631-42	4	7	Unclear
631-43	4	4	Not eligible
631-44	4	6	Unclear
631-46	3	8	Unclear
631-47	5	6	Unclear
631-54	3	7	Unclear
631-61	4	7	Unclear
631-65	1	N/A	Not eligible
631-69	4	9	Unclear
631-70	4	9	Unclear
631-71	4	9	Unclear
631-81	3	4	Not eligible
631-82	4	6	Unclear
631-88	4	9	Unclear
631-96	3	5	Unclear
631-100	4	5	Unclear
631-119	4	5	Unclear

In spite of widely variable significance scores, reduction stations may provide useful research opportunities. They are spacially discrete and are thought to represent temporally discrete, single use episodes. Many such sites manifest clear patterns of organization that indicate specific toolstone reduction techniques, can be used to develop quantifiable measures of extracted and processed toolstone, and may provide models for understanding more complex site structure. Elston (1987) notes that site function may not be obvious at these sites. They may have served as hunting camps, way stations for highly mobile groups, and/or task specific reduction loci. Clarification of site function can contribute to understanding regional settlement patterns and the "embeddedness" of lithic procurement (Elston 1987). Chronological data may be available in small hearths, temporally sensitive artifacts, or other dateable materials present (e.g., obsidian, basalt).

Reduction complexes can address a similar range of research issues, but individual sites are more variable in content and spacial organization than at reduction stations. Two (5.3%) reduction complexes have high research potential and appear eligible National Register consideration; both contain numerous discrete flaking loci, staged reduction artifacts, and abundant data. Six (15.8%) are spacially diffuse and functionally undifferentiated reduction scatters lacking formed artifacts; these have low research value and are considered ineligible to the National Register (Table 19).

Table 19. National Register Assessment of Newly Recorded Reduction Complexes.

Site No.	Integrity Score	Significance Score	National Register Status
631-6	4	7	Unclear
631-8	4	9	Unclear
631-10	4	9	Unclear
631-13	4	6	Unclear
631-15	4	10	Apparently eligible
631-18	4	7	Unclear
631-20	4	5	Unclear
631-25	4	8	Unclear
631-26	4	8	Unclear
631-29	4	6	Unclear
631-30	4	3	Not eligible
631-48	4	10	Apparently eligible
631-51	3	9	Unclear
631-52	3	9	Unclear
631-55	3	6	Unclear
631-56	3	5	Unclear
631-57	3	7	Unclear
631-58	4	6	Unclear
631-60	3	4	Not eligible
631-62	4	5	Unclear
631-63	3	7	Unclear
631-64	3	3	Not eligible
631-66	3	5	Unclear
631-68	4	8	Unclear
631-72	4	3	Not eligible
631-86	4	8	Unclear
631-87	4	7	Unclear
631-89	4	7	Unclear
631-90	4	7	Unclear
631-93	4	3	Not eligible
631-95	3	7	Unclear
631-101	4	5	Unclear
631-106	4	5	Unclear
631-108	4	5	Unclear
631-112	4	6	Unclear
631-113	4	7	Unclear
631-114	4	5	Unclear
631-122	4	4	Not eligible

Though few in number, reduction complex/residential sites yield the highest significance scores. Seven of the nine recorded (77.8%) appear eligible for National Register consideration; two sites are of uncertain status (Table 20).

Table 20. National Register Assessment of Newly Recorded Reduction Complex/ Residential Sites.

Site No.	Integrity Score	Significance Score	National Register Status
631-21	4	10	Apparently eligible
631-45	3	16	Apparently eligible
631-50	4	15	Apparently eligible
631-103	3	11	Apparently eligible
631-104	3	9	Unclear
631-109	4	14	Apparently eligible
631-111	4	12	Apparently eligible
631-115	4	12	Apparently eligible
631-120	4	8	Unclear

Three large sites (631-45, 631-50, and 631-115) are expected to contain hearths (with dateable charcoal), complex site structure, multiple activity areas, diagnostic tools, dateable materials (obsidian, basalt), and tools and debitage reflecting a range of production stages and strategies. Thus, these sites can be expected to address all research issues discussed earlier. Other sites are smaller in size and contain fewer data categories and less data abundance. They may exemplify very short term residential use and/or small group size and could be usefully compared to patterns observed at larger residential sites.

Reduction complex/residential sites have the highest significance scores (Table 20), as expected, but it is interesting to note that high scores for reduction stations and reduction complexes are comparable or higher than low scores for possible residential sites. This is taken as a measure of the utility of the rating system. In other words, when site significance is evaluated against specifically identified research issues, a range of site types, rather than only one or two site types, will achieve moderately high significance scores.

The last categories of newly recorded sites to be considered are small sites and isolated artifacts. Isolated artifacts are not considered eligible for nomination to the National Register; rating scores are included in Table 21 for comparative purposes.

Table 21. National Register Assessment of Newly Recorded Isolated Artifacts.

Site No.	Artifact Type	Integrity Score	Significance Score	National Register Status
631-7	Stage I Biface	4	3	Not eligible
631-9	Stage I Biface	4	3	Not eligible
631-12	Core	4	3	Not eligible
631-28	Projectile Point	1	N/A	Not eligible
631-33	Stage I Biface	4	3	Not eligible
631-34	Stage I Biface	4	3	Not eligible
631-49	Stage I Biface	4	3	Not eligible
631-53	Core	4	3	Not eligible
631-73	Stage I Biface	4	3	Not eligible
631-74	Stage I Biface	4	3	Not eligible
631-78	Projectile Point	1	N/A	Not eligible
631-80	Projectile Point	1	N/A	Not eligible
631-83	Core	4	3	Not eligible
631-91	Stage I Biface	4	3	Not eligible
631-92	Stage II Biface	4	3	Not eligible
631-97	Projectile Point	1	N/A	Not eligible
631-99	Projectile Point	1	N/A	Not eligible
631-107	Stage I Biface	4	3	Not eligible
631-110	Projectile Point	1	N/A	Not eligible

No small sites are considered clearly eligible for National Register consideration, and 12 (75%) are considered ineligible due to their low research potential (Table 22). Four small sites require additional study to address National Register assessment; high artifact diversity, but low abundance may signal use of these sites as overnight camps or specialized activity areas.

Table 22. National Register Assessments of Newly Recorded Small Sites.

Site No.	Integrity Score	Significance Score	National Register Status
631-16	3	3	Not eligible
631-75	4	4	Not eligible
631-76	4	4	Not eligible
631-77	4	4	Not eligible
631-79	4	6	Unclear
631-84	4	5	Unclear
631-85	4	5	Unclear
631-94	4	3	Not eligible
631-98	4	3	Not eligible
631-105	4	3	Not eligible
631-116	4	4	Not eligible
631-117	3	5	Unclear
631-118	4	4	Not eligible
631-121	4	4	Not eligible
631-123	2	3	Not eligible
631-124	4	4	Not eligible

Previously Recorded Localities

Twenty-eight previously recorded cultural localities that occur in the U.S. Steel Project Area were identified originally as components of the Tosawihi Quarries Archaeological District (Elston et al. 1987). A subsequent recommended refinement of the boundaries of site 26Ek3032, the Tosawihi Quarries, removed 4 of the 28 localities from the site (Intermountain Research 1987). Thus, four previously recorded localities are now considered discrete sites and are treated accordingly in following discussions. The remaining 24 previously recorded localities (listed in Table 23), all represent components of 26Ek3032, a site considered eligible for National Register consideration (Elston et al. 1987). Treatment of site 26Ek3032, or any of its components, is not considered herein.

Table 23. List of Previously Recorded Localities Occurring Inside the Boundaries, as Refined, of Site 26Ek3032.

Type	Reference Number
Outcrop Quarry	611-1
Isolated Quarry Pit	611-2
	611-206
	611-207
Quarry Pit Complex	
	611-10
	611-24
	611-35
	611-36
	611-39
	611-43
	611-45
Small Reduction Station	611-34
	611-37
	611-184
	611-185
	611-186
	611-200
	611-216
Reduction Station Complex	611-25
	611-46
	611-203
Rockshelter/Reduction Station	611-3
Rockshelter/Undetermined	611-164
Isolated Artifact	611-93

The four previously recorded localities now considered separate sites were rated for integrity and significance; all demonstrate moderate research potential but require additional assessment to determine their National Register eligibility. Results are presented in Table 24.

Table 24. National Register Assessments for Four Previously Recorded Localities.

Site Type	Reference Number	Integrity Score	Significance Score	National Register Status
Outcrop Quarry	611-12	4	8	Unclear
	611-13	3	9	Unclear
Reduction Station	611-181	4	5	Unclear
Reduction Complex	611-180	4	8	Unclear

In summary, 128 sites (including 4 previously recorded localities) have been evaluated in terms of their eligibility for nomination to the National register of Historic Places (Table 25). While nine sites appear Register eligible, more intensive evaluation (testing) is needed to confirm assessments. Similarly, present data is insufficient to assess eligibility for 74 sites, and additional study is required. Forty-five sites appear ineligible for National Register consideration. Finally, 24 previously recorded localities occur within the boundaries (as recommended) of site 26Ek3032, which presently is considered eligible for nomination to the National Register of Historic Places.

Table 25. National Register Eligibility Status of 152 Sites in the U.S. Steel Project Area.

Ineligible Sites	Apparently Eligible Sites	Eligibility Unclear	Eligibility Unclear (continued)	Eligible Localities of (26Ek3032)
631-7	631-15	631-1	631-70	611-1
631-9	631-21	631-2	631-71	611-2
631-12	631-45	631-3	631-79	611-3
631-14	631-48	631-4	631-82	611-10
631-16	631-50	631-5	631-84	611-24
631-17	631-103	631-6	631-85	611-25
631-19	631-109	631-8	631-86	611-34
631-27	631-111	631-10	631-87	611-35
631-28	631-115	631-11	631-88	611-36
631-30		631-13	631-89	611-37
631-33		631-18	631-90	611-39
631-34		631-20	631-95	611-43
631-35		631-22	631-96	611-45
631-44		631-23	631-100	611-46
631-49		631-24	631-101	611-93
631-53		631-25	631-102	611-164
631-60		631-26	631-104	611-184
631-64		631-29	631-106	611-185
631-65		631-31	631-108	611-186
631-72		631-32	631-112	611-200
631-73		631-36	631-113	611-203
631-74		631-37	631-114	611-206
631-75		631-38	631-117	611-207
631-76		631-39	631-119	611-216
631-77		631-40	631-120	
631-78		631-41	611-12	
631-80		631-42	611-13	
631-81		631-43	611-180	
631-83		631-46	611-181	
631-91		631-47		
631-92		631-51		
631-93		631-52		
631-94		631-54		
631-97		631-55		
631-98		631-56		
631-99		631-57		
631-105		631-58		
631-107		631-59		
631-110		631-61		
631-116		631-62		
631-118		631-63		
631-121		631-66		
631-122		631-67		
631-123		631-68		
631-124		631-69		
Total 45		9	74	24

Chapter 8. CULTURAL RESOURCE MANAGEMENT RECOMMENDATIONS

The purpose of the present archaeological investigation was to identify all cultural resources located in the U.S. Steel Project Area, assess their significance, and make management recommendations for significant sites that may be affected by proposed minerals development.

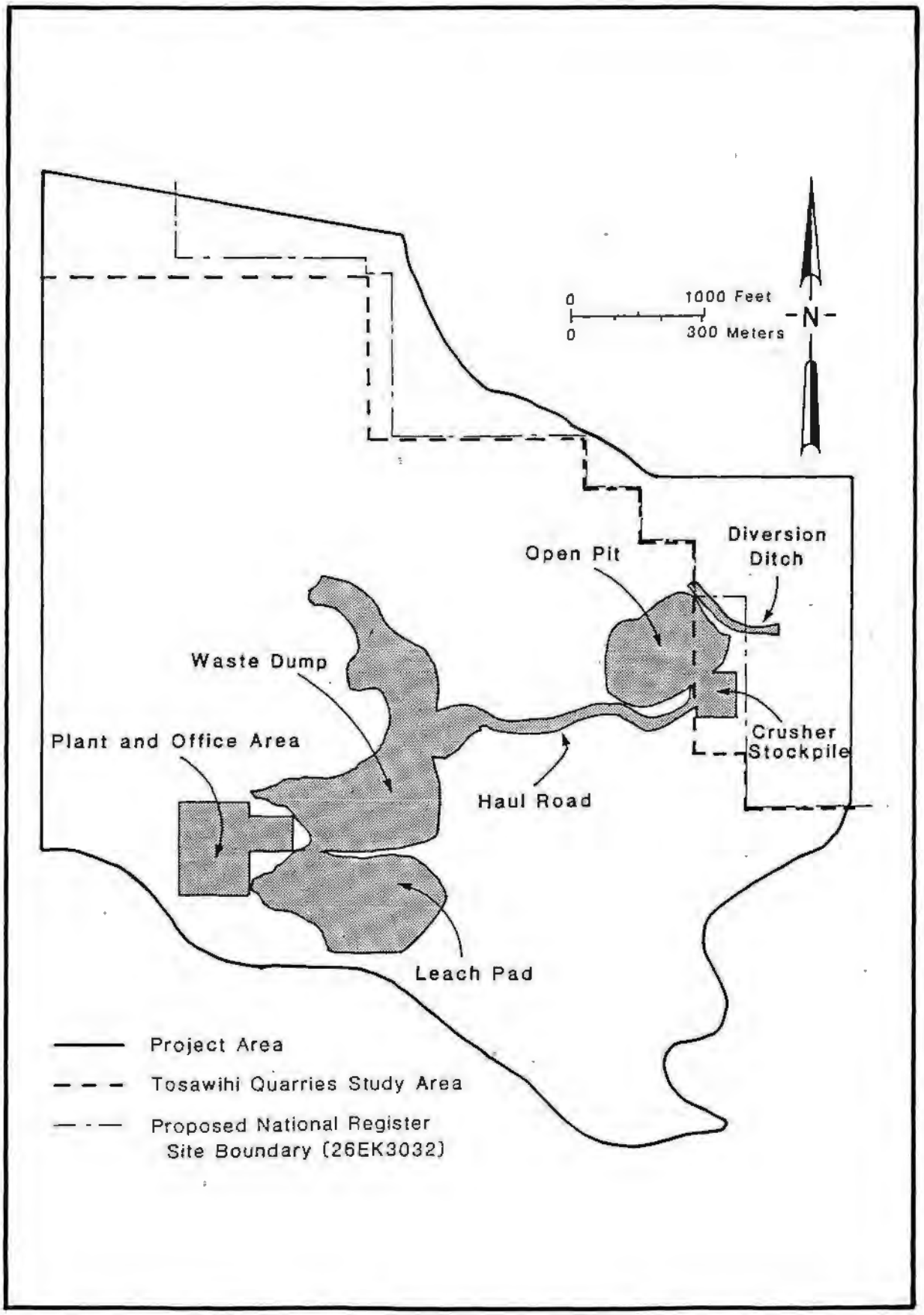
A proposed plan of operations, provided by Galactic Services, Inc., is mapped relative to recorded archaeological sites in Figure 15 (in pocket); a small scale representation of the plan appears as Figure 16. The operating plan calls for an open pit mine to be located on Red Hill. A crusher stockpile pad is to be located on the southeast edge of the pit, with a diversion ditch placed along the ravine to the northeast. Waste is to be dumped in Basalt Canyon and along the lower slopes of the finger ridges to the west. A leach pad is to be constructed in a small unnamed drainage to the south; processing plant, office, and crusher area are located on the west. A haul road connecting mine pit with processing facilities will require cutting back the steep slopes on the south edge of Red Hill and filling in the drainage where the road will cross Basalt Canyon.

Project Effects

Thirty-seven sites are located in or adjacent to proposed developments: 14 are within delimited development areas, 23 occur within 200 feet of developments (Table 24). It is assumed all sites inside project developments will be impacted; moreover, any site located within 200 feet of a proposed development is considered to be within a potential impact zone, due to our understanding that present project design may undergo slight modifications as development work proceeds.

The 37 sites include 8 considered ineligible for National Register consideration, 6 that appear eligible for National Register nomination, 20 sites of potential, but uncertain eligibility, and three localities that are components of National Register eligible site 26Ek3032 (as defined by Intermountain Research 1987).

Figure 16. Proposed Plan of Operations.


0
1000 Feet
0
300 Meters
N
Diversion Ditch
Open Pit
Waste Dump
Plant and Office Area
Crusher Stockpile
Haul Road
Leach Pad
Project Area
Tosawihi Quarries Study Area
Proposed National Register Site Boundary (26EK3032)

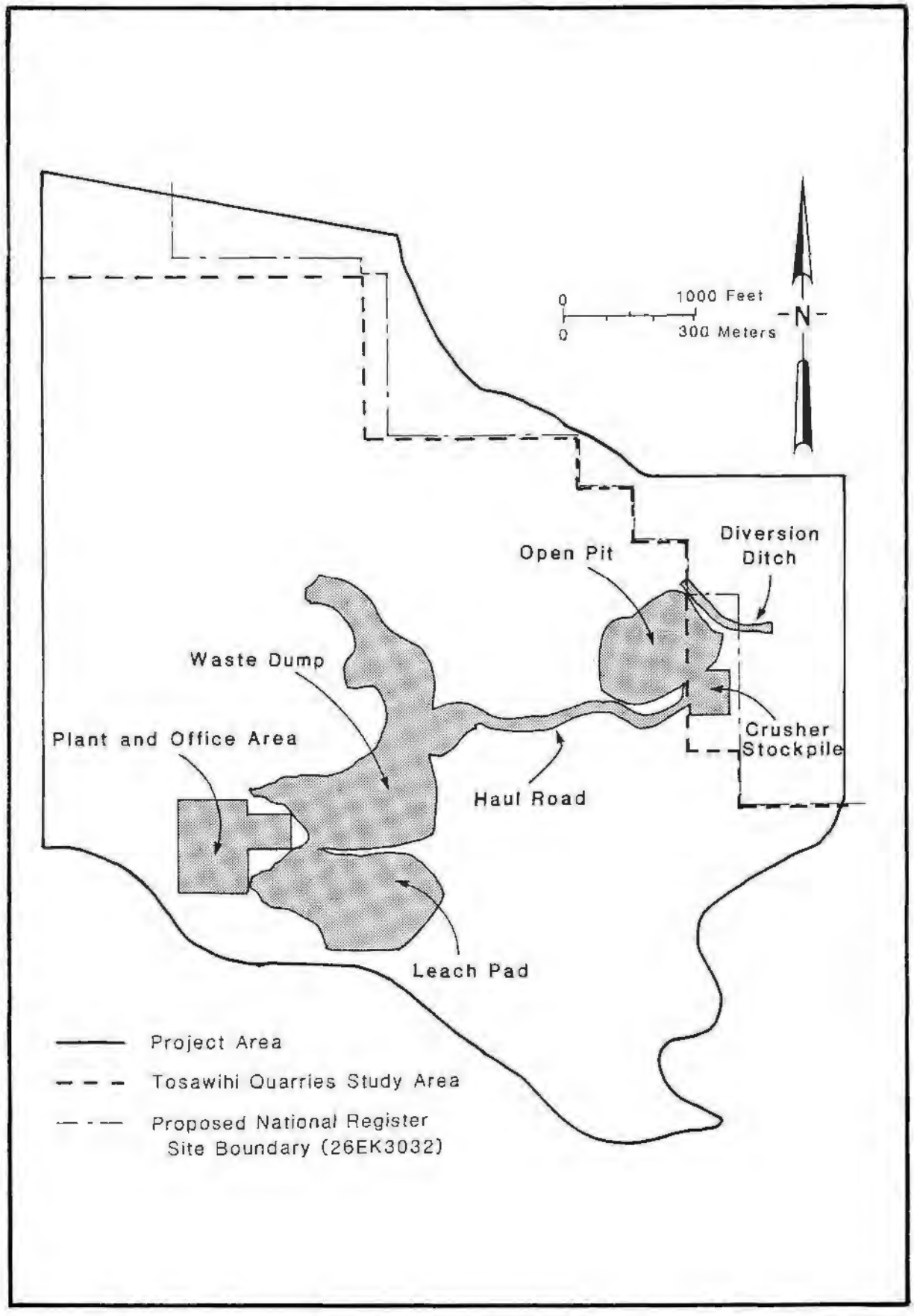

0
1000 Feet
0
300 Meters
N
Diversion Ditch
Open Pit
Waste Dump
Plant and Office Area
Crusher Stockpile
Haul Road
Leach Pad
Project Area
Tosawihi Quarries Study Area
Proposed National Register Site Boundary (26EK3032)

Table 26. Summary of Sites Located Inside and Adjacent to, Proposed Mining Developments.

Proposed Design Element	Sites Within Development	Sites Adjacent Development (distance from development)	National Register Status
Oxide East Pit			
	---	631-35 (150' W)	Not eligible
Diversion Ditch			
		611-25 (150' N)	Eligible*
		611-36 (100' N)	Eligible*
	---	631-55 (10' N)	Unclear
Crusher and Stockpile Pad			
		611-93 (150' E)	Eligible*
Haul Road			
	611-13		Unclear**
	631-37		Unclear
	631-39		Unclear
	631-47		Unclear
		631-36 (150' N)	Unclear
		631-38 (100' S)	Unclear
		631-43 (200' S)	Not eligible
Waste Dump			
	631-45		Apparently eligible
	631-50		Apparently eligible
	631-63		Unclear
	631-64		Not eligible
	631-67		Unclear
	631-68		Unclear
	631-101		Unclear
		631-46 (150' E)	Unclear
		631-48 (175' W)	Apparently eligible
		631-49 (75' W)	Not eligible
		631-52 (150' N)	Unclear
		631-66 (50' N)	Unclear
		631-69 (150' N)	Unclear
		631-70 (150' N)	Unclear
		631-74 (150' N)	Not eligible
		631-75 (100' W)	Not eligible

Table 26. Continued.

Proposed Design Element	Sites Within Development	Sites Adjacent Development (distance from development)	National Register Status
Waste Dump/ Leach Pad Overlap			
	631-115		Apparently eligible
Leach Pad			
		631-117 (180' S)	Unclear
		631-118 (75' S)	Not eligible
		631-119 (175' S)	Unclear
		631-122 (50' S)	Not eligible
Crusher Area			
	631-112		Unclear
Plant and office			
	631-111		Apparently eligible
		631-108 (25' W)	Unclear
		631-109 (100' S)	Apparently eligible

* previously recorded locality, component of 26Ek3032 (amended site boundary).

** previously recorded locality outside 26Ek3032 (amended site boundary).

Management Recommendations

Management actions recommended for the 37 affected sites are summarized in Table 27 and detailed below.

No further action is recommended on behalf of the eight sites considered ineligible for nomination to the National Register.

Avoidance and protection by project design of three previously recorded localities is recommended. These localities have not been recorded as discrete archaeological sites, but, rather, as components of Site 26Ek3032 (Elston et al. 1987). Site 26Ek3032 incorporates an area which has been determined eligible for nomination to the National Register of Historic Places. It should be noted, however, that the boundary of site 26Ek3032 remains to be clarified (Figure 16; see also Rusco 1983, Elston et al. 1987, Intermountain Research 1987).

Six sites appear eligible for National Register consideration. It is recommended that a testing program be implemented at these sites to confirm their eligibility (or demonstrate their ineligibility).

The National Register eligibility status of 20 sites is uncertain; data obtained at the survey level of investigation suggest a potential for eligibility but, as with the 11 sites above, do not confirm it. It is recommended that a testing program be implemented to evaluate these sites so that determinations of eligibility can be made. Once eligibility determinations have been made for each of the 26 sites tested, a data recovery program should be implemented, based on information generated by testing results, at each site eligible for nomination to the National Register of Historic Places.

Modification of the present proposed plan of operations may require concomitant modification of the management recommendations provided here. Consistent with above recommendations, sites which occur within 200 feet of project elements can be expected to sustain impacts from project development and should be considered within a potential impact zone. Sites apparently or potentially eligible for National Register consideration should be tested, and data recovery undertaken at those determined eligible for Register nomination. Sites considered ineligible for National Register consideration should require no further attention.

Finally, we make two further recommendations: first, formally record locality 611-13 as a discrete site; second, formally amend the boundary of site 26Ek3032, as recommended in "A Draft Cultural Resources Management Plan for the Tosawihi Quarries Archaeological Site, Elko County, Nevada" (Intermountain Research 1987:5; Figure 2).

Table 27. Recommended Actions for 37 Sites (and previously recorded localities) Affected by Proposed Project Developments.

No Further Action (site type)	Avoid by Project Design (site type)	Confirm National Register Eligibility (site type)	Evaluate National Register Eligibility (site type)
631-35 (TQ)	611-25 (RC)	631-45 (RC/RS)	611-13 (OQ)
631-43 (RS)	611-36 (QPC)	631-48 (RC)	631-36 (RS)
631-49 (IA)	611-93 (IA)	631-50 (RC/RS)	631-37 (OQ)
631-64 (RC)		631-109 (RC/RS)	631-38 (TQ)
631-74 (IA)		631-111 (RC/RS)	631-39 (OQ)
631-75 (SS)		631-115 (RC/RS)	631-46 (RS)
631-118 (SS)			631-47 (RS)
631-122 (RC)			631-52 (RC)
			631-55 (RC)
			631-63 (RC)
			631-66 (RC)
			631-67 (CQ)
			631-68 (RC)
			631-69 (RS)
			631-70 (RS)
			631-101 (RC)
			631-108 (RC)
			631-112 (RC)
			631-117 (SS)
			631-119 (RS)
Total 8	3	6	20

Key:
IA = Isolated Artifact
SS = Small Scatter
RS = Reduction Station
RC = Reduction Complex
RC/RS = Reduction Complex/ Residential Site
TQ = Talus Quarry
OQ = Outcrop Quarry
CQ = Cobble Quarry
QPC = Quarry Pit Complex

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1986 The Archaeology of the Vista Site (26Wa3017). Intermountain Reseaerch, Silver City, Nevada. Submitted to the Cultural Resources Section, Environmental Services Division, Nevada Department of Transportation, Carson City. Contract P51-84-013.

APPENDIX A: IMACS Site Forms (bound separately)

APPENDIX A: IMACS SITE FORMS

APPENDIX TO

An Archaeological Survey of the U.S. Steel Project Area

by
Elizabeth E. Budy

Intermountain Research Project No. 631
Intermountain Research Cultural Resources Use Permit N-39918
Bureau of Land Management Cultural Resources Report No.1-1124(P)

Prepared for
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January 1988

APPENDIX B: Site Evaluation Forms

TOSAWIHI QUARRIES: ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

AN INTENSIVE ARCHAEOLOGICAL SURVEY OF USX-EAST

by

Christopher Raven

Intermountain Research Job. No. 636-S
Cultural Resources Use Permit No. N-39918

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April 25, 1988

INTERMOUNTAIN RESEARCH
REPORTS

Cultural Resources Short Report Elko County, Nevada

Areal/Intensity Data: The project study area encompasses ca. 160 acres. The entire area was surveyed for cultural resources at 30 meter transect intervals. South of the principal east-west drainage, survey was accomplished in 38 linear north-south transects; on steep slopes north of the drainage (ca. 12 acres), 5 contour transects were surveyed.

Project Description: Galactic Services, Inc., proposes to develop ore processing facilities (crusher, leach pads, topsoil stockpile) for its USX Mine. Additional support facilities, including leachate collection ditches, a surface diversion ditch, and a network of 30 ft. wide access roads, are planned. As presently designed, direct surface disturbance would be confined (with a one-acre exception) to that portion of the project area lying south of the east-west drainage.

Statement of Purpose: Archaeological survey of the U.S. Steel West project area was conducted and reported by Budy (1988); since the present facilities are ancillary to that project, the present report constitutes an addendum to Budy's documentation, reporting the results of additional survey. Pains were taken to ensure that field survey methods, manner of recording, and site evaluation procedures were strictly comparable between the two studies in order to facilitate planning coordinated programs of archaeological testing and data recovery in both project areas.

Project Personnel: Survey was conducted by Christopher Raven and Kenneth E. Juell. Subsequent to survey, Juell finalized IMACS site forms while Raven calculated significance evaluation scores and prepared this report.

Cultural Resources Use Permit No.: N-39918 (expires 9/30/90).

Agency Notification: Mr. Stanley Jaynes, Elko District Office, Bureau of Land Management, was consulted regarding survey of the project area, and was notified prior to the survey party entering the field.

Dates of Field Examination: April 6-12, 1988.

Date of Report: April 25, 1988.

Map Reference: USGS Willow Cr. Reservoir SE 7.5' (1965).

Legal Description: T37N, R48E:

Section 3:	S 1/2 of NW 1/4 of SW 1/4
	SW 1/4 of SW 1/4
	NW 1/4 of SE 1/4 of SW 1/4
	Portions of SW 1/4 of NE 1/4 of SW 1/4
	Portions of NE 1/4 of SE 1/4 of SW 1/4
	Portions of SW 1/4 of SE 1/4 of SW 1/4
Section 4:	SE 1/4 of SE 1/4 of SE 1/4
	E 1/2 of SW 1/4 of SE 1/4
	Portions of SE 1/4 of NW 1/4 of SE 1/4
	Portions of S 1/2 of NE 1/4 of SE 1/4
Section 9:	Portions of NE 1/4 of NW 1/4 of NE 1/4
	Portions of SE 1/4 of NW 1/4 of NE 1/4
	Portions of NW 1/4 of NE 1/4 of NE 1/4
	Portions of NE 1/4 of NE 1/4 of NE 1/4
Section 10:	Portions of NW 1/4 of NW 1/4 of NW 1/4
	Portions of NE 1/4 of NW 1/4 of NW 1/4

Relationship to Cadastral Markers: A USGS section-corner brasscap (Sections 3, 4, 9, 10; T37N, R48E) was observed in the southern half of the central project area.

Area and Environmental Setting: The environment of the project vicinity has been sketched by Elston, Raven, and Budy (1987), with amplifications by Budy (1988); the following description relates specifically to the U.S. Steel East project area.

The area is bounded on the northeast by the deep canyon of Little Antelope Creek, a major seasonal drainage. From this base, at elevation 5580 feet amsl, the project area rises gradually to the southeast across a series of slightly dissected slopes, ridges, and knolls, achieving an elevation of 5800 feet at its southern margin. Its northern periphery encompasses the meandering gorge of an unnamed seasonal drainage that flows west into Little Antelope Creek. No permanent waters rise within or cross the area.

The northern half of the study area exhibits abundant outcrops and nodule deposits of the silicified cryptocrystalline rocks exploited prehistorically as toolstone and identified archaeologically as Tosawihi chert or opalite

(Rusco 1976, 1979; Budy 1988; Elston et al. 1987). The material is visually indistinguishable from the toolstone quarried within the Tosawihi Quarries (26Ek3032) immediately to the northeast. As the slopes rise in the southern half of the study area, the mineralogy begins to be dominated by rhyolitic exposures and the incidence of opalite declines rapidly.

Vegetation is composed of an intricate mosaic of big sage and low sage communities, the former dominating northern slopes and zones of deeper soils, the latter occurring principally in areas of surface or near-surface bedrock. Both communities include rabbitbrush, as well as grass components including Great Basin wildrye, bluebunch wheatgrass, and squirreltail. Phlox is a frequent member of the low sage community, and bitterbrush occurs infrequently along the rims of the drainage gorge.

Rabbits were noted during survey, as were evidences of badgers, pack rats, and marmots. The occasional presence of antelope and mule deer is inferred.

Review of Existing Information: Details of the regional prehistory of the project vicinity have been summarized by Elston et al. (1987) and Budy (1988) with specific reference to the chronology, exploitation, and archaeological distribution of Tosawihi opalite. These studies, together with previous research by Rusco (1976, 1978, 1979), conclude that white cherts apparently originating in the Tosawihi Quarries have been significant components of the lithic profiles of assemblages in central northern Nevada for as long as the past 8000 years.

Intensive survey of the Tosawihi Quarries immediately northeast of the project area resulted in the recording of 219 prehistoric localities consisting chiefly of quarry-related features, lithic reduction areas, residential localities, and rockshelters (Elston et al. 1987). Additional survey of the U.S. Steel West project area, ca. 0.4 mi. due west of the present project area, resulted in the recording of 124 archaeological sites, chiefly quarry-related features, reduction stations and complexes (some with possible residential functions), small sites, and isolated artifacts.

Ethnographic patterns of the Tosawihi ("White Knife") Shoshone living along the Humboldt River and exploiting the Tosawihi Quarries in the historic period have been sketched by Elston et al. (1987); greater detail is presented by Steward

(1938) and Harris (1940), but little information is available on actual aboriginal presence in the vicinity of the study area.

The history of mercury mining in the Ivanhoe Mining District, occurring sporadically between 1911 (the date of initial discovery) and 1966, has been summarized by Zeier (1987) in the context of an intensive reconnaissance and evaluation of historic resources in the Tosawihi Quarries Archaeological District.

Search of the current cultural resource records of the Bureau of Land Management, Elko District Office, as well as those of the Nevada State Museum, indicate that no prior cultural resource surveys have been performed in the project area, nor have any cultural sites been recorded previously therein.

National Register Review: Archaeological site 26Ek3032 (Tosawihi Quarries) is considered eligible for inclusion on the National Register of Historic Places (Intermountain Research 1987). Additionally, of the 124 sites recorded in the U.S. Steel West project area, 79 are regarded as potentially eligible for National Register consideration pending further assessment (Budy 1988).

Methods: The surface of the project area was scrutinized by a two-member survey team that transected the entire area at 30 meter intervals. The zone south of the drainage gorge was surveyed in 38 linear north-south transects, while that north of the gorge was surveyed in 5 contour transects. Locational control was maintained by reference to topographic features, mapped cultural features (roads, a corral, drill sites), a section-corner brass cap, and an intermittently-staked 400 foot grid surveyed by Touchstone Resources over the western one-third of the project area.

Upon detection, sites were recorded on IMACS site forms (Appendix B) and their boundaries were plotted on 1:6000 (1 in. = 500 ft.) topographic maps supplied by Galactic Services. The western half of the project area had been mapped at 5 foot contour intervals, allowing somewhat greater precision in plotting site locations than in the eastern half, where field maps were based on USGS 20 foot contour mapping. To assist in relocating sites in the field, each site was marked with a yellow pin flag inscribed with a temporary site number.

Collection of specimens was limited to chronologically diagnostic projectile points (n=3) and a single fragment of an

apparently finished Stage III biface. In each instance the location of collected specimens was noted and the position flagged on the ground for later instrument mapping.

Results of Reconnaissance: Survey of the U.S. Steel East project area resulted in the detection and recording of 37 previously unrecorded archaeological sites; no historic sites were observed within the project area, although a number of minerals exploration features (bulldozer scrapes) were observed throughout and a vertical shaft was noted at the western extreme.

Sites were classified according to criteria employed by Elston et al. (1987) and Budy (1988); the resulting typology (Table 1) segregates site types by abundance and diversity of tools and debitage, spatial patterning, occurrence of toolstone, and overall site morphology. Seven site types have been discriminated.

Table 1. Summary of Site Classification.

Site Type	n	% of Total
Quarry pit/reduction complex	5*	13.5
Outcrop quarry/reduction complex	5	13.5
Large reduction complex	4	10.8
Small reduction complex	5*	13.5
Reduction station	10	27.0
Diffuse lithic scatter	3	8.1
Rockshelter	5*	13.5
Total	37	99.9

*1 site with possible residential function

The site typology adopted here reflects apparent dominant site function as inferred from surface examination, and necessarily subsumes a range of variation within each site type; too, certain attributes appear in more than one site type, but have not been used to define additional types at this point because their occurrence is infrequent and requires further assessment. Thus, one example each of our quarry pit/reduction complexes, small reduction complexes, and rockshelters exhibits an assemblage diversity (including isolated specimens of ground stone) that suggests possible residential function. In all such cases, however, the evidence for residentiality is sparse, and awaits testing.

Attributes of each site type are discussed below.

Quarry Pit/Reduction Complexes

Quarry pit complexes occur throughout the northern half of the project area, in areas where the availability of toolstone is evident in surface or near-surface contexts; in three instances the sites exhibit bedrock outcrops of toolstone-quality opalite in the near vicinity of quarry pits. Each site contains 2-5 quarry pits, 3-8 m in diameter and 10-20 cm in depth. The contents of the pits consist chiefly of opalite cobbles, cores, and shatter, with relatively low incidences of bifaces and secondary debitage. Chippage tends to be variably denser immediately outside the pits, and each site contains often numerous concentrations of reduction debris. Table 2 summarizes the principal attributes of the type.

Table 2. Attributes of Quarry Pit/Reduction Complexes.

Site	Area (sq. m)	No. of Pits	Debitage density (Max/sq. m)	Outcrops
26Ek3170	36,500	2	300	-
26Ek3171	4,700	2	300-500	-
26Ek3195	6,600	5	500	3 low quality bedrock exposures
26Ek3197	1,400	3	500	Rimrock of brecciated opalite
26Ek3200	950	3	500	Small exposures at 1 pit

Site 26Ek3170 is distinguished from other sites of the type by its very great size and by its proximity to habitation localities 27 and 28 in the Tosawihi Quarries (26Ek3032) reported by Elston et al. (1987). While beyond the boundaries of the present project area, the nearer of these habitation areas (Locality 27) lies only 60 m north of 26Ek3170, separated from it by a slight increase in slope gradient. It seems likely that activities at 26Ek3170 were related to the occupation of Locality 27, especially in light of a mano recorded within the site precinct; if, in fact, the site represents a special activity area ancillary to a residential locus, the site may prove with further study to exhibit a greater degree of complexity than that which characterizes other quarry pit/reduction complexes.

Outcrop Quarry/Reduction Complexes

Confined to the rims and knolls overlooking the drainage gorge in the northeastern portion of the project area, five localities contain outcrops and bedrock exposures of toolstone-quality opalite that served as sources of lithic raw material. Evidence of prehistoric utilization consists of battering on exposed surfaces, an abundance of shatter, and a moderate incidence of primary debitage and cores. Concentrations of debitage occur in the vicinity of most of the outcrops, and in three instances multiple discrete lithic reduction areas are discernible. Characteristics of the type are given in Table 3.

Table 3. Attributes of Outcrop Quarry/Reduction Complexes.

Site	Area (sq. m)	Debitage density (Max/sq. m)	Outcrops	Discrete Stations
26Ek3191	8,500	5	Bedrock exposure; light use	-
26Ek3193	2,700	200	Small bedrock exposure; light use	3
26Ek3196	11,700	300	Large rim; heavy use	Several
26Ek3201	1,900	300	Bedrock and rim; moderate use	Several
26Ek3203	5,500	200	Bedrock and rim; moderate use	-

The low density of debitage and lack of discrete reduction stations at site 26Ek3191 owes to the diminutive size of the outcrop; much of the debitage encompassed by the site boundary seems less a function of the presence of the outcrop than of the incidence of a diffuse field of cobbles that has surfaced from bedrock origins and that provided prehistorically a dispersed zone of isolate source material that sometimes was assayed, and sometimes was reduced further on the spot. The other sites reflect rather enthusiastic exploitation of the toolstone sources that they offered, and hold within their precincts various areas within which the material was further reduced.

Large Reduction Complexes

Four large sites (area >2000 sq. m) in the northern half of the project area consist of flat or gradually sloping knoll tops or shelves punctuated by six to more than twenty discrete

clusters of secondary debitage, with the frequent occurrence of cores and Stage I and II bifaces and the occasional occurrence of other formed artifacts. None exhibits a lithic source within its precincts, although all are proximal (<150 m) to quarry pits or outcrops. They apparently represent clusters of reduction stations, their use conditioned by nearness to sources of raw material and topographic convenience. Their attributes are summarized in Table 4.

Table 4. Attributes of Large Reduction Complexes.

Site	Area (sq. m)	Debitage density (Max/sq. m)	No. of Loci	Artifacts C	BI	BII	BIII	Other
26Ek3184	12,850	300	20+	20	X	X	-	3
26Ek3190	2,850	100	6	-	6	4	-	1
26Ek3192	2,100	200	7	5	15	4	-	1
26Ek3198	5,650	200	12	5	20	10	4	1

C = Core
BI = Stage I Biface
BII = Stage II Biface
BIII = Stage III Biface
X = Many present, not counted

Site 26Ek3184 occupies the entire crest of a broad ridge that descends to the major drainage channel. Its great abundance of discrete reduction loci is unique among the sites considered here, a function perhaps of its proximity to 26Ek3170 and the slightly downstream habitation localities (27 and 28) of the Tosawihi Quarries. Exhibiting fewer discrete loci but a greater incidence of formed tools is 26Ek3198, which occupies a knolltop location central to three major quarrying sites (cf. map); it probably served as a general area in which to reduce materials collected at all three sources.

Small Reduction Complexes

Several microtopographic flats in the western half of the project area appear to have functioned similarly to large reduction complexes, but, owing to topographic constraints or greater distance from material sources, were less used.

Consequently, they exhibit fewer discrete flaking loci, less dense concentrations of debitage, and generally less diverse artifact assemblages. Table 5 summarizes their distinctive features.

Table 5. Attributes of Small Reduction Complexes.

Site	Area (sq. m)	Debitage density (Max/sq. m)	No. of Loci	Artifacts C	BI	BII	BIII	Other
26Ek3172	700	20	3	-	1	-	-	-
26Ek3173	160	100	3	-	1	-	-	-
26Ek3185	240	100	3	1	2	1	1	3*
26Ek3188	240	50	6	-	1	-	-	-
26Ek3189	120	50	3	2	2	-	-	-

C = Core
BI = Stage I Biface
BII = Stage II Biface
BIII = Stage III Biface
* Groundstone

The assemblage diversity of 26Ek3185 merits note; although neither density of debitage nor number of discrete loci distinguish it from other small reduction complexes, it uniquely contains finished tools (including a Desert Side-notched projectile point) as well as two fragments of ground stone. While neither the size of the site nor its abundance of material suggest repeated residential usage, artifact diversity suggests that it may have served briefly as a temporary camp.

Reduction Stations

Confined with one exception to the slopes of the southwestern quadrant of the project area are ten small sites (Table 6) composed of light to heavy scatters of secondary debitage accompanied by occasional Stage I and Stage II bifaces. None appears to contain discrete activity loci other than a central concentration of chippage the density of which falls off rapidly over a radial distance of 10 m or less. The internal composition of most of these sites appears equivalent to that of individual loci within reduction complexes, from which they are distinguished chiefly by their isolation.

Table 6. Attributes of Reduction Stations.

Site	Area (sq. m)	Debitage density (Max./sq. m)	Debitage (Rel. Freq.) P	S	Sh	T	Artifacts (Count) C	BI	BII
26Ek3174	180	50	-	3	1	-	-	-	-
26Ek3175	80	50	-	3	1	-	-	1	-
26Ek3178	40	500	-	3	1	-	-	-	4
26Ek3179	310	100	-	3	1	-	-	-	2
26Ek3180	310	10	-	3	1	-	-	1	-
26Ek3181	180	100	-	3	1	-	-	2	1
26Ek3182	240	30	-	3	1	-	-	-	-
26Ek3183	20	100	-	3	1	1	-	1	1
26Ek3186	80	30	-	3	1	1	-	-	-
26Ek3187	20	20	-	3	1	-	-	1	-

P = Primary Flakes
S = Secondary Flakes
Sh = Shatter
T = Tertiary Flakes

C = Core
BI = Stage I Biface
BII = Stage II Biface

1 = Rare 2 = Common 3 = Dominant - = Not observed

Only site 26Ek3178, geographically apart from the other reduction stations, appears anomalous. While tightly clustered in a single locus, the site exhibits a vastly greater abundance and density of debitage than any other example of the type. Moreover, the incidence of Stage II bifaces is atypically high. Comparative debitage analysis of this assemblage and that of other reduction stations is warranted to determine whether other pattern regularities confirm the uniqueness of 26Ek3178.

Diffuse Lithic Scatters

The gradual slopes and undulating ridges of the project area's southeastern quadrant are devoid of lithic material sources, and are relatively far from water and habitation loci. Prehistoric activity within the area appears to have been neither intensive nor particularly recurrent. Three sites have been identified (Table 7), all of which are large, are characterized by diffuse scatters of secondary debitage, and lack discrete loci.

Table 7. Attributes of Diffuse Lithic Scatters.

Site	Area (sq. m)	Debitage density (Max./sq. m)	Debitage (Rel. Freq.) P	S	Sh	Artifacts (Count) C	BI	BII
26Ek3176	4,250	50	1	3	1	2	1	-
26Ek3194	8,850	2	-	3	1	-	-	-
26Ek3199	1,200	10	1	3	1	5	1	-

P = Primary Flakes
S = Secondary Flakes
Sh = Shatter
T = Tertiary Flakes

C = Core
BI = Stage I Biface
BII = Stage II Biface

1 = Rare 2 = Common 3 = Dominant - = Not observed

The rare occurrence of primary flakes and cores at 26Ek3176 and 26Ek3199 signals one of their qualitative differences from reduction stations. The materials suggest transport from nearby sources, perhaps the quarry pit complex 26Ek3200 200-300 m to the east.

Rockshelters

The silicified rims of the drainage gorge are pocked with natural cavities; all of those large enough to admit comfortable human passage appear to have been utilized prehistorically as sheltered reduction stations or, in one instance, as a temporary residential shelter. Additionally, the matrices of three provided sources of opalite nodules. Five rockshelters were recorded (Table 8).

Table 8. Attributes of Rockshelters.

Site	Area (sq. m)	Est. Depth of Deposit (cm)	Debitage density (Max./sq. m)	Artifacts C	BI	BII	Other	Lithic Source
26Ek3177	6	10	100	-	1	-	-	X
26Ek3202	39	10-20	10	1	1	-	-	-
26Ek3204	56	50	300	4	17	1	9*	X
26Ek3205	24	10	5	2	-	-	-	X
26Ek3206	27	20	10	1	-	-	-	-

C = Core
BI = Stage I Biface
BII = Stage II Biface
X = Lithic Source Present
*Ground stone present

The largest of the rockshelters, 26Ek3204, is also the most complex; it exhibits the greatest abundance of debitage, the greatest diversity of artifacts, and, probably, the deepest deposits. Among the artifacts noted on the surface, a drill, a scraper, and a mano suggest possible residential function. Tertiary flakes of obsidian were noted as well. The intact surface of the interior suggests that the site may retain evidence of spatially discrete behavior; two fragments of a mano were noted in immediate proximity, and three hammerstones (the only specimens of the class) were clustered likewise.

Significance Evaluations

The significance of each site recorded in the U.S. Steel East project area was assessed to determine its potential eligibility for inclusion on the National Register of Historic Places. Assessments were based on quantitative ratings of the integrity and research significance of the sites, as measured in the emerging framework of regional research concerns generated by surveys (Elston et al. 1987; Budy 1988) and formal research design (Elston 1987). In order to ensure comparability with prior evaluations, and particularly with those applied to sites in the U.S. Steel West project area, the rating systems for integrity and research significance employed by Budy (1988:44-62) have been adopted here.

Integrity scores were assigned relative to the degree of surface disturbance observed; score equivalents are given in Table 9.

Table 9. Integrity Rating Scheme

Score	Scoring Standards
1	Severely disturbed over more than 50% of site area. Disturbance may be a result of extensive erosion, numerous roads, drill pads, minerals exploration features, bulldozer cuts, or of artifact collection.
2	Moderately to heavily disturbed over less than 50% of total site area. Disturbance may be a result of erosion, roads, or minerals exploration, but significant portions of the site remain intact.

Table 9, continued.

Score	Scoring Standards
3	Discrete, areal disturbance restricted to less than 25% of total site area. Disturbance may include a road or mining exploration feature as well as slopewash and rodent turbation.
4	Essentially undisturbed. Minor disturbance may be a result of slopewash, trampling, or bioturbation.

Research significance scores were tallied from cumulative scores relative to quantity of material, clarity of site organization, and variety of data classes (Budy 1988:50). Score equivalents are given in Table 10.

Table 10. Research Significance Rating Scheme.

RESEARCH CRITERIA	SCORE
Quantity Measures	
1-10 items/sq. m.	1
>10-100 items/sq. m.	2
>100 items/sq. m.	3
Clarity Measures	
Isolated artifact	1
Undifferentiated spatially	2
Single activity locus	3
Multiple activity loci	4
Multiple activity loci/ Possible residential features	5
Variety Measures	
Quarry Categories	
On-site opalite source	1
Quarry feature	1
Reduction Categories	
Cores	1
Stage I bifaces	1
Stage II bifaces	1
Stage III bifaces	1

Table 10, continued.

RESEARCH CRITERIA	SCORE
Specialized Activity Measures	
Groundstone	1
Hammerstones/cobble spalls	1
Basalt Biface Reduction Debitage	1
Obsidian	1
Specialized Tools	1
	Total Score

Results of the scoring exercise for each site are presented in Appendix A; they are summarized below.

The integrity of all sites in the project areas is superior; by the ratings defined in Table 9, 28 sites receive scores of 4, while 9 receive scores of 3. Most of the disturbance in the latter cases owes to roads and mining exploration, although the largest zone of disturbance observed in the project area, central to site 26Ek3170, was the consequence of heavy vehicle and equipment movement during a moist episode in the winter of 1987-1988. In this instance, however, the great size of the site (ca. 36,500 sq. m) allowed most of its data to emerge unimpaired. The National Register eligibility of no site in the project area, therefore, is diminished by low integrity.

The research significance of the U.S. Steel East sites ranges in score from 3 to 15. Applying the standards employed by Budy (1988) in the U.S. Steel West project area, sites scoring 4 or lower would be considered ineligible for nomination to the National Register, those scoring 10 or higher would be regarded apparently eligible, and those scoring 5-9 would be considered of unclear eligibility. The sites of the East project area, however, exhibit a notably higher mean score (8.84) than do those recorded in the West (6.83) when measured against the same objective criteria, and we believe that the research potential of the area as a whole is pitched somewhat higher. We suggest, therefore, that translation of the raw research significance scores into measures of National Register eligibility appropriately defines a higher frame of reference; we believe that the apparent profile of unique research significance excludes sites scoring 6 or lower from National Register eligibility, and suggests that sites scoring 11 or higher may be eligible for National Register nomination. Sites whose score falls in

the range 7-10 are regarded as of unclear eligibility, and require further assessment. Tables 11-17 array the integrity and research significance scores for all sites by category, and the consequent evaluation of their National Register eligibility.

Table 11. National Register Assessment of Quarry Pit Reduction Complexes.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3170	3	13	Apparently Eligible
26Ek3171	3	12	Apparently Eligible
26Ek3195	4	12	Apparently Eligible
26Ek3197	4	11	Apparently Eligible
26Ek3200	4	11	Apparently Eligible

Mean Research Significance = 11.80

The class of Quarry pit/reduction complex exhibits the highest mean research significance rating within the project area. All sites of the class are considered potentially eligible for National Register consideration owing to their structural complexity, their abundance of cultural material, and the diversity of artifact types they contain.

Table 12. National Register Assessment of Outcrop Quarry/ Reduction Complexes.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3191	4	7	Eligibility Unclear
26Ek3193	4	11	Apparently Eligible
26Ek3196	4	11	Apparently Eligible
26Ek3201	4	11	Apparently Eligible
26Ek3203	4	10	Eligibility Unclear

Mean Research Significance = 10.0

Outcrop quarry/reduction complexes score generally high in terms of research potential, and appear on the whole largely eligible for National Register nomination. Frequently, in fact, they exhibit greater abundances or higher

densities of cultural material than quarry pit/reduction complexes, although the diversity of their assemblages tends to be somewhat lower. Site 26Ek3191 is more diffuse than the other sites of the class, and is notably lower in both abundance and assemblage diversity.

Table 13. National Register Assessment of Large Reduction Complexes.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3184	3-4	13	Apparently Eligible
26Ek3190	3	9	Eligibility Unclear
26Ek3192	4	12	Apparently Eligible
26Ek3198	4	13	Apparently Eligible

Mean Research Significance = 11.75

Large reduction complexes, owing to the number of discrete activity areas they exhibit, apparently representing repeated use of the same general area over long periods of time, contain not only high densities of debitage but frequently high diversities of artifact types. Site 26Ek3184 displays an especially high incidence of discrete flaking loci (more than 20), rendering it the most spatially complex site recorded in the project area.

Table 14. National Register Assessment of Small Reduction Complexes.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3172	3	8	Eligibility Unclear
26Ek3173	4	8	Eligibility Unclear
26Ek3185	4	15	Apparently Eligible
26Ek3188	3	7	Eligibility Unclear
26Ek3189	3	8	Eligibility Unclear

Mean Research Significance = 11.50

The National Register eligibility of most reduction complexes is unclear; their research potential is not dismissable, as they exhibit frequent complexity in spatial structure and abundance of cultural material (chiefly debitage), although they generally display slight assemblage

diversity. Site 26Ek3185 constitutes a notable exception; apparently a short-term residential site, it exhibits one of the highest assemblage diversities noted in the project area. Its research significance, accordingly, is atypically high for the class.

Table 15. National Register Assessment of Reduction Stations.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3174	4	6	Apparently Ineligible
26Ek3175	4	6	Apparently Ineligible
26Ek3178	4	7	Eligibility Unclear
26Ek3179	4	7	Eligibility Unclear
26Ek3180	4	6	Apparently Ineligible
26Ek3181	4	8	Eligibility Unclear
26Ek3182	3	7	Eligibility Unclear
26Ek3183	3	9	Eligibility Unclear
26Ek3186	4	5	Apparently Ineligible
26Ek3187	4	6	Apparently Ineligible

Mean Research Significance = 6.70

Half the small reduction stations recorded during the present effort appear so small, sparse, and homogenous that their research significance scores suggest ineligibility for National Register nomination. Among the remainder, measures of abundance or diversity suggest that useful information might be extracted through programmed testing or data recovery. Their National Register eligibility, therefore, remains to be assessed.

A special case is presented by site 26Ek3182, in which all evidence of cultural activity is disclosed in rodent mounds. Since this site, uniquely, is visible only in disturbed material recently brought to the surface, it seems important to assess the degree to which it, and perhaps other, similar locations, conceal cultural materials in subsurface contexts. Its research significance, therefore, has been inflated selectively owing to this anomaly (cf. Appendix B).

Table 16. National Register Assessment of Diffuse Lithic Scatters.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3176	4	6	Apparently Ineligible
26Ek3194	4	3	Apparently Ineligible
26Ek3199	4	5	Apparently Ineligible

Mean Significance = 4.66

Ranking categorically lowest in research significance, diffuse lithic scatters appear ineligible for National Register nomination. Their low densities of cultural material, lack of discernible internal spatial organization, and very low assemblage diversity suggest that their potential data contribution to identified research issues (Elston 1987) would be minimal.

Table 17. National Register Assessment of Rockshelters.

Site	Integrity Score	Research Significance Score	National Register Eligibility
26Ek3177	4	9	Eligibility Unclear
26Ek3202	4	9	Eligibility Unclear
26Ek3204	4	14	Apparently Eligible
26Ek3205	4	6	Apparently Ineligible
26Ek3206	4	6	Apparently Ineligible

Mean Research Significance = 8.80

Two recorded rockshelters (26Ek3205 and 26Ek3206) appear to retain low data contents in both surface assemblages and estimated depths of deposit; neither is regarded eligible for National Register nomination. Site 26Ek3204, on the other hand, exhibits both a highly diverse, abundant surface assemblage and the promise of sufficient depth that stratigraphic sorting of cultural materials may be retrievable; its National Register eligibility seems highly likely. The remaining rockshelters await further field evaluation.

Summary and Recommendations: Of 37 prehistoric sites recorded in the U.S. Steel East project area, 13 are considered apparently eligible for nomination to the National Register of Historic Places, 10 are considered ineligible, and the eligibility of 14 requires further evaluation for determination. Since the proposed development of ore processing facilities would entail potential impacts to all the sites, it is recommended that a testing program be initiated to record essential locational information for all sites, to determine the significance of those sites the National Register eligibility of which currently is unclear, and to confirm or deny the eligibility of those sites identified on the basis of survey data as apparently eligible for inclusion on the Register. Such testing, conducted in advance of project development, should define the parameters and extent of data recovery necessary to mitigate impacts if the project is to proceed.

Table 18. Summary Recommendations

Site	Type	National Register Eligibility Status	Test	Confirm Location NFA*
26Ek3170	Quarry pit/reduction complex	Apparently eligible	X	
26Ek3171	Quarry pit/reduction complex	Apparently eligible	X	
26Ek3195	Quarry pit/reduction complex	Apparently eligible	X	
26Ek3197	Quarry pit/reduction complex	Apparently eligible	X	
26Ek3200	Quarry pit/reduction complex	Apparently eligible	X	
26Ek3191	Outcrop quarry/reduction complex	Unclear	X	
26Ek3193	Outcrop quarry/reduction complex	Apparently eligible	X	
26Ek3196	Outcrop quarry/reduction complex	Apparently eligible	X	
26Ek3201	Outcrop quarry/reduction complex	Apparently eligible	X	
26Ek3203	Outcrop quarry/reduction complex	Unclear	X	
26Ek3184	Large reduction complex	Apparently eligible	X	
26Ek3190	Large reduction complex	Unclear	X	
26Ek3192	Large reduction complex	Apparently eligible	X	
26Ek3198	Large reduction complex	Apparently eligible	X	
26Ek3172	Small reduction complex	Unclear	X	
26Ek3173	Small reduction complex	Unclear	X	
26Ek3185	Small reduction complex	Apparently eligible	X	
26Ek3188	Small reduction complex	Unclear	X	
26Ek3189	Small reduction complex	Unclear	X	
26Ek3174	Reduction station	Ineligible		X
26Ek3175	Reduction station	Ineligible		X
26Ek3178	Reduction station	Unclear	X	
26Ek3179	Reduction station	Unclear	X	
26Ek3180	Reduction station	Ineligible		X
26Ek3181	Reduction station	Unclear	X	
26Ek3182	Reduction station	Unclear	X	

Table 18, continued.

Site	Type	National Register Eligibility Status	Test	Confirm Location NFA*	
26Ek3183	Reduction Station	Unclear	X		
26Ek3186	Reduction Station	Ineligible		X	
26Ek3187	Reduction Station	Ineligible		X	
26Ek3176	Diffuse lithic scatter	Ineligible		X	
26Ek3194	Diffuse lithic scatter	Ineligible		X	
26Ek3199	Diffuse lithic scatter	Ineligible		X	
26Ek3177	Rockshelter	Unclear	X		
26Ek3202	Rockshelter	Unclear	X		
26Ek3204	Rockshelter	Apparently eligible	X		
26Ek3205	Rockshelter	Ineligible		X	
26Ek3206	Rockshelter	Ineligible		X	
		Total	27	10	37

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TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

APPENDIX A: National Register Significance Evaluations

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 363-1 Type Quarry pit / reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26Ek3170

Integrity Score 3 Total Research Value Score 13

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	5
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	1
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-2 Type Quarry pit/reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26EK3171

Integrity Score 3 Total Research Value Score 12

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	1
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 336-3 Type Small reduction complex

Max. Area (sq. m.) _____ Perm. Site # 26BK3172

Integrity Score 3 Total Research Value Score 8

QUANTITY MEASURES	Point Value	Score
1–10 items/sq. m.	1	
>10–100 items/sq. m.	2	
>100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	1
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-4 Type Small reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26 EK 3173

Integrity Score 4 Total Research Value Score 8

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-5 Type Reduction station

Max. Area (sq.m.) _____ Perm. Site # 26 EK 3174

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2

CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3

VARIETY MEASURES		
Quarry Categories		
On-site oalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	_____
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	1
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-6 Type Reduction Station

Max. Area (sq. m.) _____ Perm. Site # 26EK3175

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-7 Type Diffuse lithic scatter

Max. Area (sq.m.) _____ Perm. Site # 26Ek3176

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	2
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-8 Type Rockshelter / lithic source

Max. Area (sq.m.) _____ Perm. Site # 26Ek3177

Integrity Score 4 Total Research Value Score 9

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 126-9 Type Reduction station

Max. Area (sq.m.) _____ Perm. Site # 26EK3178

Integrity Score 4 Total Research Value Score 7

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	_____
Stage II bifaces	1	1
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-10 Type Reduction station

Max. Area (sq.m.) _____ Perm. Site # 26EK3179

Integrity Score 4 Total Research Value Score 7

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site oalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	_____
Stage II bifaces	1	1
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-11 Type Reduction station

Max. Area (sq.m.) _____ Perm. Site # 26EK3180

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-12 Type Reduction Station

Max. Area (sq. m.) _____ Perm. Site # 26EK3181

Integrity Score 4 Total Research Value Score 8

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
) 10-100 items/sq. m.	2	
) 100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-13 Type Reduction station

Max. Area (sq.m.) _____ Perm. Site # 26Elk3182

Integrity Score 3 Total Research Value Score 5 (*7)

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2

CLARITY MEASURES

Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3

VARIETY MEASURES

Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	_____
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

* NB: Exposure of site confined to rodent mounds, thus may be largely buried; add 2 discretionary points.

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-14 Type Reduction station

Max. Area (sq. m.) _____ Perm. Site # 26Ek3183

Integrity Score 3 Total Research Value Score 9

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	
Quarry feature	1	
Reduction Categories		
Cores	1	
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	1
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-15 Type Large reduction complex

Max. Area (sq. m.) _____ Perm. Site # 26Ek3184

Integrity Score 3-4 Total Research Value Score 13

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	1
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	1
Specialized Tools	1	1

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-16 Type Small reduction complex/Res.

Max. Area (sq. m.) _____ Perm. Site # 26EL3185

Integrity Score 4 Total Research Value Score 15

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	5
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	1
Specialized Activity Measures		
Groundstone	1	1
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	1
Specialized Tools	1	1

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-17 Type Reduction Station

Max. Area (sq. m.) _____ Perm. Site # 26EK3186

Integrity Score 4 Total Research Value Score 5

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2

CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3

VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	_____
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 136-19 Type Reduction station

Max. Area (sq.m.) _____ Perm. Site # 26Ek3187

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2

CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3

VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	
Quarry feature	1	
Reduction Categories		
Cores	1	
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-20 Type Small reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26EK3188

Integrity Score 3 Total Research Value Score 7

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-21 Type Small reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26 Ek 3189

Integrity Score 3 Total Research Value Score 8

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site qualite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-22 Type large reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26EK3190

Integrity Score 3 Total Research Value Score 9

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	2

CLARITY MEASURES

Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4

VARIETY MEASURES

Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	1
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-23 Type Outcrop quarry/reduction comple

Max. Area (sq.m.) _____ Perm. Site # 26Ek3191

Integrity Score 4 Total Research Value Score 7

QUANTITY MEASURES	Point Value	Score
1–10 items/sq. m.	1	
>10–100 items/sq. m.	2	
>100 items/sq. m.	3	1
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	2
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-24 Type large reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26EK3192

Integrity Score 4 Total Research Value Score 12

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	1
Specialized Tools	1	1

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-25 Type Outcrop quarry

Max. Area (sq.m.) _____ Perm. Site # 26Ek3193

Integrity Score 4 Total Research Value Score 11

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-26 Type Diffuse lithic scatter

Max. Area (sq.m.) _____ Perm. Site # 26 Ek 3194

Integrity Score 4 Total Research Value Score 3

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	1

CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	2

VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	_____
Stage I bifaces	1	_____
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-27 Type Quarry pit/reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26Ek3195

Integrity Score 4 Total Research Value Score 12

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	1
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-28 Type Outcrop quarry/reduction comple

Max. Area (sq.m.) _____ Perm. Site # 26Ek3196

Integrity Score 4 Total Research Value Score 11

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site oalite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-29 Type Quarry pit/reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26Ek3197

Integrity Score 4 Total Research Value Score 11

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-30 Type large reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26EK3198

Integrity Score 4 Total Research Value Score 13

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site coalite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	1
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	1
Specialized Tools	1	1

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-31 Type Diffuse lithic scatter

Max. Area (sq.m.) _____ Perm. Site # 26EK3199

Integrity Score 4 Total Research Value Score 5

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	1
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	2
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-32 Type Quarry pit/reduction complex

Max. Area (sq.m.) _____ Perm. Site # 26Ek3200

Integrity Score 4 Total Research Value Score 11

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	1
Quarry feature	1	1
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-33 Type Outcrop quarry/reduction compl

Max. Area (sq. m.) _____ Perm. Site # 26 Ek 3201

Integrity Score 4 Total Research Value Score 11

QUANTITY MEASURES	Point Value	Score
1–10 items/sq. m.	1	
) 10–100 items/sq. m.	2	
) 100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site opalite source	1	1
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	1
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	1
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-34 Type Rockshelter

Max. Area (sq. m.) _____ Perm. Site # 26EK3202

Integrity Score 4 Total Research Value Score 7 (*9)

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site qualite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

* Evident depth of deposit; add 2 points

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-35 Type Outcrop quarry/reduction comple

Max. Area (sq.m.) _____ Perm. Site # 26EK3203

Integrity Score 4 Total Research Value Score 10

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	4
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temo. Site Number 636-36 Type Rockshelter/lithic source

Max. Area (sq.m.) _____ Perm. Site # 26EK3204

Integrity Score 4 Total Research Value Score 14*

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
)10-100 items/sq. m.	2	
)100 items/sq. m.	3	3
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	1
Stage II bifaces	1	1
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	1
Basalt Hammerstones/cobble spalls	1	1
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	1
Specialized Tools	1	1

Total Score

* Note probable residential function (not scored)

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-37 Type Rockshelter/lithic source

Max. Area (sq.m.) _____ Perm. Site # 26EK3205

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	1
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	1
Quarry feature	1	
Reduction Categories		
Cores	1	1
Stage I bifaces	1	
Stage II bifaces	1	
Stage III bifaces	1	
Specialized Activity Measures		
Groundstone	1	
Basalt Hammerstones/cobble spalls	1	
Basalt Biface Reduction Debitage	1	
Exotic Obsidian	1	
Specialized Tools	1	

Total Score

SIGNIFICANCE EVALUATION CRITERIA DATA SHEET

Temp. Site Number 636-38 Type Rockshelter

Max. Area (sq.m.) _____ Perm. Site # 26EK3206

Integrity Score 4 Total Research Value Score 6

QUANTITY MEASURES	Point Value	Score
1-10 items/sq. m.	1	
>10-100 items/sq. m.	2	
>100 items/sq. m.	3	2
CLARITY MEASURES		
Isolated artifact	1	
Undifferentiated spacially	2	
Single reduction activity locus	3	
Multiple reduction activtiy loci	4	
Multiple reduction activtiy loci/ Possible residential features	5	3
VARIETY MEASURES		
Quarry Categories		
On-site oolite source	1	_____
Quarry feature	1	_____
Reduction Categories		
Cores	1	1
Stage I bifaces	1	_____
Stage II bifaces	1	_____
Stage III bifaces	1	_____
Specialized Activity Measures		
Groundstone	1	_____
Basalt Hammerstones/cobble spalls	1	_____
Basalt Biface Reduction Debitage	1	_____
Exotic Obsidian	1	_____
Specialized Tools	1	_____

Total Score

APPENDIX B: Intermountain Antiquities Computer System Site Records

(Bound in a separate volume)

THE TOSAWIHI QUARRIES: AN ARCHAEOLOGICAL TESTING PROGRAM

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INTERMOUNTAIN RESEARCH
REPORTS



CULTURAL RESOURCES MANAGEMENT SUMMARY

Minerals exploration, proposed minerals extraction, and development of attendant support facilities in the Ivanhoe Project Area, a subarea of the Ivanhoe Mining District in Elko County, Nevada, prompted in 1987-1989 a program of archaeological surveys, site testing, and cultural resource significance evaluations (Figure A). Proposed mining developments lie peripheral to the Tosawihi Quarries archaeological site (26Ek3032), a prehistoric opalite quarry determined eligible for nomination to the National Register of Historic Places. Currently administered by the Elko District Office of the Bureau of Land Management, cultural resources in selected portions of the project area were identified, recorded, evaluated, tested, and their evaluations subsequently revised in accordance with Federal regulations and then-current BLM policy guidelines (Nevada BLM 1985; USDI-BLM n.d.). The present discussion summarizes the results of those exercises in terms of the predicted effects of the proposed action on the cultural resource base of the project area, measured by the apparent eligibility of the entailed properties for inclusion on the National Register.

Structure of the Proposed Ivanhoe Project

Development will be staged in three activity areas discussed separately here owing to differences in the cultural resource complement of each, the nature and intensity of impacts that each will receive, and the results that archaeological investigations in each have yielded so far. Each activity area is subsumed by one of the study areas discussed in the present volume.

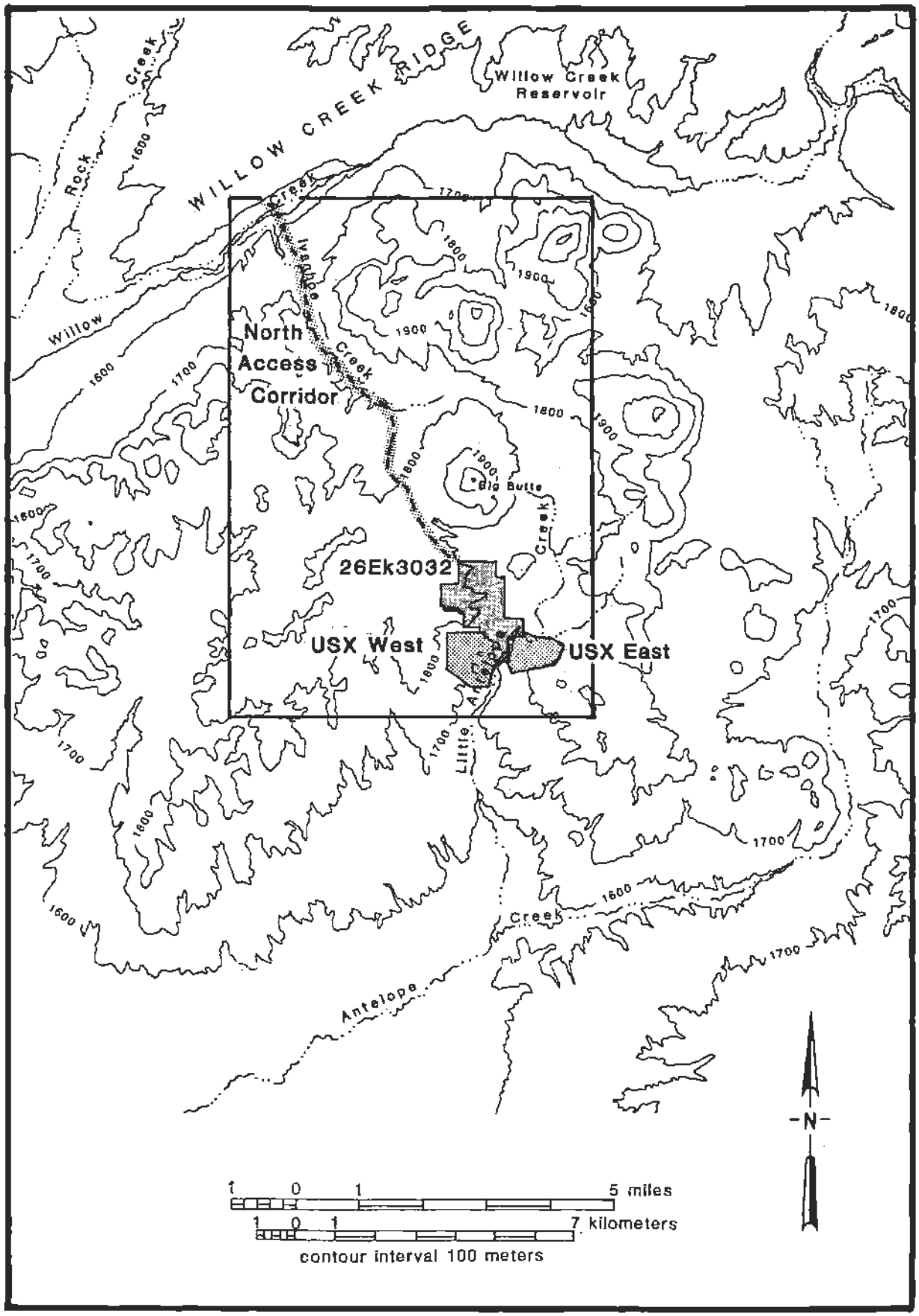
History of Investigations

Developments proposed in each of the three study areas resulted in independent intensive surveys to identify and evaluate cultural resources, assess potential adverse effects, and determine which of the subject properties required testing to clarify their National Register eligibility. Circumstances and findings of the surveys are summarized below.

North Access Corridor Study Area

Extending approximately 7.7 miles to State Route 789 from the northern boundary of the Tosawihi Quarries, proposed improvement (widening and grading) of an existing access road would involve the surface disturbance of about 120 acres. Additionally, four borrow pits (material sites) are proposed in support of road construction, entailing the disturbance of about 27 acres.

Figure A. Location of Ivanhoe Project Study Areas, Relative to Archaeological Site 26Ek3032 (Tosawihi Quarries).


WILLOW CREEK RIDGE
Willow Creek Reservoir
Rock Creek
Willow Creek
Ivanhoe Creek
North Access Corridor
Big Butte
Big Butte Creek
26Ek3032
USX West
USX East
Little Antelope Creek
Antelope Creek
1600
1700
1800
1900
N
1 0 1 5 miles
1 0 1 7 kilometers
contour interval 100 meters

Survey of the North Access Corridor (Drews 1988) resulted in the recording of 28 previously unrecorded sites (Figure B). Corridor realignment subsequent to survey avoided 18 of them (IMR 1988c), with the result that 10 sites remain within the zone of direct impacts (cf. Table A and Figure B); 2 of these were determined by survey to be ineligible for National Register consideration. The remaining eight sites were evaluated by the testing program described herein.

Table A
Sites Impacted by Proposed Developments,
North Access Corridor.

Design Element	Archaeological *Site*
Road Construction	26Ek3228
	26Ek3231
	26Ek3232
	26Ek3234
	26Ek3237
	26Ek3238
	26Ek3239
	26Ek3251

USX-West Study Area

The USX-West Study Area comprises approximately 480 acres immediately southwest of the Tosawihi Quarries (Figure C). Within this area, approximately 334 acres would sustain direct ground disturbance as a consequence of the proposed action. Project elements within this contiguous block proposed at the time of original survey (November, 1987) consisted of an open pit, a leach pad, a waste dump, a haul road, and a plant and office area. Owing to the degree of disturbance anticipated from the proposed facilities, it was assumed that any archaeological sites coincident with them would be destroyed utterly. Accordingly, testing was designed to evaluate cultural resources within the impact zone of the area.

Subsequent to field operations, design elements of the proposed action evolved; the plant and office facility were relocated outside the study area as were ore processing elements, while topsoil stockpiles and an additional waste rock dump were proposed. Anticipated impacts of the newly proposed facilities required that further testing be undertaken to evaluate sites not entailed in the original plan of operations.

In November, 1987, an intensive cultural resource survey was conducted over about 480 acres in response to proposed developments in the USX-West area (Budy 1988). The survey returned data on 124 previously unrecorded prehistoric

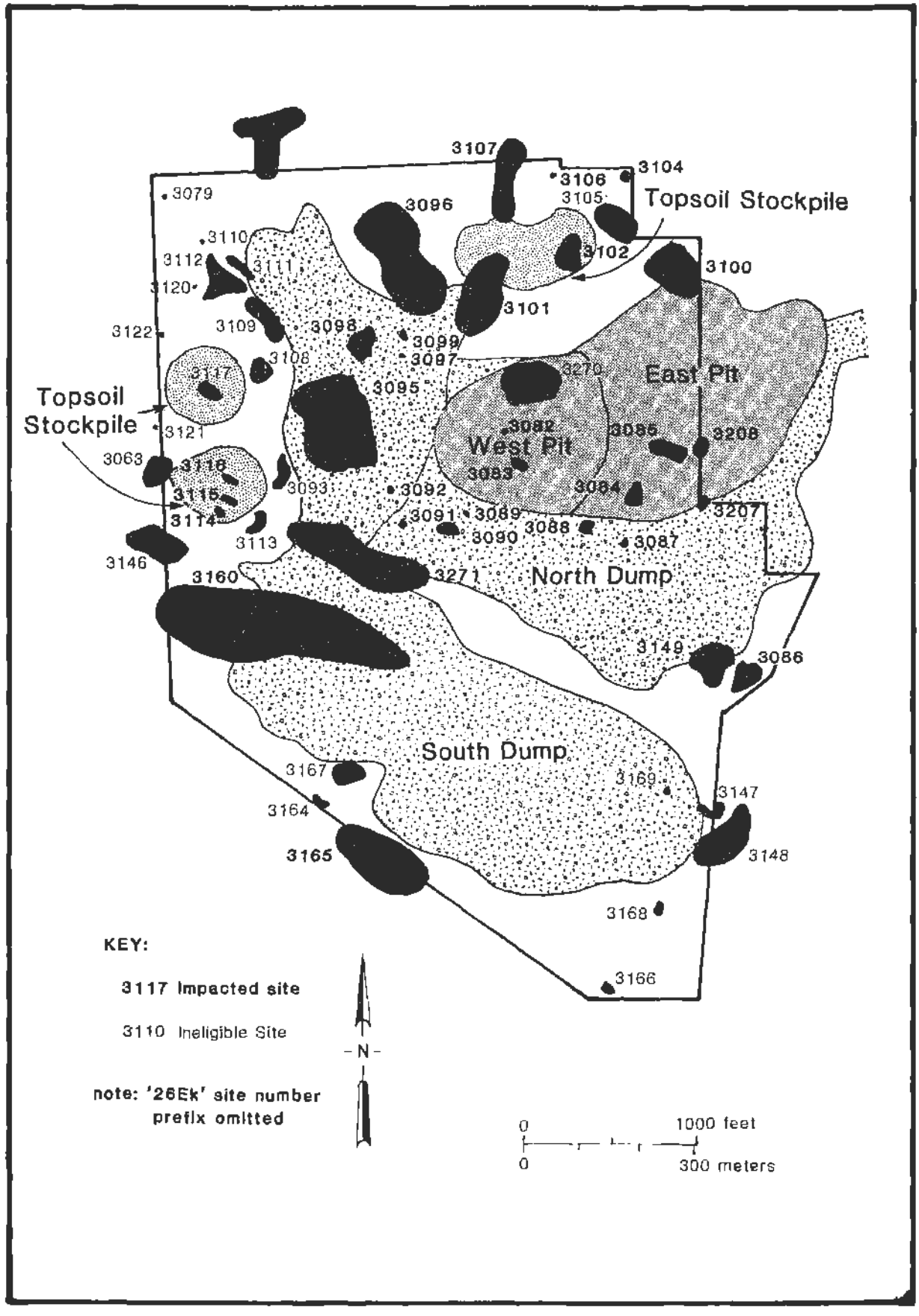
Figure B. Project Design Elements and Impacted Archaeological Sites, North Access Corridor Study Area.

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Figure C. Project Design Elements and Impacted Archaeological Sites, USX-West Study Area.


3107
3104
3106
3079
3105
Topsoil Stockpile
3096
3110
3102
3112
3111
3100
3120
3101
3122
3109
3098
3099
3097
3108
3279
East Pit
3117
3095
Topsoil
Stockpile
3121
3082
West Pit
3085
3208
3063
3116
3083
3115
3093
3092
3084
3174
3091
3089
3088
3207
3113
3090
3087
3146
3160
3271
North Dump
3149
3086
South Dump
3167
3169
3147
3164
3165
3148
3168
3166
KEY:
3117 Impacted site
3110 Ineligible Site
note: '26Ek' site number prefix omitted
N
0
1000 feet
0
300 meters

archaeological sites, of which 35 were determined to lie within zones that would be impacted directly by proposed project elements; 11 of these sites were determined by the survey to be ineligible for National Register consideration. Twenty-four sites subsequently became the target population for archaeological testing and evaluation, together with six additional sites (26Ek3086, 26Ek3104, 26Ek3106, 26Ek3107, 26Ek3149, and 26Ek3167) that, while not within the direct impact zones of proposed design elements, lie in such proximity to them that they seem equally at risk (cf. Table B and Figure B).

Table B
Sites Impacted by Proposed Developments, USX-West.

Design Element	Archaeological Site
East Pit	26Ek3084
	26Ek3085
	26Ek3100
	26Ek3208
West Pit	26Ek3082
	26Ek3083
North Dump	26Ek3086
	26Ek3087
	26Ek3088
	26Ek3090
	26Ek3091
	26Ek3092
	26Ek3093
	26Ek3095
	26Ek3096
	26Ek3097
	26Ek3099
	26Ek3149
	26Ek3207
	26Ek3271
South Dump	26Ek3160
	26Ek3165
Topsoil Stockpiles	26Ek3101
	26Ek3102
	26Ek3104
	26Ek3106
	26Ek3107
	26Ek3114
	26Ek3115
	26Ek3116

USX-East Study Area

Comprising about 160 acres southeast of the Tosawihi Quarries, the USX-East Study Area is proposed as the site of ore processing facilities related to the planned developments in USX-West. Principal elements of the proposal consist of an ore crusher, two leach pads, holding ponds, and a topsoil stockpile, as well as a system of leachate collection ditches and a network of access roads (Figure D). Virtually the entire surface of the study area would experience severe disturbance and, as in the USX-West study area, it is assumed that any archaeological sites lying within the disturbance boundary of the proposed facilities would suffer total destruction.

The USX-East area was surveyed in April, 1988 (Raven 1988). Approximately 160 acres were given intensive scrutiny, resulting in the recording of 37 previously unrecorded prehistoric archaeological sites. Of these, 27 would suffer direct impacts from execution of the proposed design elements. Six of the 27 were determined by survey to be ineligible for National Register consideration; therefore, 21 sites, together with six additional sites (26Ek3177, 26Ek3197, 26Ek3200, 26Ek3202, 26Ek3203, 26Ek3204) lying within 200 feet of proposed developments, constitute the evaluative and sample universe of USX-East (cf. Table C and Figure D).

Table C
Sites Impacted by Proposed Developments, USX-East.

Design Element	Archaeological Site
Crusher and Ponds	26Ek3170
Leach Pad	26Ek3171
	26Ek3172
	26Ek3173
	26Ek3179
	26Ek3181
	26Ek3182
	26Ek3183
	26Ek3184
	26Ek3185
	26Ek3188
	26Ek3189
	26Ek3190
	26Ek3191
	26Ek3192
	26Ek3193

Table C, continued.

Design Element	Archaeological Site
Future Leach Pad	26Ek3177
	26Ek3178
	26Ek3197
	26Ek3198
	26Ek3200
	26Ek3201
	26Ek3202
	26Ek3203
	26Ek3204
Topsoil Stockpiles	*26Ek3195*
	26Ek3196

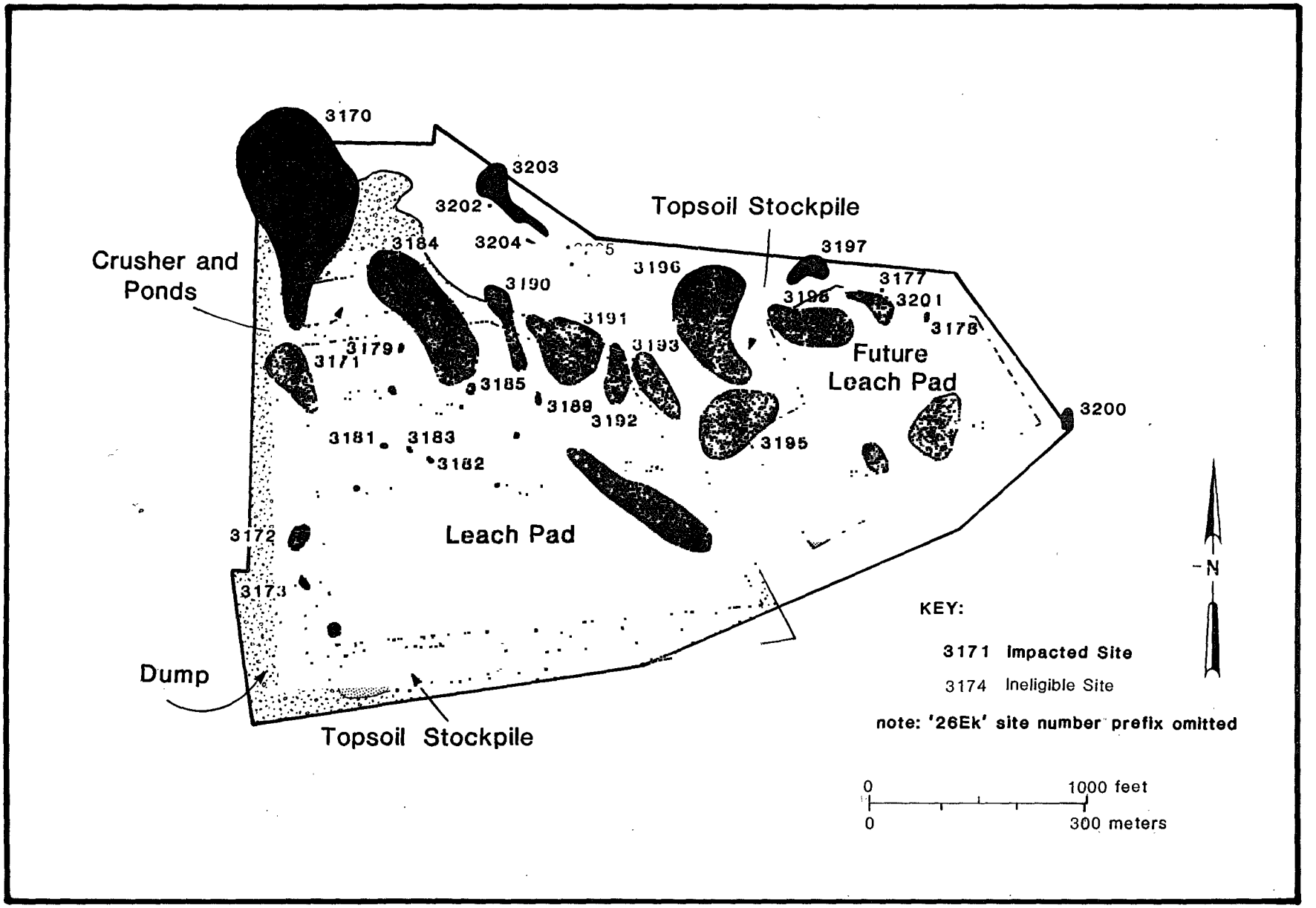
National Register Assessments of Tested Sites

Two evaluative exercises were undertaken in each of the study areas to identify with increasingly refined information those sites most likely to merit nomination to the National Register of Historic Places. In both cases, emphasis was placed on the data content and research potential of the subject sites, on the general premise that National Register eligibility most often is conferred upon prehistoric sites exhibiting significant research potential (NPS 1982).

The first exercise was conducted immediately after the initial surveys, and the results included as components of the various survey reports (Budy 1988:44-62; Drews 1988:12-16; Raven 1988:12-18). To ensure comparability, uniform criteria of integrity and research significance were established and scores were assigned to each site in light of its performance against the criteria.

Integrity was evaluated in terms of degree of existing surface disturbance sustained within site precincts, measured by the standards expressed in Table D. Only the lowest integrity rating (score = 1) dismissed sites from further consideration for National Register eligibility; sites with higher scores were considered potentially eligible pending evaluation of their research significance.

Figure D. Project Design Elements and Impacted Archaeological Sites, USX-East Study Area.


3170
3203
3202
Topsoil Stockpile
3204
3184
3197
3196
Crusher and Ponds
3190
3177
3198
3201
3191
3178
3179
3193
3171
Future Leach Pad
3185
3189
3192
3200
3181
3183
3195
3182
3172
Leach Pad
3173
Dump
Topsoil Stockpile
N
KEY:
3171 Impacted Site
3174 Ineligible Site
note: '26Ek' site number prefix omitted
0
1000 feet
0
300 meters

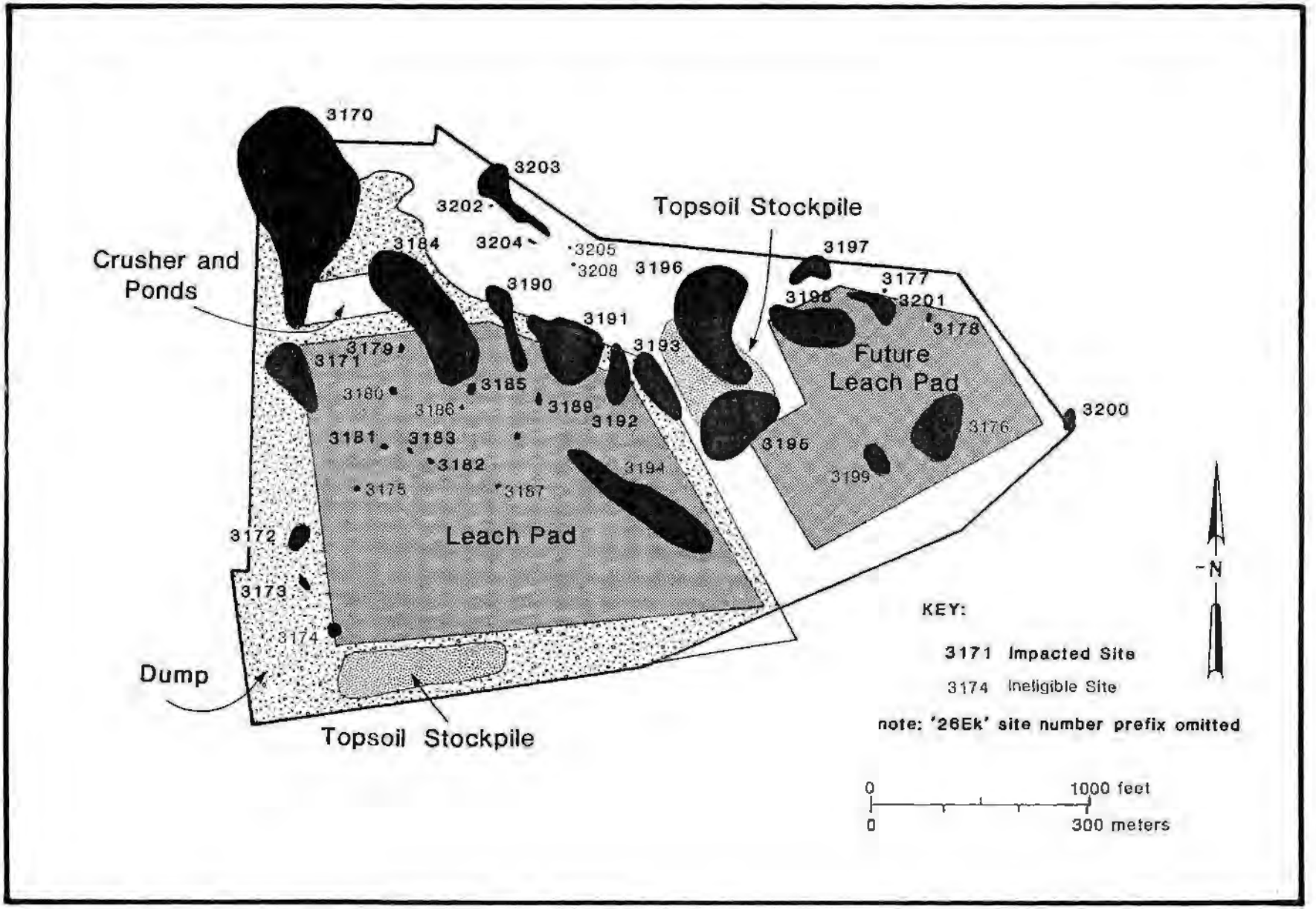

3170
3203
3202
Topsoil Stockpile
3204
3205
3208
3196
3197
3177
3201
3178
3198
Crusher and Ponds
3184
3190
3191
3193
3179
3171
3185
3180
3186
3189
3192
3200
Future Leach Pad
3176
3181
3183
3182
3194
3195
3199
3175
3187
Leach Pad
3172
3173
3174
Dump
Topsoil Stockpile
N
KEY:
3171 Impacted Site
3174 Ineligible Site
note: '26Ek' site number prefix omitted
0
1000 feet
0
300 meters

Table D. Integrity Rating Scheme.

Score	Scoring Standards
1	Severely disturbed over more than 50% of of site area. Disturbance may be a result of extensive erosion, numerous roads, drill pads, minerals exploration features, bulldozer cuts, or artifact collection.
2	Moderately to heavily disturbed over less than 50 of total site area. Disturbance may be a result of erosion, roads, or minerals exploration, but significant portions of the site remain intact.
3	Discrete, areal disturbance restricted to less than 25% of total site area. Disturbance may include a road or mining exploration feature as well as slopewash and rodent turbation.
4	Essentially undisturbed. Minor disturbance may be a result of slopewash, trampling or bioturbation.

Research significance was assessed in terms of several objective measures identified by Glassow (1977); a cumulative score was tallied for each site on the basis of the quantity of cultural materials discernible, the clarity and complexity of spatial organization, and the diversity of artifact classes identified. Specific score equivalents are given in Table E.

Table E. Research Significance Rating Scheme.

RESEARCH CRITERIA	SCORE
Quantity Measures	
1-10 items/sq. m.	1
>10-100 items/sq. m.	2
>100 items/sq. m.	3
Clarity Measures	
Isolated artifact	1
Undifferentiated spacially	2
Single activity locus	3
Multiple activity loci	4
Multiple activity loci/ Possible residential features	5

Variety Measures	
Quarry Categories	
On-site opalite source	1
Quarry feature	1
Reduction Categories	
Cores	1
Stage I bifaces	1
Stage II bifaces	1
Stage III bifaces	1
Specialized Activity Measures	
Groundstone	1
Hammerstones/cobble spalls	1
Basalt Biface Reduction Debitage	1
Obsidian	1
Specialized Tools	1
Total Score	

The results of these evaluations were translated in expressions of National Register eligibility. In the USX-West and North Access Corridor Study Areas, cumulative research significance scores of 10 or greater were taken to indicate that a site was apparently eligible for nomination to the National Register, and scores of 5-9 to indicate unclear eligibility status; scores of 4 or lower were taken to signal ineligibility. Because mean significance scores for sites in the USX-East Study Area were slightly higher, eligibility standards were adjusted upward; scores of 11 or higher indicated National Register eligibility, scores of 6 or lower, ineligibility, and scores of 7-10, uncertain eligibility.

Subsequently, the selection of sites for testing was guided by the combined criteria of project impact and National Register eligibility; in each study area those sites were tested that 1) would be impacted directly by proposed design elements, and 2) were ranked as clearly eligible, or of uncertain eligibility, for the National Register. Sites lying beyond the compass of project impacts and those judged ineligible for the National Register generally were omitted from the testing program.

Testing served not only as a basis for clarifying issues of National Register eligibility, but also for designing site-specific data recovery plans. Upon the completion of testing, all entailed sites were reevaluated in the light of test data, their significance this time being assessed more specifically by their relative potential to address explicit research issues relevant to the Ivanhoe Project area (IMR 1988a).

North Access Corridor Study Area

Of the 10 affected sites in the North Access Corridor Study Area, testing confirmed the National Register eligibility of two

(26Ek3237 and 26Ek3251); all sites of which eligibility was unclear prior to testing now are regarded ineligible. Table F summarizes pre-testing and post-testing assessments.

Table F
Assessment of Archaeological Significance,
North Road Study Area.

Site	Pre-testing National Register Status	Post-testing National Register Status
26Ek3228	Unclear	Ineligible
26Ek3231	Unclear	Ineligible
26Ek3232	Unclear	Ineligible
26Ek3234	Unclear	Ineligible
26Ek3237	Eligible	Eligible
26Ek3238	Unclear	Ineligible
26Ek3239	Unclear	Ineligible
26Ek3251	Eligible	Eligible

USX-West Study Area

In the USX-West Study Area, two sites originally considered to be of National Register quality (26Ek3093 and 26Ek3271) were demoted from that eminence, the first because it had nothing particular to say about identified research issues, the second because the magnitude of disturbance that it had sustained was found to be greater than first perceived. Further, four sites the National Register eligibility of which was regarded initially to be unclear (26Ek3084, 26Ek3085, 26Ek3092, and 26Ek3208) are now seen to contain data useful for addressing various identified research issues, and thus are considered eligible for National Register consideration. Table G compares pre-testing and post-testing assessments of National Register eligibility of potentially affected sites in the study area.

Table G
Assessment of Archaeological Significance,
USX-West Study Area.

Site	Pre-testing National Register Status	Post-testing National Register Status
26Ek3082	Unclear	Ineligible
26Ek3083	Unclear	Ineligible
26Ek3084	Unclear	Eligible
26Ek3085	Unclear	Eligible
26Ek3086	Unclear	Ineligible
26Ek3087	Unclear	Ineligible
26Ek3088	Unclear	Ineligible
26Ek3090	Unclear	Ineligible
26Ek3091	Unclear	Ineligible
26Ek3092	Unclear	Eligible
26Ek3093	Eligible	Ineligible
26Ek3095	Eligible	Eligible
26Ek3096	Unclear	Ineligible
26Ek3097	Unclear	Ineligible
26Ek3099	Unclear	Ineligible
26Ek3100	Unclear	Ineligible
26Ek3101	Unclear	Ineligible
26Ek3102	Unclear	Ineligible
26Ek3104	Unclear	Ineligible
26Ek3106	Unclear	Ineligible
26Ek3107	Unclear	Ineligible
26Ek3114	Unclear	Ineligible
26Ek3115	Unclear	Ineligible
26Ek3116	Unclear	Ineligible
26Ek3149	Unclear	Ineligible
26Ek3160	Eligible	Eligible
26Ek3165	Eligible	Eligible
26Ek3207	Unclear	Ineligible
26Ek3208	Unclear	Eligible
26Ek3271	Eligible	Ineligible

USX-East Study Area

In the USX-East Study Area, four sites initially regarded to be of National Register quality (26Ek3185, 26Ek3193, 26Ek3196, and 26Ek3201) demonstrated during testing substantially less research potential than believed originally, and now are considered ineligible for National Register consideration. Additionally, 26Ek3182, believed before testing to be of unclear eligibility, was reevaluated (but not tested) in the field and judged ineligible in terms of both research significance and integrity. No sites were found in testing to be eligible for National Register consideration that were not so regarded before testing was undertaken. Table H summarizes pre-testing and post-testing perceptions of National Register eligibility in the study area.

Table H
Assessment of Archaeological Significance,
USX-East Study Area.

Site	Pre-testing National Register Status	Post-testing National Register Status
26Ek3170	Eligible	Eligible
26Ek3171	Eligible	Eligible
26Ek3172	Unclear	Ineligible
26Ek3173	Unclear	Ineligible
26Ek3177	Unclear	Ineligible
26Ek3178	Unclear	Ineligible
26Ek3179	Unclear	Ineligible
26Ek3181	Unclear	Ineligible
26Ek3182	*Unclear*	*Reevaluated ineligible*
26Ek3183	Unclear	Ineligible
26Ek3184	Eligible	Eligible
26Ek3185	Eligible	Ineligible
26Ek3188	Unclear	Ineligible
26Ek3189	Unclear	Ineligible
26Ek3190	Unclear	Ineligible
26Ek3191	Unclear	Ineligible
26Ek3192	Eligible	Eligible
26Ek3193	Eligible	Ineligible
26Ek3195	Eligible	Eligible
26Ek3196	Eligible	Ineligible
26Ek3197	Eligible	Ineligible
26Ek3198	Eligible	Eligible
26Ek3200	Eligible	Eligible
26Ek3201	Eligible	Ineligible
26Ek3202	Unclear	Ineligible
26Ek3203	Unclear	Ineligible
26Ek3204	Eligible	Eligible

Additional to those discussed above, 5 sites (26Ek3174, 26Ek3175, 26Ek3180, 26Ek3186, and 26Ek3187), regarded from the first to be ineligible for National Register consideration, were investigated in the interest of defining the range of variation in the study area. The effort served to aid in assessment of the significance of other sites in the area. Results of the investigations are discussed in the present volume.

Summary

In summary, investigations of 65 sites discussed in this volume found 17 sites, all of them prehistoric, eligible for nomination to the National Register of Historic Places. Of those, all (7 in USX-West, 8 in USX-East, and 2 in the North Access Corridor) would be affected adversely by consummation of the proposed action. Accordingly, impact mitigation in the form of data recovery is recommended for each of them.

ABSTRACT

The Tosawihi Quarries constitute the largest, most intensively exploited, and probably longest-visited prehistoric chert toolstone sources currently known in the Great Basin. Preliminary investigations have involved the archaeological testing of 65 sites peripheral to the heart of the quarries, inquiring about the nature of quarrying, its implications for an archaeological record, and the particular manifestations of that record at Tosawihi. A suite of research questions guided the inquiry, the goal of which was to identify fruitful lines of investigation regarding chronology, paleoenvironmental circumstances, site structure and formation processes, variability in site function and assemblage composition, and the implications of all these for understanding the economic and strategic organization of lithic procurement.

Evidence for clearly reconstructable sequences of environmental change so far remains equivocal, although tephrachronology and faunal assemblages may provide important keys. The broad outlines of a cultural chronology, however, are better understood; time-sensitive artifacts (projectile points and ceramics) suggest that the quarries have been visited repeatedly over the past 8000 years, with an apparent intensification of use during Rosegate and Desert times. Radiocarbon assay of charcoal from quarry pits will allow refinement of the chronology, and will permit finer-grained inquiry into temporal differences in the intensity of quarrying.

Structural observations segregate quarrying features, reduction loci, and residential complexes as distinct classes of site also differentiated by assemblage composition, diversity, and inferred function; assemblage composition, especially, is conditioned strongly by distance from toolstone source. Guided by the results of testing, further inquiry into the spatial, temporal, technological, and functional differences in units of the archaeological record should clarify salient details of the organization of lithic procurement at Tosawihi, and should pose models of more universal applicability.

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PREFACE

The present report is the product of archaeological testing at 65 prehistoric sites in the vicinity of the Tosawihi Quarries, Elko County, Nevada. The work followed initial campaigns of archaeological survey, recording, and evaluation, during the course of which a suite of theoretical and regional research issues was developed to guide the conduct of multi-phased research at Tosawihi and its peripheries. These research issues formed the bases for phrasing testing strategies, assessing the research potential of each site, and, ultimately, designing plans for data recovery at a subset of the sites tested.

Intermediate between site recognition and data recovery, archaeological testing is largely an evaluative exercise. In the case of the work reported here, our intent was to weigh the value of each site in terms of its potential clarification of identified research issues, and to provide a framework within which the answers to lingering questions might be sought. Emphatically, our intent was not to resolve research issues and report conclusions, but rather to lay a descriptive foundation upon which, through data recovery, we might build to that goal.

There is, accordingly, much description and analysis of data here, but little synthesis. That is because we believe synthesis to be premature at this stage of reporting, more logically deferred until final results are in hand and we are able to address how well our questions have been answered. And although these pages were still being composed while data recovery was underway, the logic of the later exercise was dictated entirely by what testing had disclosed and what is reported here. Our final synthesis, then, awaits the consummation of data recovery, when we can return, better informed, to the research issues that have motivated our inquiry.

Part I. Introductory Information

Part I is intended to provide the reader with an overview of the natural and cultural settings of the three project areas considered herein, and with the goals and methods of the testing program.

Chapter 1. INTRODUCTION

by Elizabeth E. Budy, Robert G. Elston, and Christopher Raven

Minerals exploration is being conducted and extraction is planned in the Ivanhoe Mining District, Elko County, Nevada (Figure 1), in the vicinity of archaeological site 26Ek3032, the Tosawihi Quarries (Figure 2). In connection with proposed mining development, archaeological site inventories were made in two areas adjacent the Tosawihi Quarries (Budy 1988; Raven 1988) and along a proposed access road corridor extending from the northern boundary of the Quarries to Willow Creek (Drews 1988). These areas are referred to hereafter as USX-West, USX-East, and the North Access Corridor (Figure 3).

The North Access Corridor covers a linear road alignment extending from the northern boundary of the Tosawihi Quarries Site 26Ek3032, thence along Ivanhoe Creek, to Willow Creek which forms the northern terminus. A total of 28 archaeological sites, 3 of them historic and 25 prehistoric, have been recorded along the route (Drews 1988); 8 of these were the subject of the present testing program. The USX-West project area is adjacent the Tosawihi Quarries on the southwest. A total of 152 prehistoric sites were recorded here during initial survey (Budy 1988), 30 of which were tested and the results reported herein. The USX-East project area lies adjacent the Tosawihi Quarries on the east. Thirty-seven sites were recorded by survey of this area (Raven 1988) and 27 of them were tested.

The present report details the findings of the testing program, and evaluates the research significance of each site. The report is divided into five parts. Part I introduces the project, describes the natural and cultural setting, outlines a theoretical approach, and discusses research methods. Part II describes artifact classes used throughout the report. Parts III, IV, and V describe testing results from the North Access Corridor, USX-West, and USX-East, respectively. Part VI presents conclusions; statements of National Register eligibility and assessments of project effects on tested sites preface this report.

Natural Setting

The project areas occupy a rocky, gently undulating expanse lying at the junction of the Sheep Creek Range and the southwestern foothills of the Tuscarora Mountains. Moderately dissected by currently seasonal drainages, landforms in the area clearly have been considerably eroded since their formation, although there is little evidence of high-energy runoff or deposition. Measured against local vertical relief, the area constitutes a mid-to-upland zone transitional between nearby ecologically distinct milieus; encompassing elevations from 5500

Figure 1. Project vicinity map.

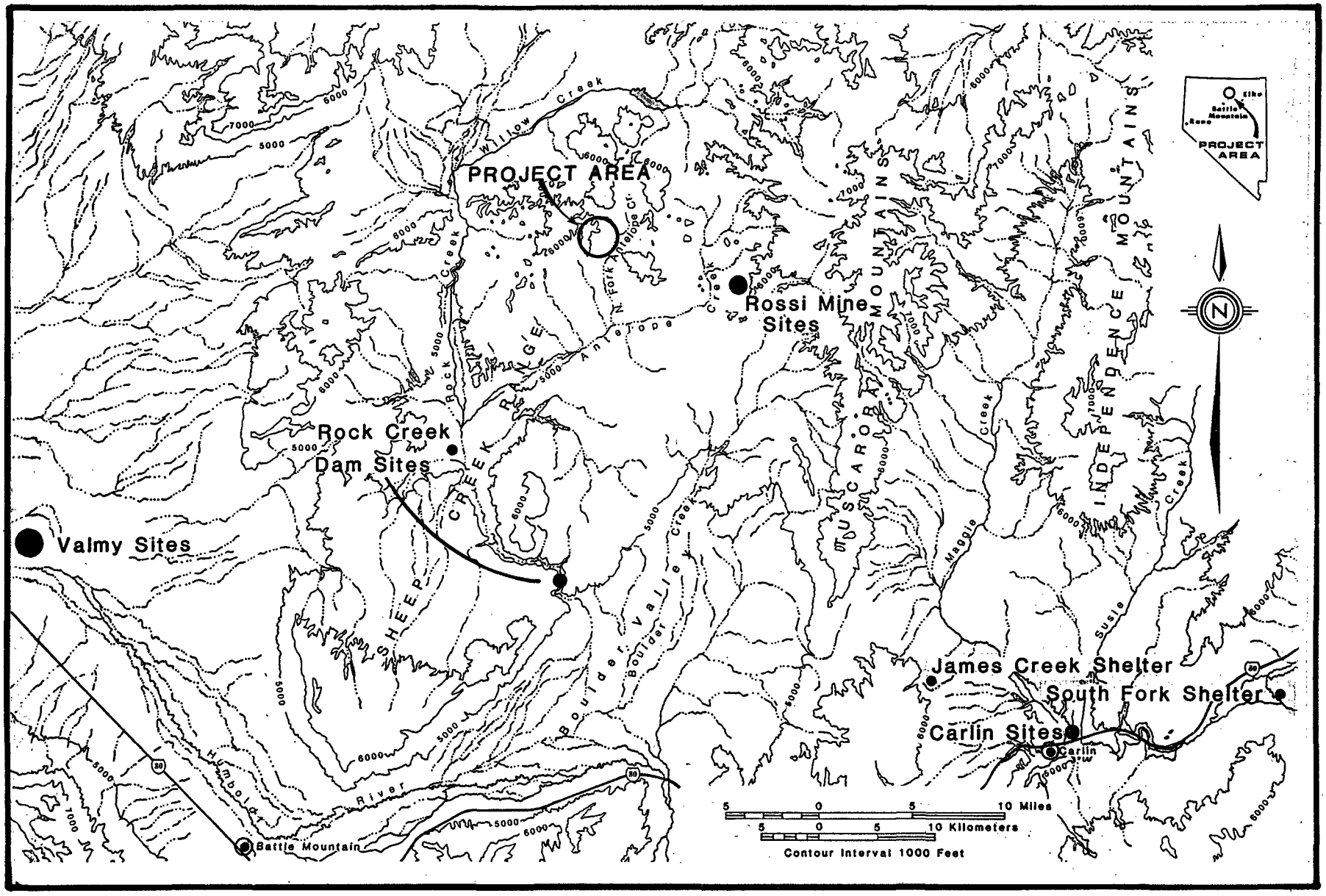

PROJECT AREA
Rossi Mine Sites
Rock Creek Dam Sites
Valmy Sites
James Creek Shelter
South Fork Shelter
Carlin Sites
Carlin
Battle Mountain
Willow Creek
Rock Creek
N. Fork Antelope Cr.
Antelope Creek
Boulder Creek
Boulder Valley
Sheep Creek Ridge
Humboldt River
Maggie Creek
Susie Creek
Tuscarora Mountains
Independence Mountains
Elko
Battle Mountain
Reno
PROJECT AREA
N
5 0 5 10 Miles
5 0 5 10 Kilometers
Contour Interval 1000 Feet

Figure 2. Location of 26Ek3032, the Tosawihi Quarries.

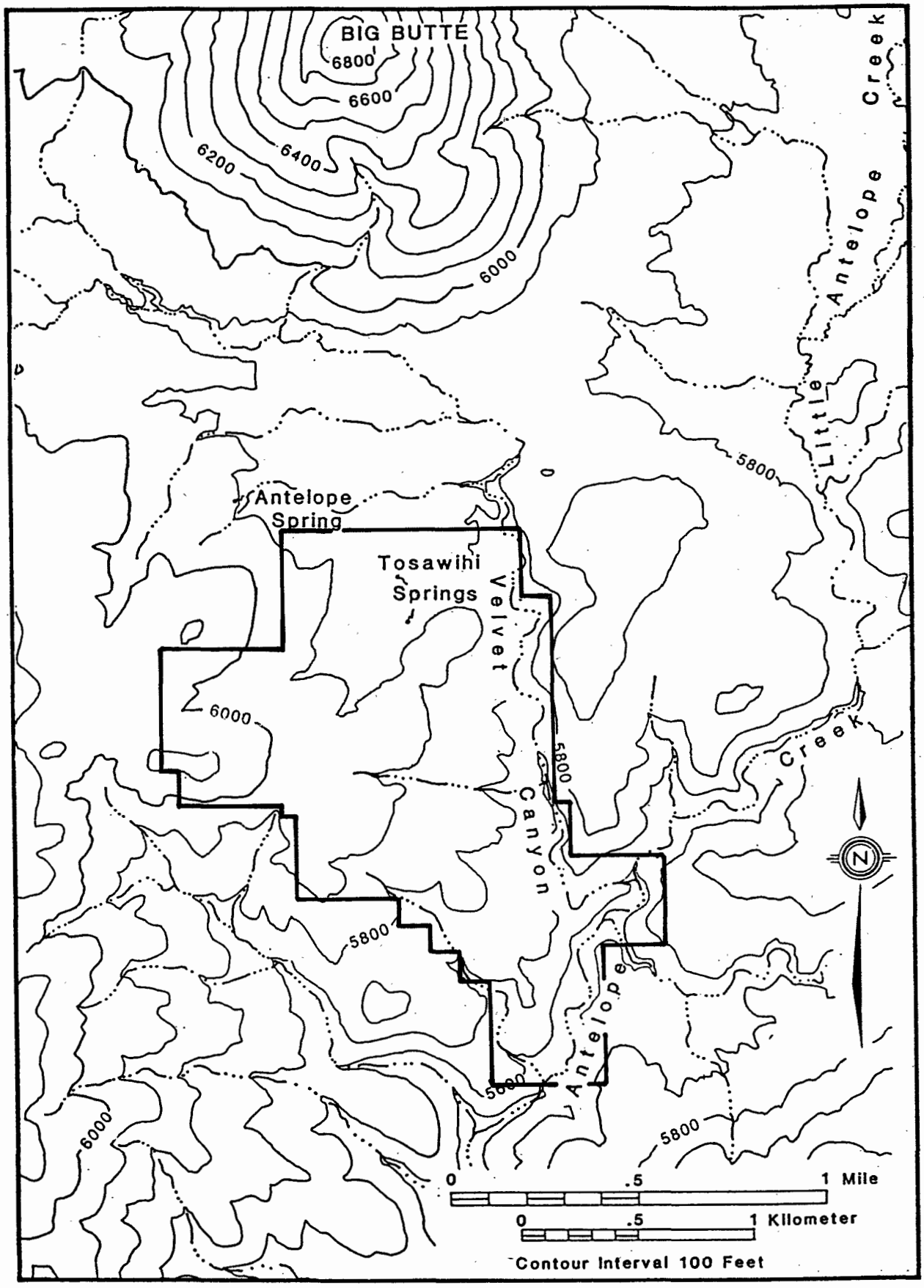
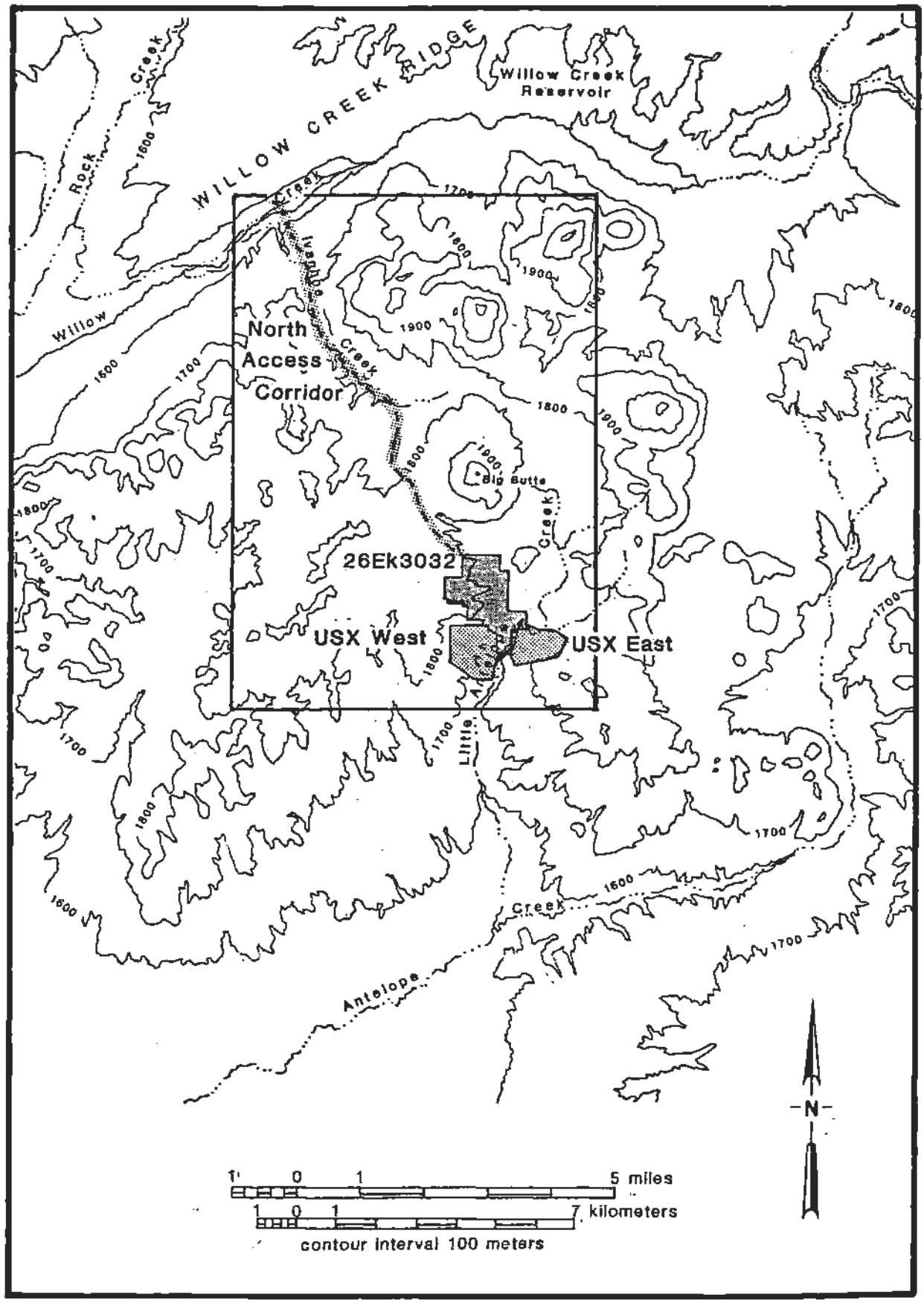

BIG BUTTE
6800
6600
6400
6200
6000
5800
Little Antelope Creek
Antelope Spring
Tosawihi Springs
Velvet Canyon
Antelope Creek
N
0 .5 1 Mile
0 .5 1 Kilometer
Contour Interval 100 Feet

Figure 3. Study areas relative to site 26Ek3032.


WILLOW CREEK RIDGE
Willow Creek Reservoir
Rock Creek
Willow Creek
Ivanhoe Creek
North Access Corridor
Big Butte
Little Antelope Creek
26Ek3032
USX West
USX East
Antelope Creek
1600
1700
1800
1900
N
1 0 1 5 miles
1 0 1 7 kilometers
contour interval 100 meters

to 6100 feet amsl, it stands some 700 feet above the extensive plains that flank it to the west and south, and some 1900 feet below the peaks of the Tuscarora Range 12-15 miles to the east. Intermediate between two more extensive ecozones, the study areas host a biotic mosaic composed largely of communities and species more dominant in neighboring settings.

Geology

The chief component of archaeological concern centers on the extensive opalite formations in the Tosawihi Quarries and which outcrop here and there in each of the three study areas. The opalite, the extraction and reduction of which focuses prehistoric use of the area, is described relative to historic mercury mining in the area (Bailey and Phoenix 1944) and in the context of earlier stages of Tosawihi archaeological investigations (Duffe' 1976a, b). The formation is the product of late Miocene or early Pliocene silicification of volcanic rocks and sediments (rhyolitic ash, tuffs, obsidian, and rhyolite) induced by a series of hydrothermal episodes. Permeation of the matrices by silica-rich solutions along fissures and bedding planes resulted in localized deposits of opalite that subsequent millenia of dehydration and crystallization have transformed into a chert-like group of cryptocrystallines (Bailey and Phoenix 1944:17-21). Minimal internal structure and relative homogeneity lent the material desirability as prehistoric toolstone; the entrapment of cinnabar in its upper members rendered it historically desirable as a source of mineable mercury ore.

The other principal surface geologic unit consists of andesitic basalt that outcrops in the red hills on the southwest. Large basalt cobbles were transported prehistorically from the area to the Tosawihi Quarries where they served as hammerstones and provided raw materials for projectiles and digging tools; tabular pieces provided seed grinding surfaces and abraders for percussion tools.

Hydrology

Surface water is a fugitive resource in the Tosawihi vicinity. Although contributing eventually to the flow of the Humboldt River and flanked at lower elevations on the north and west by major perennial streams, the area experiences rapid runoff and seasonally depleted aquifers. Willow Creek is a perennial stream located at the north end of the North Access Corridor; Ivanhoe Creek, fed by three springs, is an ephemeral tributary to it. On the southwest and southeast, the terrain is severely dissected and narrow ephemeral drainages descend to the canyon of Little Antelope Creek. During storm episodes, the seasonal streams of the canyons probably are fed as much by direct slope-wash as they are by the contribution of the numerous minor tributaries.

Vegetation

Vegetation is an expression of the Artemesian biotic province characteristic of the high desert valleys and lower foothills of the northern Great Basin (Billings 1951:110-113; Cronquist et al. 1972:122-125). Several local communities are found in the area; their distribution is related primarily to variation in soil depth and effective soil moisture. To facilitate reference throughout this report, genus and species are provided here while common names are used elsewhere in the document (Table 1).

Table 1. Key to Scientific Plant Names.

Common Name	Scientific Name
big sagebrush	Artemisia tridentata
bitterroot	Lewisia rediviva
bitterroot (pygmy)	L. pygmaea
buckwheat	Eriogonum spp.
cheatgrass	Bromus Tectorum
chokecherry	Prunus virginiana
death camas	Zygadensus venenosos
fiddleneck	Amsinckia sp.
gooseberry	Ribes sp.
Great Basin wild rye	Elymus cinereus
horsebrush	Tetradymia sp.
Idaho fescue	Festuca idahoensis
larkspur	Delphinium nuttallianum
linear-leafed paintbrush	Castilleya linariaefolia
locoweed	Astragalus spp.
low sage	Artemisia arbuscula
nutgrass	Carex sp.
onion	Allium sp.
phlox	Phlox spp.
rabbitbrush	Chrysothamnus viscidiflorus
rock basalm	Balsamorhiza hookeri
sage (other)	Artemisia ludoviciana
scarlet gilia	Gilia aggregata
sego lily	Calochortus nuttallii
serviceberry	Amelanchier alnifolia
silky lupine	Lupinus sericeus
squirrel tail grass	Sitanion hystrix
tumble mustard	Brassica nigra
wheat grass	Agropyron spp.
wild rose	Rosa sp.
willow	Salix sp.
white yarrow	Achillea millefolium
wiregrass	Juncus sp.

Occupying much of the silty bottomlands and other areas of deeper soils, and semi-shadowed northern exposures, is a community dominated by big sage and rabbitbrush in the shrub component, and by Great Basin wildrye and bluebunch wheatgrass in the grass component. On the other hand, thin-soiled settings such as knoll-tops, cobble fields, and washes where seasonal drainage has continuously inhibited soil development, tend to be occupied by a community composed chiefly of low sage, phlox, and the grasses squirreltail and Idaho fescue. Forbs common to the big sage communities include buckwheats, lupine, onion, balsam, paintbrush, larkspur, and scarlet gilia. Rocky ridgetops host bitterroot, sego lily, and onion; all provide edible tubers.

Microenvironmental anomalies support sporadic appearances of species related to other communities, but their prevalence is always dominated by the area's two principal assemblages. Thus the bottoms of gorges are prone to sparse stands of wild rose; the bases of rims often shadow clumps of gooseberry, chokecherry, or service berry; brief strings of willow, occasionally supporting wiregrass or nutgrass, cluster along the moistest of stream channels. Several other plants are common on disturbed sites, including tumble mustard, thistle, fiddleneck, and cheat grass.

Wildlife

Animals observed in the project areas include coyote, cottontail rabbit, and chipmunk. Big sagebrush thickets, and deeper soils, often contain badger burrows and ground squirrel colonies. Antelope were noted during an earlier survey (Elston et al. 1987:8), and mule deer are likely seasonal visitors. Archaeological sediments have yielded bones from big horn sheep, antelope, and bison. Common names, used throughout this report, are keyed to scientific terms in Table 2.

Except for ground squirrel, animals were not observed in abundance during the field exercise, although those species noted suggest broader patterns characteristic of other settings. Commensurate with other mid-to-upland zones, antelope probably are attracted to the area from the valley bottoms in spring when forbs are most plentiful and water sources most reliable. Mule deer also are likely to be seasonal visitors, their presence in the area limited by the availability of forage and water.

In high valley/foothill settings such as the Tosawihi vicinity, the upper Sonoran life zone (Merriam 1898) hosts as well kit foxes, marmots, jackrabbits, and wood rats. Numerous of the mammalian species listed by Hall (1946) as typical of the zone, particularly several species of rodents, are probably present but went unnoticed.

Species of birds likely to inhabit the area are discussed by Linsdale (1936), reptiles by Stebbins (1966), and fish by LaRivers (1962). None of these phyla was given significant scrutiny during the archaeological investigations.

Table 2. Key to Scientific Names of Animals

Common Name	Scientific Name
antelope	Antilocarpa americana
bighorn sheep	Ovis canadensis
badger	Taxidea taxus
bison	Bison bison
bushy-tailed wood rat	Neotoma cinerea
chipmunk	Eutamias spp.
cottontail rabbit	Sylvilagus nuttallii
coyote	Canis latrans
ground squirrel	Spermophilus cf. richardsonii
jackrabbit	Lepus spp.
kit fox	Vulpes macrotis
marmot	Marmota flaviventris
mule deer	Odocoileus hemionus
pocket gopher	Thomomys spp.
pygmy rabbit	Sylvilagus idahoensis
vole	Microtus sp.

Cultural Setting

A summary of ethnographic patterns, cultural chronology, and previous archaeological research in the region is provided by Elston et al. (1987). The discussions which follow highlight selected cultural background information and guide the reader to relevant literature sources.

Ethnography

The project area constitutes a portion of the foraging territory used by the ethnographic Tosawihi, or "White Knife," Shoshoni whose winter settlements were centered along the Humboldt River in the vicinity of present day Battle Mountain (Steward 1938). The group name refers to a locally available white toolstone (Steward 1938:162), most certainly the Tosawihi Quarries opalite. Ethnographic sources include Steward (1937, 1938, 1939, 1941), Harris (1940), and Powell and Ingalls (1874), but they record little ethnographic data concerning the mechanisms of opalite procurement, transport and trade, or relationships to Shoshoni settlement and subsistence. These questions are the focus of previous archaeological studies in the vicinity, as described below.

Previous Archaeological Research

The archaeology of the project area is tied closely to inquiry into the exploitation and manipulation of opalite toolstone from the Tosawihi Quarries. Though the significance of the Quarries has been known for some time (cf. Steward 1938), research has been limited and present understanding is preliminary.

Investigation of the Tosawihi Quarries was initiated by Mary Rusco in the 1970s. Initial research focused on chemical as well as macroscopic physical characterization of Tosawihi opalites and on the distribution of apparent Tosawihi material in sites outside the quarry source, in light of gravity models and ethnic boundaries (Rusco 1976a, 1976b, 1978, 1979, 1983). X-ray fluorescence methods for chemical characterization so far have proven equivocal (Duffe' 1976a, 1976b), but other approaches are being contemplated (Mary Rusco, personal communication 1987).

Identification of the nature and distribution of lithic materials derived from the Tosawihi Quarries has been addressed by subsequent research at archaeological sites 50 to 90 km east of the quarry source: at South Fork Shelter (Heizer et al. 1968; Spencer et al. 1987:72), at James Creek Shelter (Elston and Budy 1989), and at sites near Carlin (Rusco, Davis, and Jensen 1979) and along Susie Creek (Armentrout and Hanes 1986).

Investigations at five late prehistoric sites at a proposed Rock Creek Dam location, about 30 km southwest of the project area, indicate that reduction of Tosawihi opalite bifaces was a primary activity there; it has been inferred that the material was taken to the sites in the form of Stage II or Stage III bifaces (Clay and Hemphill 1986). Tosawihi opalite was also the dominant toolstone material present at seven sites investigated near the Rossi Mines, located about 10 km east of the Tosawihi Quarries (Rusco 1982); there, projectile points suggest a possible time depth of 8500 years.

The most intensive archaeological investigations to have been undertaken in the region were in connection with development of the Valmy power plant some 50 km southwest of the Tosawihi Quarries; studies included preliminary surveys (Bard 1980; Busby and Bard 1979; Rusco and Seelinger 1974) and intensive surface collections and test excavations at several sites near Treaty Hill (Davis et al. 1976; Rusco and Davis 1979; Elston et al. 1981). These investigations indicate human use of the area over the past 7000 years, with Tosawihi opalite composing the dominant toolstone at the sites studied.

An intensive reconnaissance of the 823 acre Tosawihi Quarries Study Area recently was conducted by Elston et al. (1987). The study recorded 219 prehistoric localities: isolated artifacts, discrete clusters of artifacts, rockshelters, open

residential localities, and quarry-related localities (isolated quarry pits, quarry pit complexes, outcrop quarries, adits, and surface cobble quarries). Survey of the USX-West project area is reported by Budy (1988), of USX-East by Raven (1988), and along the North Access Corridor by Drews (1988).

Cultural Chronology

Syntheses of the regional cultural chronology are available in James (1981), Rusco (1982), Smith et al. (1983), and Elston (1986a); Figure 4 compares regional cultural sequences. A sequence proposed for the upper Humboldt, based on recent excavations at James Creek Shelter (Elston and Budy 1990), 50 km southeast of the project area, is outlined below.

Dry Gulch Phase: ? - 6000 B.C.

Diagnostic artifacts for the earliest known phase for the upper Humboldt include large, concave-base projectile points, Great Basin Stemmed points, flaked stone crescents, heavy core tools, scrapers, and choppers. Originally defined as a lacustrine adaptation, or the Western Pluvial Lakes Tradition (Bedwell 1973), presently it is recognized in riparian and upland settings as well. Regarded as Pre-Archaic in the broader sequence of Great Basin adaptations (Elston 1982), the phase is characterized by a distinctive lithic technology, lack of seed grinding implements, and a high degree of residential mobility. Artifacts diagnostic of the phase have been noted at Valmy (Elston et al. 1981), Susie Creek (Armentrout and Hanes 1986), Rye Patch Reservoir (Rusco and Davis 1987), and at the Tosawihi Quarries (Elston et al. 1987).

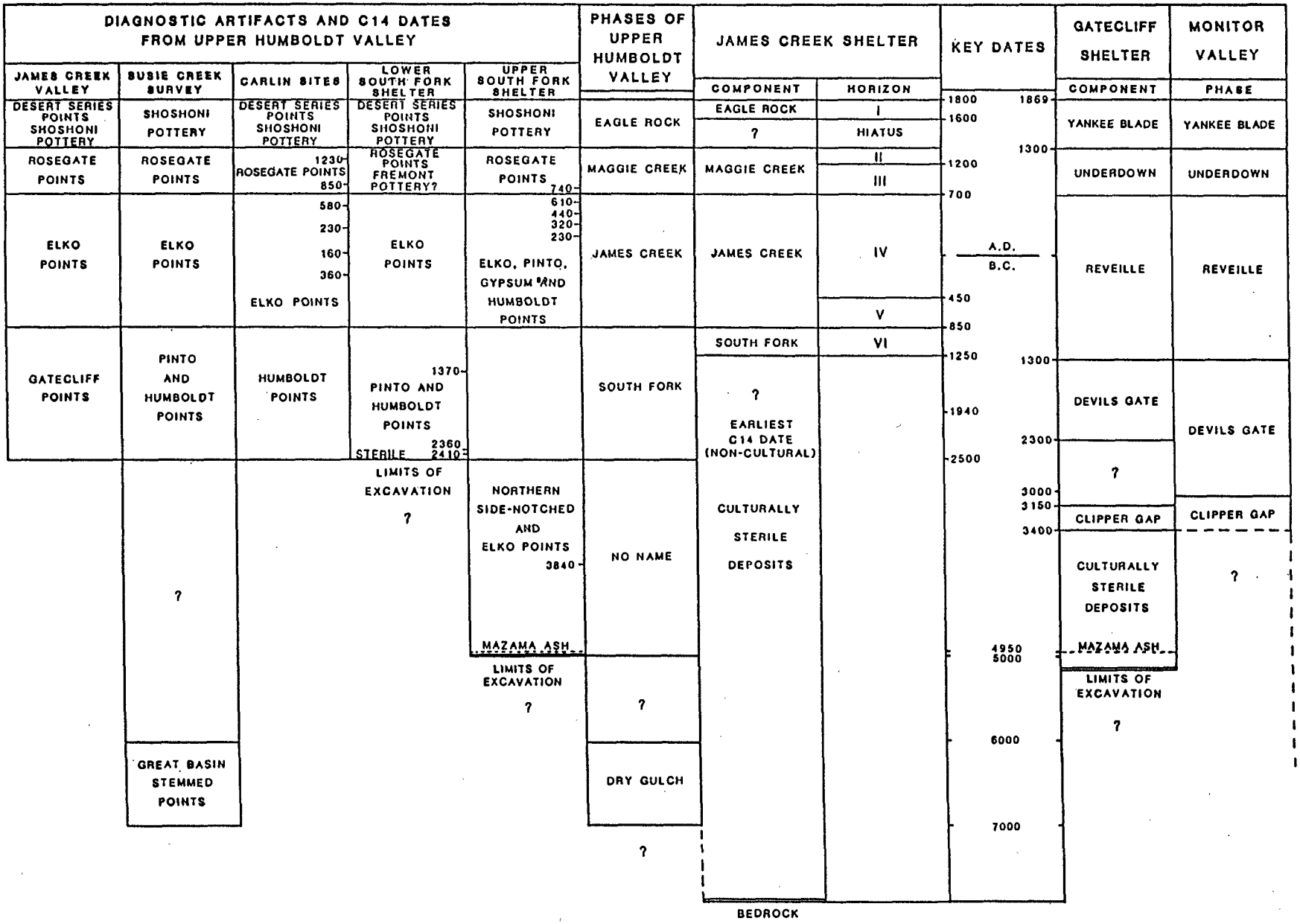
No Name Phase: 5000-2500 B.C.

The emergence of the Early Archaic adaptation in the upper Humboldt River drainage is marked by Northern Side-notched and Humboldt Series projectile points (Heizer and Hester 1973; Thomas 1981, 1983). Elsewhere in the Great Basin, Early Archaic adaptations reflect the inception of intensified seed use, increased locational diversity in land-use patterns, probable increase in breadth of diet, and logistical structuring of subsistence pursuits. In the upper Humboldt, few sites of this time period have been observed (Elston and Budy 1990).

South Fork Phase: 2500-850 B.C.

The Middle Archaic adaptation on the upper Humboldt is not well characterized by existing data; however, Humboldt and Gatecliff Series projectile points are considered diagnostic (Elston and Budy 1990).

Figure 4. Prehistoric chronology for the upper Humboldt Valley, Nevada (after Elston et al. 1987:Figure 2.2).


DIAGNOSTIC ARTIFACTS AND C14 DATES FROM UPPER HUMBOLDT VALLEY
JAMES CREEK VALLEY
SUSIE CREEK SURVEY
CARLIN SITES
LOWER SOUTH FORK SHELTER
UPPER SOUTH FORK SHELTER
PHASES OF UPPER HUMBOLDT VALLEY
JAMES CREEK SHELTER
COMPONENT
HORIZON
KEY DATES
GATECLIFF SHELTER
COMPONENT
MONITOR VALLEY
PHASE
DESERT SERIES POINTS SHOSHONI POTTERY
SHOSHONI POTTERY
DESERT SERIES POINTS SHOSHONI POTTERY
DESERT SERIES POINTS SHOSHONI POTTERY
SHOSHONI POTTERY
EAGLE ROCK
EAGLE ROCK
I
1800
1869
YANKEE BLADE
YANKEE BLADE
?
HIATUS
1600
ROSEGATE POINTS
ROSEGATE POINTS
1230
ROSEGATE POINTS
850
ROSEGATE POINTS FREMONT POTTERY?
ROSEGATE POINTS
740
MAGGIE CREEK
MAGGIE CREEK
II
III
1300
1200
UNDERDOWN
UNDERDOWN
700
580
230
160
360
ELKO POINTS
ELKO POINTS
ELKO POINTS
610
440
320
230
ELKO, PINTO, GYPSUM AND HUMBOLDT POINTS
JAMES CREEK
JAMES CREEK
IV
A.D.
B.C.
REVEILLE
REVEILLE
450
V
850
SOUTH FORK
VI
1250
1300
1370
PINTO AND HUMBOLDT POINTS
GATECLIFF POINTS
PINTO AND HUMBOLDT POINTS
HUMBOLDT POINTS
SOUTH FORK
?
EARLIEST C14 DATE (NON-CULTURAL)
1940
DEVILS GATE
DEVILS GATE
2300
2500
2360
2410
STERILE
LIMITS OF EXCAVATION
?
3000
3150
?
CLIPPER GAP
CLIPPER GAP
3400
NORTHERN SIDE-NOTCHED AND ELKO POINTS
3840
NO NAME
CULTURALLY STERILE DEPOSITS
CULTURALLY STERILE DEPOSITS
?
MAZAMA ASH
MAZAMA ASH
4950
5000
LIMITS OF EXCAVATION
?
LIMITS OF EXCAVATION
?
?
?
6000
GREAT BASIN STEMMED POINTS
DRY GULCH
7000
?
BEDROCK

James Creek Phase: 850 B.C.-A.D. 700

This phase marks the full expression of the Archaic adaptation. Elko Series projectile points are the principal phase-markers, and their distribution indicates the exploitation of an extremely wide range of settings and resources, a marked broadening of the prey-base, and a more eclectic use of the environment.

Maggie Creek Phase: A.D. 700-1300

At James Creek Shelter, this phase is characterized by further intensification of plant exploitation, increased pursuit of small game, and introduction of the bow and arrow. Rosegate Series projectile points (and Fremont Grayware ceramics in the eastern Great Basin) are diagnostic.

Eagle Rock Phase: A.D. 1300 to protohistoric times

The phase apparently represents the archaeological record of the Numic peoples who occupied the area at historic contact. Along the upper Humboldt, the phase is marked by Desert Series projectile points (Desert Side-notched and Cottonwood), and by Shoshone Brownware ceramics (Elston and Budy 1990).

History

The project area is located in the historic Ivanhoe Mining District (Bailey and Phoenix 1944:17-21). Mercury ore was discovered in 1911, but development, north of the project area at the Clementine, Butte, and Velvet workings, dates from about 1929 (Zeier 1987:6). Mining continued intermittently through the 1940s, with most production generated by the Butte Quicksilver Mine. Mercury mining increased with the advent of World War II and lasted, at least intermittently, until 1947. Mining saw a brief resurgence between 1957 and 1962, and again in 1966, most likely in response to increased international mercury prices (Zeier 1987:6). In 1979, exploratory drilling for other mineral resources was initiated in the area. Gold associated with the local opalite formation and deposits at Red Hill motivates the present proposed mining developments.

Chapter 2. RESEARCH APPROACH

by Elizabeth E. Budy, Robert G. Elston, and Christopher Raven

This chapter opens with a discussion of relevant research issues. We first review the literature of prehistoric North American quarries to provide an overall context for the Tosawihi Quarries study, and then outline a theoretical perspective for the archaeological study of Tosawihi Quarries wherein toolstone supply and demand are linked to mobility in settlement and subsistence strategies. Subsequent sections focus more narrowly on particular research topics and appropriate investigative strategies. As well, we identify criteria that measure the potential of a site to inform with regard to the a particular research issue. In the second part of the chapter, field and laboratory methods are described.

Theoretical Concerns

Archaeological research issues relevant to the Tosawihi Quarries and vicinity have been identified by Elston 1988. The ability of any particular site to address any particular issue depends on site function, position in the landscape, access to water, depositional environment, and proximity to sources of toolstone. These factors vary considerably among Tosawihi Quarries and areas peripheral to it. Similarly, there is considerable variation among these factors from one peripheral area to another. Thus, the archaeological records of USX-East, USX-West, and the Access Road Corridor were expected to reflect research domains and topics unequally.

Lithic Quarry Studies

Interest in prehistoric lithic quarries has a long history in North American archaeology (cf. Holmes 1919; Honea 1983 and references; Ahler 1986a:1). In the last decade or so, increased interest in lithic quarries and workshops has resulted from the attention now accorded to adaptive cultural processes, including the procurement and use of toolstone in subsistence systems and in trade (cf. Butler and May 1984; Davis 1978; Ericson and Earle 1982; Ericson and Purdy 1984; Plew et al. 1985; Vehik 1985a; Wright 1977).

Great Basin quarries have long been noted (cf. Botti 1976; Davis 1964; Elston and Turner 1968; Grosscup 1956; Harrington 1951; Meighan 1955; Pippin 1980), but, until recently, little studied. Although analysis of lithic tools and manufacturing waste are increasingly foci of Great Basin archaeological studies (for central Nevada, see Drews and Clerico 1985; Elston et al. 1981; Novick 1987; Rusco and Davis 1987; Stearns and

Matranga 1984; Thomas 1983; Zeier 1985), only a handful of quarries and quarry workshops have been studied in all the western Great Basin (Elston and Zeier 1984; Elston et al. 1987; Elston and Budy 1990; Pedrick 1985; Raymond 1984; Rusco various; Rusco et al. 1982; Singer and Ericson 1977; Toney 1972; Tuohy 1970).

Several obsidian quarries in the Great Basin (Ragier and Lancaster 1966; Lohse 1980; Singer and Ericson 1977; Elston and Zeier 1984), and at least one chert quarry in an adjacent region (cf. Berry 1975), are as large or larger in extent than the Tosawihi Quarries. However, Tosawihi is the single largest known silicified toolstone quarry in the Great Basin proper, and the intensity of prehistoric activity there is unprecedented elsewhere in the region. Time-diagnostic projectile points suggest the quarries have been visited for the last 8,000 to 10,000 years (Elston et al 1987:108). Chert artifacts that appear to have been made from Tosawihi material were found at Gatecliff Shelter, ca. 175 km south of the quarry (Novick 1987), and Tosawihi-like, white chert artifacts are common throughout the western Great Basin, although they tend to decrease in numbers with distance to the west (Stephenson and Wilkenson 1969; Rusco 1978).

White chert toolstone is the most common lithic material type in large sites along the upper Humboldt River (Elston et al. 1981). The Tosawihi Quarries were obviously an important resource for the ethnographic Shoshone of the Humboldt Valley. The group living in the vicinity of Battle Mountain called themselves Tosawihi or White Knife, while other Humboldt River Shoshone groups were identified by food names; i.e., the Tsogwi (a root) yuyugi (shakes like jelly) of the Elko area (Steward 1938:154).

Lithics and Prehistoric Hunter-Gatherer Adaptations

The general significance of prehistoric lithic quarry and workshop studies for understanding hunter-gatherer adaptation can be appreciated by considering that, in prehistoric societies without metal, technology is based on organic materials (shell, bone, sinew, hide, membrane, plant fiber, wood, resin) and on stone. Although many organic materials can be gathered with the hands and used "as is", the procurement and processing of others requires hard and sharp piercing, cutting, and scraping edges. Such implements can be made from shell, hardwood, or bone, but, for sharpness and durability, only metal surpasses stone. Thus, for hunters and gatherers with a stone-based technology, toolstone is an extremely important, possibly limiting, resource.

In order to fully understand the role of lithic technology in prehistoric adaptive strategies, one must examine the

technology and economics of toolstone procurement at quarry and workshop sites, in addition to the use and discard of finished stone tools at other sites. The distribution of lithic raw material across the landscape (toolstone availability) and the degree of mobility in settlement and subsistence patterns all affect toolstone supply and demand (Elston and Budy 1987 and references). Hence, analysis of toolstone extraction, processing, manufacturing, utilization, transport, and discard reveal not only the economic value of toolstone resources in ancient societies, but organization of production, patterns of mobility and settlement, subsistence strategies, trade, social structure, and group relationships (Butler and May 1984:xix; Goodyear and Charles 1984:1; Raymond 1984:1; Vehik 1985a:2).

In the Great Basin, piercing, cutting, and scraping tools invariably were made by flaking or knapping. Knapping requires a brittle, isotropic medium (Cotterell and Kamminga 1987) such as obsidian (volcanic glass), cryptocrystalline or micro-crystalline silicate rocks including flint, chert, jasper, chalcedony, and opalite, as well as fine-grained basalt and andesite.

Toolstone availability is controlled by geology and geomorphology; in any given region, toolstone abundance and distribution varies widely across the landscape (Gould 1985). Isotropic rocks are relatively uncommon in most regions, but tend to be more abundant in uplands and mountain ranges, and scarce in alluvial valleys. Of course, toolstone quality and abundance may differ considerably among different areas and among different sources in the same area.

Mobility and Toolstone Economics

Binford's (1980) continuum of mobility is a useful means of conceptualizing variability in hunter-gather subsistence and settlement strategies. At one end are highly mobile foragers who tend to operate in a large annual range, frequently moving from camp to camp. At each camp, a particular set of resources is exploited in a relatively small area within the foraging radius (the distance one can walk, do business, and return in a day) until return rates for target resources fall off (a matter of days to a few weeks), at which point the camp is moved to a new area where the resource set may be different. The total area exploited in a given year is the annual foraging range. In the forager strategy, resources are consumed as they are taken, not stored: people move to resources.

The greater the mobility and annual range of a group, the more toolstone sources are likely to be available to them and choices can be made among the highest quality sources. Quantities of toolstone on the surface may be sufficient to meet demands without more intensive procurement techniques. Since

considerable time may elapse between visits to the best sources, foraging groups might be expected to "gear up" (Binford 1979) with new tools when a high quality source is encountered. In addition, the lithic tools of mobile foraging groups are likely to be highly symmetrical in form (ease of maintenance) and large in size (mobile storage of toolstone); Paleoindian tools are a case in point (Goodyear 1979). Biface technology, particularly well adapted for use by highly mobile hunter-gathers (Kelly 1988), has been the focus of lithic production in the Great Basin throughout prehistory.

At the other end of the continuum are less mobile collectors, who establish a long term base camp with a view toward a variety of resources or resource sets. In temperate climates, these sites tend to be occupied in the late fall and winter; e.g., the Humboldt River Shoshone winter settlements described by Steward (1938). As in the forager strategy, resources in the vicinity of the base camp (foraging radius) are taken, but a much larger area (defining the logistical radius) is also exploited by means of logistical task groups. These are formed to procure a specific resource or restricted range of resources (i.e., pine nuts or mountain sheep). Such groups may travel a long distance from base camp, establish one or more temporary field camps, obtain the target resource(s), then return to base camp. Logistical field camps are likely to be occupied for a relatively short period of time, perhaps a few days (but see Downs 1966:30). Because transport is limited sharply by human load carrying capacity (Madsen n.d.), resources usually are processed at or near their source to reduce bulk and weight. The collector strategy is designed to deal with seasonal shortages, so storage is an integral part of the collector strategy. Resources can be cached at the field camp, at the main base camp, or at points between the two.

Several factors may increase toolstone demand among collectors. Scheduling conflicts and time limitations with regard to key food resources may increase sharply toolstone demands for limited periods, or prevent collection of sufficient supplies through casual surface collection. Logistically based collectors, or hunter-gatherers practicing a seasonally mixed mode strategy, may operate within a smaller annual range than pure foragers. When this results in limited access to toolstone sources, the importance of any high quality sources within the annual range may increase, along with the intensity of their use. Intensity of exploitation at a source can also be expected to increase with duration of occupation in its vicinity, as people exhaust supplies of toolstone brought to the place and turn to local sources for replenishment. In terms of the functional site types discussed above, the highest intensity of exploitation (including quarry pitting) is expected at lithic sources within the foraging radius of long term, winter base camps and, in decreasing order, short term foraging base camps, and logistical field camps.

Thus, the different toolstone supply and demand problems faced by foragers and collectors are likely to be solved in different ways. The extremes of surface collection and quarry pit excavation do not exhaust the strategies for toolstone exploitation, but do suggest several important archaeological questions with regard to Tosawihi Quarries. The quarries are in a hinterland far from any known ethnographic or prehistoric winter base camps, yet hundreds of quarry pits and vast quantities of processing debris suggest very intense exploitation. Why is this so? Was use of other toolstone sources constrained by shifting settlement patterns, changing trade networks, or increased population? How much time and effort does intense exploitation through quarry pitting consume? Could this level of activity possibly be accomplished through an "embedded" strategy of exploitation, or would logistical organization and special task groups be required? If logistical organization was required, how could task groups be supported while at the quarries? Would visiting the quarries be more advantageous during a particular time of the year? Could the archaeological record at Tosawihi Quarries be the cumulative result of relatively infrequent episodes of toolstone procurement over the last 10,000 years, or is it due to one or more sharp, temporally bounded peaks in toolstone production? How far did people travel to obtain Tosawihi chert, and how far did it travel through transportation and trade?

As it happens, the present phase of investigation involves numerous archaeological sites adjacent the quarries, but relatively few of them are quarry sites. Most are lithic workshops and/or residential sites apparently occupied by people who were procuring and processing toolstone from the quarries. Investigation of such sites presents an opportunity to address many of the questions posed above.

The Nature of the Resource

The nature of the toolstone at Tosawihi Quarries is the aspect of the resource least controlled by prehistoric miners and knappers. Geological forces created Tosawihi opalite and have determined where it is exposed and accessible for extraction by means available to prehistoric people. We assume that toolstone quality was a major factor guiding prehistoric choices among toolstone sources. Moreover, we believe it likely that the standard of acceptable quality may have varied according to toolstone supply and demand. Thus, understanding the geology of Tosawihi opalite, its range of quality throughout the Quarries, and its chemical identification, are essential to understanding the economics and strategy of prehistoric extraction-production.

Geologic Context of Tosawihi Toolstone

Tosawihi "chert" is amorphous cryptocrystalline rock formed by silicification of Tertiary rhyolite tuff through subsurface hydrothermal action, as well as deposits of chalcedontic sinter formed at the surface by active hot springs (Bailey and Phoenix 1944:19-20). Erosion has removed overlying strata and cut into the beds of opalite and sinter. The silicified bedrock now lies near the surface, thinly mantled with colluvium and exposed in stream cuts.

Potential toolstone sources include bedrock outcrops, thinly mantled bedrock, opalite talus deposits, and colluvium containing opalite clasts, each of which may vary through a particular range of quality and require different methods of extraction and processing (Elston, Raven and Budy 1987:77-19). The geologic context of Tosawihi "chert" thus determined its accessibility to prehistoric people and no doubt strongly influenced the choice of strategies for its extraction.

Possible variables affecting the choice of toolstone sources are toolstone quality, depth of colluvium, and the proportion of high quality toolstone to waste rock. Size and abundance of chert clasts in colluvium may be important also (Elston, Raven and Budy 1987:77).

Criteria for Research Potential

Virtually any site with unambiguous evidence of toolstone extraction can inform regarding the nature of the source exploited. Particularly important are quarry pits or adits that provide "windows" into the local geology.

Investigative Strategies

Backhoe and hand-dug trenches sampled quarry pits, and depth of colluvium was measured directly. Stratigraphic documentation of trench profiles and column sampling were employed to investigate variation with depth in size and abundance of colluvial chert clasts and proportion of waste rock.

Variability in Toolstone Quality

All three study areas contained too few quarry features to provide a representative sample of variability in toolstone quality. However, toolstone quality was monitored in notes and samples of tools and cores.

Chemical Identification of Tosawihi Toolstone

The question of chemical identification of Tosawihi chert in sites outside the quarries is a pressing issue, inhibiting all attempts at a broader view of Tosawihi; a realistic evaluation of the importance of the place depends upon an ability to determine how far and in what volumes Tosawihi chert actually travelled.

In addition, the chemical identification of different chert sources within the quarry would make it possible to monitor the distance toolstone was transported from source to workshop/field camp to see if particular sources and/or particular camp sites were favored, and to inform regarding such questions as how many sources were exploited during a given visit to the quarry. By identifying different sources smong a sample of debitage from winter base camps along the Humboldt River, one might come to know if different groups traditionally exploited different parts of the quarry.

The large scale spatial distribution of Tosawihi chert can tell much about trade, toolstone economics, settlement, and subsistence throughout a large portion of the western Great Basin. For instance, critical to the issue of embeddedness in lithic procurement, is the structure of commodity distribution and resource access across the western Great Basin. If Tosawihi cherts are as widely distributed in the archaeological record as they have seemed to be, the probability that they were acquired by trade increases with distance, and this conditions any cost/benefit model that might be applied to primary procurement.

By the same token, the presence and identification of toolstone exotic to the quarries informs as to the distance and direction of travel and/or trade. Obsidian is the best toolstone for this kind of study because many sources have been identified throughout western North America (Hughes 1983, 1984).

Investigative Strategies

Renfrew's (1977) decay, or inverse gravity model, is a descriptive statement of toolstone fall-off rates (both in terms of volume and reduction state) with increasing distance from a source. This model already has been applied tentatively to lithics from Rossi Mine sites (Rusco et al. 1982), Valmy sites (Elston et al. 1981), and James Creek Shelter (Elston and Budy 1990). However, Duncan Metcalf (personal communication) has suggested ways in which marginal utility (Earle 1980), or marginal value (Charnov 1976) can be combined with the transport cost model recently developed by Madsen (1988) to actually predict raw material fall-off rates, tool size, and degree of reduction. Although a full scale study of these relationships

will require the investigation of many points (sites) radiating from the quarries, a start in this direction can be made with data from the Access Road Corridor.

Samples taken from selected toolstone sources within the project area, together with samples from the Tosawihi Quarries, form part of a pilot study of source identification through trace elements identified by neutron activation analysis. The findings of this study are to be presented in a subsequent data recovery report.

Chemical source identification of obsidian is now routine and inexpensive (Hughes 1983, 1984). Obsidian artifacts from sites in the three study areas were collected. Source identification and analysis of a sample will be undertaken in planned data recovery efforts.

Criteria for Research Potential

Any site associated with a discrete toolstone source or any site that contains demonstrably exotic toolstone has potential for investigating the chemical identity of toolstone.

Economics of Toolstone Procurement

Resource procurement has been viewed increasingly in archaeology as a problem of economics (Ericson and Purdy 1984); the expenditure of effort in acquiring resources reflects values measurable in terms of their relative benefits and costs. Tosawihi opalites apparently played a role, not only in the technological systems of the peoples exploiting the quarries directly, but also in long-distance trade networks. Thus, the value of the resource was enhanced not only by its immediate abundance and utility, but was well by its function as a commodity.

Since at least the recent past, the quarries appear to have been exploited by groups not living nearby. Exploitation required time and effort for travel and search, extraction, processing and manufacturing; all of which are problems affecting the economics of subsistence strategies, settlement structure, time allocation, and, perhaps, social networks. Several research issues relating to these economics factors merit particular scrutiny.

Toolstone Cost/Benefit Currency

Comparison of the costs and benefits of toolstone procurement and use requires a currency. People do not derive energy directly from toolstone; rather, organic resources that

do produce energy are captured and processed more efficiently through the use of stone tools (Elston and Budy 1990). Since stone tools generate benefits only during the time they are used, the greatest benefit will accrue from tools with the longest service life. Service life is partly a function of mass, but mass alone is not a sufficient currency, because toolstones differ in hardness, isotropy, durability, and workability. Other factors that influence service life are tool design, the technology of maintenance, and the material of the workpiece. Under average technological constraints, user skills and work conditions prevailing in a particular cultural system, toolstone currency is average weight of toolstone consumed per service time (weight/ST). Thus, a 1000 gram tool made of toolstone with a service life of 810 minutes has a utility of *0.81 minutes per gram*.

Toolstone Return Rates

The procurement costs of toolstone, as any other resource, can be thought of in terms of search time and handling time. Searching entails time spent traveling to the toolstone source or patch, finding toolstone items in the patch, as well as visual inspection and assaying likely toolstone items. Handling time includes both extraction and processing. Extraction varies from simply plucking an item from the surface, through recovery of toolstone clasts by excavation of soil, to excavation of toolstone in beds and outcrops. Processing includes those tasks necessary to render the toolstone into usable form (decortication, core preparation, flake blake production, initial biface reduction, heat treatment). The point at which processing ends and tool manufacturing/maintenance begins is contingent on constraints of time and task. When comparing costs and benefits of two different toolstones, return rates should be calculated (using toolstone utility) as the total service life of the toolstone procured, minus handling time and search time. If looking at the costs and benefits of different strategies for exploiting a single toolstone, utility can be ignored, using weight procured per handling and search time.

Toolstone Procurement Strategies

There are two basic strategies for toolstone procurement: surface collection and quarrying. The collection of surface material has the advantage of low initial search time; everything present is visible. Moreover, this strategy is embedded easily in hunting, gathering, and traveling. However, the disadvantages of surface materials are several. Surface material is often dispersed so that there is a significant time gap between encounters. In addition, surface items occur within a narrow size range constrained by local geology. Surface toolstone is usually weathered (checked, dehydrated); most

pieces have to be assayed, and many pieces will be rejected because of stresses and flaws that would increase processing tome and decrease use-life. The average return rate for a particular surface toolstone patch is the weight of potential toolstone items encountered, minus the weight of items rejected, per unit of time. For most surface patches, the dispersion of items, high ratio of unsuitable material, and constrained size range will keep average return rates relatively low.

Procurement of toolstone through quarrying also has disadvantages. Finding buried toolstone requires a visual search of the ground surface, assaying likely pieces, and a certain amount of prospecting or test pitting (Binford and O'Connell 1984). This must be followed by quarry pitting, the creation of an excavation of sufficient size and depth to reach toolstone clasts in a soil matrix and/or toolstone bedrock. If bedrock is to be quarried, it must be broken up into manageable pieces with hammers and wedges, and possibly with fire. After all the toolstone has been recovered from the bottom of the original excavation, a new excavation must be created to obtain additional material. All this requires the application of considerable time and energy that must influence the size and composition of the group employed in the enterprise.

However, buried toolstone has several advantages. Less subject to weathering and thermal stress, need for assay is minimized. Localities can be selected to ensure uniformity of quality, maximizing processing and ratios of toolstone to waste rock. With exploitation of bedrock, the size of cores and flake blanks is limited only by technology and human physical characteristics. Moreover, the moisture content of buried toolstone increases its workability, also decreasing waste. All these factors can increase return rates for buried toolstone far beyond what can ordinarily be achieved by exploitation of surface material.

As discussed previously, time spent at Tosawihi figures in a number of research domains. Available time in the toolstone source area might be limited by a variety of factors, including weather, availability of food and water, or conflicts with critical food resources in other areas. It is assumed that time required for quarry pitting was considerable and it must have been planned carefully to take such constraints into consideration.

Quantity of Toolstone Processed and Removed From Tosawihi

In conjunction with studies of chronology, settlement, and subsistence, estimates of the quantity of toolstone processed and removed from Tosawihi, if possible, can allow assessment of the importance of that toolstone resource and the total human investment of time and energy devoted to obtaining it (Ahler

1986a:18). This question cannot be addressed fully at this time, given the small number of quarry features in the present study areas. However, data collected during the present study will contribute useful information toward that end.

Investigative Strategies

The amounts of toolstone extracted in single episodes at individual quarry features will be estimated through documentation of stratigraphic detail. Volume of material in quarry pits, berms, and colluvium will be estimated directly from column samples taken from excavations in quarry pits, pit vicinities, and cobble fields. This will in turn allow the estimation of time and energy invested in extraction and processing at individual localities (cf. Ahler 1986a:18), useful in calculating rough estimates of extraction for the entire quarry.

Criteria for Research Potential

Any quarry feature with well preserved, stratified deposits, contains data that ultimately can bear on the problem.

Level of Effort Expended at Tosawihi Quarries

The total manpower invested in extraction, processing, and manufacturing at Tosawihi bears on a variety of archaeological problems including the organization of these activities, the structure of groups visiting the quarries, the place of the quarries in regional subsistence strategies, and trade. For instance, assuming that the source was exploited for as long as the few known time markers suggest, could the archaeological record have accumulated as the product of 10,000 (or so) short seasonal visits by small groups engaged principally in other activities? What were annual rates of production? Did these vary through time?

Investigative Strategies

Although volumetric studies of quarry pit waste can contribute to calculating the time and energy required to extract raw material from various kinds of pits or outcrop sources, other data not present in the archaeological record can be obtained from ethnoarchaeological models and actualistic experiments. Ahler (1986a) based his level of effort estimates for the Knife River Flint quarry site 32DU508 on the excavation rate of the 1982 archaeological crew using modern picks and shovels. However, actualistic experiments, using materials and tools available prehistorically (digging sticks, wedges,

hammerstones, bone and stone scoops, and baskets), will provide more reliable data regarding the amount of useable material removed as toolstone, the amount dispersed in the vicinity as waste (both debitage and rejects), and the amount of person-time sufficient to accomplish these tasks. Knapping experiments can provide time estimates for processing and manufacturing. These data can be checked against the ethnoarchaeological record documenting quarry behavior among Australian Aborigines (Binford and O'Connell 1984; O'Connell n.d.; Gould 1977:163-164; Gould 1980:124-127).

Criteria for Research Potential

Any quarry feature with stratified, datable deposits contains data that ultimately can bear on the problem.

Place of the Quarries in the Regional Economy

The ethnographic Shoshone groups of the Humboldt River, like most Great Basin Indians, employed a mixed mode settlement/subsistence strategy; a sedentary, logistical collecting mode from winter base camps on the Humboldt River and a highly mobile foraging mode throughout the annual range for the remainder of the year. Territory in the Humboldt River valley was divided loosely into "districts" (Steward 1938:153-154) containing from one to several "semipermanent" base camps (often clustered into villages) considered home by certain families who returned there when they could do so. The only winter base camp sites recorded by Steward (1938) in the country between the Humboldt River and the Snake River in Idaho were those on the Upper Humboldt River, on Maggie Creek, and on the south fork of the Owyhee River, all major corridors for north-south travel. It is possible that people occasionally wintered on Rock Creek or Willow Creek in favorable years, although there is no ethnographic evidence for this.

However, it appears that uplands such as the Tosawihi Quarries vicinity were hinterlands visited mostly by foraging and logistical groups. During all but a few weeks in spring, the upland steppe seems too cold, too dry, and too unproductive to have supported very many people for any length of time. Thus, long-term residential occupation of Tosawihi Quarries is considered unlikely.

How then, were the quarries exploited? We have proposed that the settlement/subsistence strategy of a given population determines encounter rates for toolstone sources and duration of occupation in their vicinity. Most of the time, hunter-gatherers position themselves with regard to sources of food, water, and shelter, rather than to toolstone. Binford (1979, 1985; Binford and Stone 1985) maintains that toolstone

procurement by hunter-gatherers is always "embedded" in food-getting activities, occupies slack time, or is pursued when primary target food resources fail to materialize. However, when demand is high because of critical task requirements, or religious and trade incentives (Gould 1980, 1985; Gould and Saggers 1985; Hughes and Bettinger 1984), hunter-gatherers may employ a more direct strategy, making forays targeted specially at toolstone, where procurement of other resources is of secondary importance.

Gould's Australian data (1977, 1980) suggest that procurement strategies and use of toolstones may vary with the type of lithic source. Low to medium quality toolstone is distributed widely across the Australian landscape. This material is obtained through an embedded strategy on an encounter basis, used for expedient tasks "more or less on the spot", and discarded after completion of the task. The archaeological "signature" of this strategy comprises isolated tools and small scatters of flakes.

Higher quality toolstone (such as that available at Tosawihi Quarries) was procured directly at quarries, often by logistical groups, "small parties of men who made a special effort to visit the quarry site, sometimes detouring from some other route for that purpose or else making an expedition from their habitation camp primarily to procure isotropic stone" (Gould 1980:124). Gould maintains that such toolstone procurement was the most time-consuming and laborious part of stone tool manufacture, requiring trips over distances of 10 to 30 kilometers with overnight or longer stays at the quarry. Even travelling by automobile, toolstone procurement by one group of Alyawara Aborigines took most of a day (Binford and O'Connell 1984); prior to historic times, overnight stays at quarries very distant from residential camps must have been the rule.

Data in Steward (1938:162) suggest the usual logistical radius for Humboldt River groups was 50 or 60 km, and longer trips (up to 100 km one way) made to the vicinity of Austin for pine nuts, and to the headwaters of the Owyhee River and other tributaries of the Snake River for salmon, suggest the extent of the maximum annual range. The Tosawihi quarries are well within the logistical and summer foraging ranges of Humboldt River people and probably within the extended range of many Owyhee-Snake River groups as well. Since people lacked the concept of land ownership and food surpluses commonly were shared by several different groups, it seems likely that everyone had equal access to Tosawihi toolstone.

An embedded strategy of toolstone procurement (obtaining toolstone while pursuing other resources) is most likely to be employed by people traveling light and moving frequently through a landscape in which toolstone is relatively abundant. Tools can be replenished as required, and since there is no need to

procure large amounts of toolstone, there is little payoff for using intensive extraction methods (Elston and Budy 1990). The embedded strategy would fit well with the ethnographic pattern of summer foraging in small, extended family groups. It might also be employed by task groups on long range forays passing through Tosawihi Quarries to target resources elsewhere.

Yet, the hundreds of quarry pits and great quantities of waste rock and debitage at Tosawihi bespeak an intensity of exploitation that seems too great for highly mobile people pursuing an embedded strategy of toolstone procurement. The lithic procurement activities of the Alyawara, probably carried out on logistical trips, created lithic debris and shallow pit features very similar to those observed at Tosawihi Quarries, although on a smaller scale (Binford and O'Connell 1984; James O'Connell, personal communication).

At Tosawihi Quarries, then, it must have taken people at least a couple of days to excavate pits, manufacture large bifaces, transport those to near-by field camps, heat-treat the bifaces, and then reduce them further prior to their transport out of the area. Similar reasoning, and time-effort estimates, for the creation of certain quarry features at the Knife River Flint Quarry led Ahler to believe (1986a:106) that special task groups were involved in their creation. The intensive exploitation of Tosawihi Quarries through a logistical strategy is most likely for collectors, who may be able to target more routinely a particular lithic source than could foragers; in fact, they are more likely to do so if their access to other toolstone sources is restricted or their annual range is constrained. In any case, collectors can organize the time and effort required for intensive exploitation as a logistical task.

Perhaps the possibility of extended visits to Tosawihi Quarries was resource limited. If the availability of food and water limited the size of the group that could be supported for the amount of time they could spend there, certain seasons may have been favored for visits to Tosawihi Quarries. It may be that extended visits were possible only once in a run of years. While water is abundant in winter, and pronghorn antelope (present at Tosawihi Quarries today) congregate in the largest groups then (Hall 1946:629), winter at Tosawihi Quarries is harsh; the ground freezes, snow drifts deep, and it is very cold. In spring, though, plants (bitterroot) and small mammals (particularly burrowing rodents) are most abundant, there is plenty of water, and the weather is more hospitable. These conditions prevail into early summer.

The foregoing observations notwithstanding, logistical and embedded procurement do not always employ mutually exclusive technological approaches: members of foraging groups could have excavated quarry pits; logistical groups may have taken meat or roots as well as toolstone. We suspect that people probably

made every effort to lower the cost of toolstone procurement at Tosawihi, embedding as much travel time as possible in the pursuit of other resources, either at Tosawihi Quarries or in the vicinity. The presence of a particularly good bitterroot crop, a herd of antelope, or a periodic population explosion of rabbits or ground squirrels might have made it possible to spend more time at Tosawihi Quarries than usual. But whether people went to Tosawihi to get toolstone, obtained toolstone while they were there doing something else, or employed some combination of procurement strategies, probably has to do most with the overall structure of the settlement and subsistence system, and the seasonal position of people vis a vis the Quarries.

Investigative Strategies

As outlined above, the estimation of level of effort per quarry episode will provide data concerning minimum occupational duration. If the average episode of quarrying and processing consumed only a few hours, people well may have pursued these activities as they passed through on their way elsewhere. If, on the other hand, quarrying and processing were more time consuming, people, of necessity, may have stayed at the Quarries longer.

Identifying the diet people consumed at Tosawihi will provide information concerning seasonality and the possibility of provisioning from the resources in the vicinity of the Quarries. Direct evidence of local subsistence may be obtained from excavation at sites where faunal and floral remains are preserved, especially rockshelters with dry deposits.

Whether or not field camps of logistically organized task groups can be distinguished from the short term camp sites of foraging groups is a particularly thorny problem (Thomas 1983a, 1988; Elston and Budy 1990). If structures are present, do they suggest short term occupation (brush windbreaks, pit shelters) or longer term occupation (wickiups, flattened surfaces); were fires built in simple surface hearths or in lined pits; was toolstone heat treated; are "domestic" artifacts in evidence?

Indirect evidence of group size, composition, and duration of occupation may be revealed by analysis of site structure and artifact variability, as outlined below, especially at small camp sites recorded on the periphery of the Quarries (Budy 1988; Raven 1988).

In order to know whether assemblages representing non-quarrying activities at Tosawihi are unique or similar to assemblages from non-quarry sites elsewhere, comparative data must be gathered from sites in the surrounding region. Samples from sites on Willow Creek and Ivanhoe Creek should be particularly interesting in this regard.

Criteria for Research Potential

Sites bearing evidence of diet, seasonality, shelter, hearths, heat treating, exotic toolstone and/or stratified quarry deposits have potential for addressing questions of regional economy.

Site Function, Structure, and Distribution

Questions of site function are concerned with why particular sites were occupied, and what activities occurred there. Site structure involves the use and organization of site space, and its study must consider the ways archaeological sites were formed and how they since have been transformed. Site distribution, on the other hand, reflects the overall organization of lithic extraction and processing, and the tasks of daily life, and their distribution in the Tosawihi landscape.

Site Function

Archaeological localities in the Tosawihi Quarries site (26Ek3032) have been classified tentatively on the basis of surface evidence (Elston, Raven and Budy 1987), and a similar classification system was applied to sites recorded on the Quarries periphery (Budy 1988; Raven 1988). The functional distinctions implied by these classes remains to be demonstrated. For instance, what were the functions of "Reduction Stations", the small, discrete lithic scatters found usually on ridges or in small rockshelters? Do they represent hunting stations, or procurement of lithic material by groups just passing through on their way elsewhere, or places where specialized reduction tasks were carried out? Another example is the set of sites judged to be "Residential" by the presence of ground stone and "finished" tools. Some of these are represented by open lithic scatters and others by rockshelters. Do these two situations imply a basic functional difference? Are shelters somehow more or less residential than open sites? We have observed considerable structural complexity in several of the open sites. Are more complex sites functionally different from less complex sites?

Investigative Strategies

Site function can be addressed by assessment of variability in the content of individual localities and by comparing the relative variability among assemblages (Thomas 1983; Elston and Juell 1987; Elston and Budy 1990). Functional tool classes and relative frequencies of distinct artifact types (numbers of bifaces vs. flake tools; projectile points, drills and scrapers vs. groundstone) will signal the range of activities as well as

their intensity. The presence or absence of residential features (hearths, storage pits, and house pits or other structures) indicate duration of occupation and the functional range of a site.

Criteria for Research Potential

Virtually any site with formed artifacts can contribute to the study of site function, but sites with discrete features and faunal or floral remains are particularly significant in this regard.

Site Structure

Structure of a site often suggests the size, social structure, and duration of occupation of groups occupying it (Binford 1978; 1983a; O'Connell 1986; Zeier and Elston 1986; Novick 1987; Thomas 1983b, 1988; Elston and Budy 1990). Obviously, quarry localities, workshops, rockshelters, and open habitation sites all may exhibit different structures because each presented a different set of spatial constraints and each may have been occupied by different sized groups for different sets of activities over different periods of time.

Whether or not the organization of field camps is highly structured probably has a great deal to do with length of occupation. If archaeologically visible, sites occupied for a very short duration usually will have a correspondingly simple structure, consisting of a discrete scatter of debris. Conversely, the structure of sites occupied over longer periods, and those consistently reoccupied, often are blurred accumulated debris: subsequent occupants may find it advantageous to clear certain space and keep it clean, to empty hearths, and otherwise organize and reorganize work areas and places of debris disposal. Moreover, non-cultural processes such as slope wash and bioturbation bury and move cultural remains.

The ethnoarchaeological literature, particularly that of Australia, provides some insight into what we might expect of the site structure of lithic quarries and workshops (Binford and O'Connell 1984, 1986; Gould 1977, 1980:124-125; Hayden 1979:51; O'Connell 1974, n.d.; Tindale 1965:140). Toolstone materials assay is expected to generate a distribution of assayed cobbles and debitage, often correlated only with the geology of toolstone. In areas where surface toolstone is abundant, but of poor quality, assaying could generate relatively dense scatters of assayed cobbles and debitage but have no quarry pits. Such places should have a distinctive debitage profile and artifact assemblage: assayed cobbles and primary debitage will dominate; exotic hammerstones, later stage cores, and bifaces will be rare; quarry pits will be absent for the most part, or small and

shallow when present; the scatter of surface artifacts will lack structure, appearing essentially random. Toolstone extraction and processing generates distinctive kinds of features and debris, including quarry pits and berms, adits, cobble concentrations, and dense flake scatters. Some O'Connell (personal communication) photographs document the creation of such features by Alyawara in Australia.

Quarry pitting occurs when the quality of subsurface toolstone is higher than that of surface material. Gould (1980:125), O'Connell (personal communication), and Binford and O'Connell (1984) report that Australian Aborigines at a quarry of high quality material would excavate one to two feet below the surface to secure unweathered toolstone.

Quarry pitting progresses through several stages. First, surface rocks are assayed to locate likely subsurface stone. The archaeological consequences include primary flakes and assayed cobbles. Once a partially buried boulder or outcrop is located, minimal excavation is conducted in order to expose enough of the subsurface rock to assay it. This creates a small, shallow pit around the margins of the buried rock, a slight berm of soil and waste rock (tailings) along the edge of the pit, and primary and secondary debitage, mostly in the bottom of the pit. If assaying shows satisfactory results, further excavation exposes and removes the buried rock. Larger rocks may be moved with a lever, or they may be broken up using block on block or fire techniques. The archaeological consequences are expected to be a large pit and berm, large pieces of waste rock and chunks of shattered toolstone in the berm, exhausted extraction tools (hammer stones, picks, and shovels) and spall from their use, charcoal, and fire-altered toolstone in the pit and berm.

The objective of Tosawihi quarrying was large bifaces and so the pattern of reduction should be somewhat different from that exhibited by the Alyawara. Judging from the numbers of bifaces in quarry pits and on pit berms, flake blank production and initial bifacial reduction often took place at the quarry pit. Alyawara sometimes cleaned surfaces of debris and vegetation to provide clear areas in which to reduce cores. Cleared spaces have not been observed at Tosawihi Quarries, and discrete lithic scatters are usually found only some distance from quarry pits; those on slopes tend to be fan shaped as a result of slope movement.

Investigative Strategies

Site structure will be monitored through description and systematic collection of feature and non-feature areas, detailed mapping, tests for size-grading of artifacts, and plots of tool distributions. These data will be compared with ethnographic models.

Criteria for Research Potential

Sites with potential for the study of site structure have well preserved, discrete cultural features, as well as patterned distributions of artifacts and features.

Site Formation Processes

Interpretation of the archaeological record at Tosawihi will be enhanced by an understanding of how archaeological sites there were formed and how they have been transformed in the interval since (Binford 1979, 1980; Schiffer 1976). People create archaeological sites by living and working in them. Use of space is differentiated as people sleep in one place, work in another, and dispose of refuse in yet another. Erosion, deposition, soil formation, bioturbation, chemical change, and human activity all affect archaeological deposits as they are created and for as long as they exist thereafter. Several models of site formation processes derived from ethnographic data (Binford 1977, 1978; Binford and O'Connell 1984, 1986; Yellen 1977; Gould 1977; 1980) are applicable at Tosawihi and vicinity.

Activities at residential sites also can be expected to create cultural features and transform archaeological sites; for example, excavation and cleaning of hearths and heat treating ovens, creation of debitage scatters, disposal of lithic and other waste, clearing of work spaces, and shelter construction. In caves and rockshelters, the latter may effect massive transformations of archaeological deposits (Elston and Budy 1990).

Geological and biological processes begin to transform archaeological sites as soon as they are created. In the present project areas, the notable agencies of non-cultural site transformation are slope movement, eolian and alluvial deposition, and bioturbation by burrowing animals. Most slopes show evidence of soil movement through solifluction and slope wash; discrete lithic scatters on slopes are typically fan shaped, with the apex of the fan upslope. Eolian and alluvial deposition has buried archaeological deposits, now visible on the surface only in tailings of animal burrows. Some open sites have been churned thoroughly by burrowing animals. Coverage of site surfaces by annual tailings where burrowing animals are active appears to range between five and twenty percent per annum, suggesting the entire site is turned over every decade or so. Pack rats (Neotoma sp.), mammalian predators, and raptors all contribute to the faunal content of caves and rock shelters; the former two may cause extensive disturbance of archaeological deposits through burrowing (Elston and Budy 1990).

Investigative Strategies

Investigation of site formation processes requires careful analysis of sediments in context, and understanding site-transforming cultural and natural features. An integrated interpretation of site formation will be derived from feature mapping, trench profiling, and geomorphic studies. Where applicable, analysis of faunal remains can reveal the proportion of naturally and culturally introduced bone (Schmitt 1990).

Criteria for Research Potential

Site formation processes are best studied in sites containing discrete cultural features and/or strata, along with chronological indicators such as carbon or obsidian.

The Organization of Lithic Production

One tentative scenario for the organization of lithic production at Tosawihi has been sketched (Elston, Raven, and Budy 1987): chert was extracted, processed, and transformed into early stage bifaces at the place of extraction, transported to a habitation site where it was reduced further, heat treated, reduced yet again, and then transported elsewhere. This model seems most suited to a logistical strategy of lithic procurement and production; foragers probably used a different strategy.

Investigative Strategies

The organization of lithic production can be studied in several ways. Using a gravity model, hammerstone size already has been shown to be an inverse function of distance from basalt source (Elston, Raven and Budy 1987). The same approach might work with debitage volume vs. distance from field camp; the principle of least effort suggests that intense exploitation should occur at the nearest available source, other things (such as stone quality) being equal. The actual distribution, then, would test the model and suggest where other things are not equal (i.e., where quality of toolstone or its near-surface accessibility have conditioned less than the most efficient extraction). In fact, the gravity model can be used for all kinds of predictions; for instance, hammerstone size also may have a direct relationship to distance from habitation. If we can rank toolstone quality and accessibility, those variables could be added.

A strong formal characterization of the differences in debitage (stage, size, raw material type, presence or absence of heat treatment) observable at quarry pits and at habitation sites will help evaluate whether reduction carried on there was

simply pre-transport lightening of the load or whether folks were remaining in place long enough to make the production of finished tools worthwhile.

Criteria for Research Potential

Most sites in the study areas are expected to contain evidence of lithic extraction and/or processing that will be useful in the reconstruction of the organization of production.

Chronology and Paleoenvironments

All the research domains discussed above entail significant temporal dimensions. As a consequence, control of chronological sequences and variation becomes a research issue critical to the understanding of all other data categories, and must be an element in the investigation of each. Four lines of chronological inquiry especially pertinent to research in the Tosawihi Quarries are discussed below, with the understanding that, in fact, all other research issues must address chronology to greater or lesser degrees.

Cultural Chronology

A cultural chronology describes the dates and sequence of phases in the culture history of a locality or region (Willey and Phillips 1958:22). Cultural phase boundaries mark changes in technology, style, subsistence, or other cultural attributes. A fairly detailed cultural chronology exists for the last 3200 years in the upper Humboldt River region (Elston and Budy 1990), although prior to that, the record becomes progressively sketchy with time. The oldest radiocarbon date in the Upper Humboldt region is 5790 B.P. from Upper South Fork Shelter (Spencer et al. 1987), although diagnostic projectile points suggest people were operating in the region (including Tosawihi) by at least 8000 B.P. (Spencer et al. 1987).

Local chronological questions consider the earliest use of Tosawihi chert, the inception of quarry pitting, outcrop quarrying, and other intensive extraction techniques, and when occupation of rockshelters and open sites began.

Investigative Strategies

Construction of a local cultural chronology for Tosawihi that can be fitted into, or even expand, the regional sequence, requires a series of radiocarbon dates from stratified or otherwise discrete cultural deposits. The most likely places in the present study areas are sites in alluvial situations, such

as stream terraces. However, small hearths with dateable charcoal, expected to be present at short term camps, certainly can contribute (Budy 1988; Raven 1988).

It is possible that dateable, stratified deposits exist in the Quarries; over two meters of stratified quarry debris were observed in historic trenches at locality 44 (Elston, Raven and Budy 1987), and similar deposits may exist in other places as well. If fire was used in the quarrying process, datable charcoal may be present in quarry pits or in waste dumps at outcrop quarries. Moreover, hearths may have been used for warming and/or cooking in quarry areas, and hearths may also be present in some of the small, discrete surface lithic scatters designated Reduction Stations (Elston, Raven and Budy 1987:61).

Tephrachronology provides another precise dating method (Bradley 1985:110-112). Tephra, or ash deposited from volcanic eruptions, can travel thousands of kilometers from the source and become incorporated in cultural and geological deposits. Tephras from different eruptions are chemically distinct, and most major Holocene eruptions in the western United States have been well dated. The most widespread tephra in Nevada is ash from the Mt. Mazama eruption (which formed Crater Lake) of about 7,000 years ago (Davis 1978). Mazama ash has been found in several localities in the Upper Humboldt region, including Valmy on the Humboldt River (Elston et al. 1981), in the James Creek drainage (Elston and Budy 1990), at Upper South Fork Shelter (Spencer et al. 1987), and on Mahala Creek in North Fork Valley (Madsen 1985), and there is every reason to expect Mazama ash at Tosawihi.

Stratigraphic superposition will allow the relative dating of artifacts within stratified alluvial deposits, as well as determination of the relative ages of adjacent quarry pits in pit complexes.

Temporally diagnostic artifacts, such as projectile points, shell beads, and pottery, help constrain the age of the deposits in which they are found within certain limits (between several hundred and several thousand years, depending on the artifact class). Other dating methods, such as obsidian hydration, may be applicable to establishing a chronology at Tosawihi. Though obsidian hydration lacks the precision of the radiocarbon method, careful considerations of soil temperature and chemical composition can be used to develop a local hydration rate appropriate for dating obsidian artifacts at Tosawihi and its vicinity (Zeier 1987). Obsidian is present in small amounts at numerous sites on the Quarry periphery (Budy 1988; Raven 1988), and is expected to be present in rockshelter deposits; combined with radiocarbon dating, obsidian hydration may provide a useful chronology for the area.

Criteria for Research Potential

Sites with datable, well-stratified deposits and/or discrete cultural features and quantities of temporally diagnostic artifacts are well suited to the study of cultural chronology.

Temporal Variation in Quarry Use

Assuming chronological control at the Quarries and means to measure the intensity of quarry use and occupation there, variation in use of the quarry through time can be investigated. Such variation may be influenced by a variety of factors, including climatic change, shifts in trade networks, and overall technological change, or may occur as annual ranges and base camp locations shift through time (Binford 1983b). When it can be monitored, the latter kind of change often has a cyclical pattern. For instance, use of James Creek Shelter, about 50 km southeast of Tosawihi Quarries, was at first slight, grew more intense, and then waned over a 3200 year period (Elston and Budy 1990).

Change in the intensity of use also may have occurred at a different scale. Present evidence suggests that the adaptive strategies of Pre-Archaic groups of the Pleistocene-Holocene Transition (12,000 - 8,000 B.P.) were different from those of the later Archaic (Elston 1982, 1986a). The Pre-Archaic strategy seems to have been based on highly mobile foraging, while the Archaic marks the inception of mixed-mode foraging and collecting known in ethnographic times.

Thus, the quarries are likely to have played different roles in the economies and subsistence patterns of Pre-Archaic and Archaic people. In the Pre-Archaic, the Quarries may have been visited infrequently. Sufficient high quality toolstone may have been available on the surface, so that excavation of quarry pits was unnecessary. Under these circumstances, the archaeological visibility of Pre-Archaic toolstone procurement and subsistence may be low, perhaps preserved only in deeper deposits of habitation sites.

In the Archaic, the Quarries may have been visited much more frequently, both by summer foraging groups and by logistical groups operating out of Humboldt valley base camps. Under these conditions, one might expect a temporal vector to technological change in the extraction and processing of raw material from particular kinds of sources (surface cobbles, colluvium, bedrock outcrops) that require different levels of effort for exploitation and that yield different cost-benefit ratios. It may be that, while some sources at Tosawihi were exhausted, others continued to be worked through increased level of effort, change in technological efficiency, or acceptance of poorer quality raw material.

Investigative Strategies

Temporal change in the use of Tosawihi Quarries is likely to be signaled by variations in proportions of diagnostic artifacts and number of features dated through radiocarbon or obsidian hydrations.

Criteria for Research Potential

Any dated site, component, or discrete feature provides important data relevant to the problem of temporal variation in the use of Tosawihi Quarries.

Temporal Variation in Knapping Technology

Differences in the technology of stone tool manufacture are expected between the Pre-Archaic and Archaic (Elston 1982, 1986a). Pre-Archaic tools are large; bifacial implements are broad, thin, and carefully flaked. In the Archaic, tools are smaller and less consistent in attention to symmetry, relative thinness, and other details. There is a tendency for Archaic tools to decrease in size through time, but, at present, there is little evidence for change in the basic technology of biface manufacture during the Archaic of the western Great Basin (Elston and Budy 1990; Novick 1987). However, local changes in intensity of use, site function, and organization of production may have incorporated technological changes at Tosawihi that would not be evident elsewhere.

Investigative Strategies

Temporal variation in knapping technology may be evident upon analysis of assemblages from distinct stratigraphic components at habitation sites or in technological comparisons between quarry and reduction localities.

Criteria for Research Potential

As with temporal variation in quarry use, any dated site, component, or discrete feature provides important data relevant to the problem of temporal variation in knapping technology.

Paleoenvironmental Reconstruction

Considerable climatic and environmental variation has occurred in the Great Basin since the end of the Pleistocene (Wells 1983; Mehringer 1986). Whether or not these changes were of sufficient magnitude to effect the density and distribution

of non-lithic resources at Tosawihi and vicinity through time adds a temporal dimension to questions regarding prehistoric economy.

Investigative Strategies

Paleoenvironmental reconstruction is a complex issue that can be approached through numerous lines of evidence (Bradley 1985). Aside from basic stratigraphy and sedimentology, the approach with most promise for the present work is recovery and analysis of faunal remains from alluvial sites and discrete features.

Criteria for Research Significance

Any site which contains dated paleoenvironmental evidence (faunal remains, pollen, or plant macrofossils) has the potential to inform regarding paleoenvironments at Tosawihi Quarries.

Research Methods

The following section describes field and laboratory methods employed in the collection and analysis of cultural remains and other information.

Field Methods

Field methods were designed to recover data appropriate to identified research problems. As sites vary in the abundance, kind, and distribution of data categories, so field methods varied depending upon whether the site contained a primary toolstone source or whether it served as a secondary reduction and/or residential locus.

The initial assessment of sites involved intensive surface reconnaissance, mapping, and systematic collection. First, formed artifacts and features were located by close interval (two meter) transect survey; precise site boundaries were established and mapped. Formed artifacts (i.e., obviously modified tools, bifaces, and cores) not part of a defined feature locus were assigned specimen numbers, mapped, and collected; obsidian flakes of a size suitable for sourcing were collected similarly.

A datum was established at each site, each artifact and feature located, and a contour map prepared using a theodolite and electronic distance measuring device. Transit data and mapping notes were recorded in an HP 71 computer; files were

transferred to floppy disc and printed daily. Later, mapping data were entered into a data base on a Kaypro 286i computer and contour maps were generated using the SURFER mapping program driving an HP 7475A plotter.

Features, defined as patterned arrangements of artifacts and human modifications of the landscape, commonly consist of debitage concentrations, tool clusters, and quarry pits; less frequent features include hearths, adits, rockshelters, and living surfaces. As each feature was located, a central datum was set and its location recorded using the total station. Artifactual arrangements were drawn in plan view and described. Formed artifacts were plotted on the plan, assigned specimen numbers, and collected.

A sample of the features then was selected judgmentally for more intensive study; the sample drawn reflects the full range of discernible surface variability exhibited by the features recorded at the site. Sample features are the foci of systematic collection. In most cases, the entire surface assemblage was collected, using a 1 m grid system. Collection was conducted by skim shoveling the upper 2 cm below surface and passing the sediment through 1/4 in. screen. Where the abundance of surface materials precludes total recovery, certain features were sampled systematically, with smaller units arranged along a transect.

During assessment, sites with accumulations of alluvial or eolian sediments were tested with one or more backhoe trenches. Trench profiles were cleaned and scraped and the presence of artifacts and cultural features noted. Profiles demonstrating significant buried cultural materials were photographed, profiled, and described in detail.

Controlled excavation sampled both feature and nonfeature contexts; units of variable size (but usually 1 by 1 m or 50 cm by 1 m) were excavated to bedrock or to an appropriate depth devoid of artifacts. Where backhoe trenches resulted in the identification of cultural layers or features, excavation units were placed adjacent the trench in order to further explore the feature. Materials were segregated by 10 cm arbitrary levels and sorted through either 1/8 in. or 1/4 in. screen. Excavation unit size and screen mesh used are reported for each site in subsequent chapters.

Strategies for assessing quarry sites varied somewhat from those used at secondary reduction, residential, and other open sites. Survey methods remain consistent: isolated artifacts and obsidian were located and collected, and features mapped and recorded formally. Sample quarry features, however, received special treatment to extract data on their structure, the quality of toolstone present, and the kinds and intensity of activities carried out. Owing to the great volume of material

(both cultural and non-cultural) present at quarry features, a systematic sample usually was collected from the surface in several standardized contexts (interior, berm, exterior). Both cultural and non-cultural materials were recovered from sample units to allow assessment in the laboratory of the volumetric relationships of debitage to shatter and naturally weathered opalite. Subsequent to collection, the feature was trenched, either by hand or backhoe, in order to expose its internal structure. Profiles were drawn and sediment samples collected from each discernible layer, as feasible.

Bulk samples were returned to the laboratory for processing and constituent analysis. These samples were used to calculate volumes of waste rock removed versus volume of toolstone extracted. Cultural materials also were used for mass debitage analysis.

Cultural materials at outcrop quarries often are scattered along several hundred feet of rimrock. Debitage was sampled with a combination of systematic feature collections and discretionary collection units, and limited excavation. Cobble quarries, which tend to lack concentrations of cultural material, were sampled variously with discretionary collection units. Samples of unmodified toolstone were collected from all quarry sites for chemical identification and quality assessments.

Intact rockshelters with vertical cultural deposits hold tremendous potential for supplying data relative to several research problems. Assessment of rockshelters tested the abundance and spatial patterning of cultural materials, depth and integrity of deposits, degree of preservation of organic remains, and the presence of plant macrofossils and dateable charcoal. Strategies varied depending on the size and apparent depth of deposits, but in all cases entailed detailed mapping, recording, and collecting of surface artifacts. Subsurface testing included controlled excavation and cross sectional exposure using hand-excavated trenches, as appropriate.

The recovery of radiocarbon samples from all appropriate charcoal deposits was emphasized. Charcoal concentrations were exposed, cleaned, and sampled when first encountered. Charcoal was collected with a clean trowel and wrapped in aluminum foil. Then, the context was exposed fully and evaluated for contamination by roots, krotovina, or recent human intrusion. This procedure insured recovery of charcoal from thin, ephemeral cultural lenses which might be destroyed or contaminated in the course of excavation.

Field Documentation

Records documenting the progress of excavation, methods used, and findings were maintained on a daily basis. Mapping

notes were recorded as previously described. Soils and geomorphology notes were recorded in concert with stratigraphic drawings. Excavation unit/level records, completed for every excavated level, include horizontal plan views, description of findings, a list of samples collected, and general soil descriptions.

A reference number system is employed to retain control over samples, artifacts, and recording forms. In this system, each completed form is assigned a unique reference number maintained in a reference number log. The latter documents the unit to which each number is assigned and other pertinent data. Each assigned reference number then was included on associated field records and artifact bags.

Collected materials were placed in bags marked with site number, excavation unit, level, date, collection personnel, reference number, and bag number. Color and black and white 35 mm photographs document all phases of the field work. Photo record forms were maintained for each roll and exposure. Slides, prints, and negatives were indexed and stored in plastic sleeves.

Laboratory Procedures

Once transported to the laboratory, collections were cleaned, sorted, labeled, and cataloged. Each distinctive artifact or artifact lot was assigned a catalog number comprised of site number, reference number, and specimen number. When possible and prudent, the number was applied directly to the artifact using indelible white or black ink covered with clear lacquer. Debitage, bone fragments, and other bulk sample items were cataloged in lots. All non-organic materials were placed in clean plastic bags identified with provenience tags that identifies catalog number, artifact class, excavation unit and level, date of recovery, collector, and cataloger.

As materials were logged in at the lab, personnel sorted special samples from more typical level and surface collection bags. Radiocarbon, flotation, soil, and bulk sediment samples were held out for special handling. Radiocarbon samples, some of which were derived from floated sediment samples, were cleaned manually of soil, air-dried, and weighed. They were repackaged in clean aluminum foil, then placed in plastic bags and shipped to Beta Analytic, Inc., for dating.

Flotation samples were weighed and processed by means of an agitated water system which segregates light organic material from heavy soil matrix, each of which is collected, dried and rebagged separately, ready for analysis.

Analytic Methods

Certain standard analytical methods are applied consistently throughout the Great Basin for describing and classifying particular artifact classes and for identifying faunal remains. Our analysis follows procedures developed by Thomas (1981) for projectile points, by Juell (1990) for ground stone, by Madsen (1977) for ceramics, and by Lyman (1979) for faunal materials. All analytical data were coded and entered into a computer data base. Several data categories, recorded and entered in anticipation of detailed analysis in the data recovery phase, are not analyzed here.

Technological Analysis of Flaked Stone Artifacts

Basic data gathered for all tool categories include specimen measurements (length, width, thickness, and weight), material type, color, and quality, presence or absence of cortex, presence of thermal alteration (if any), and evidence of utilization.

Length, width, and thickness of each piece was measured to the nearest tenth of a millimeter with the aid of calipers. Determining longitudinal axis differed slightly among tool types, as illustrated in Figure 5. In the case of cores, choppers, and battered stones, observers oriented each specimen relative to its observed (when whole) or imagined (when fragmentary) longitudinal axis. After length was established, width and thickness were measured relative to it, for all tools. Width is the longest axis perpendicular to the length; thickness is the maximum distance between faces.

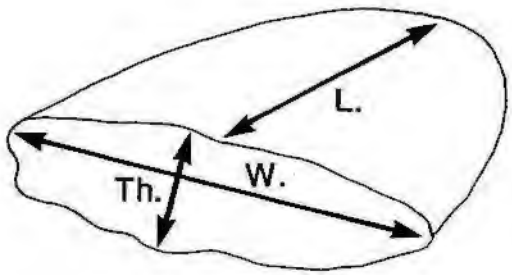
Orienting a biface for measurement requires identifying proximal and distal ends of a complete piece, or recognizing the fragment according to its proximal, distal, medial, or lateral position on a once-complete biface. In most cases, biface length is greater than width, but occasionally the converse is true.

For flake tools, the observer first distinguished proximal (bulbar) and distal (feathered, hinged, or stepped) ends of the original flake (tool blank). The line between them forms the longitudinal axis of the piece; width and thickness are as above. Very commonly, flake length is less than flake width, as shown in Figure 5.

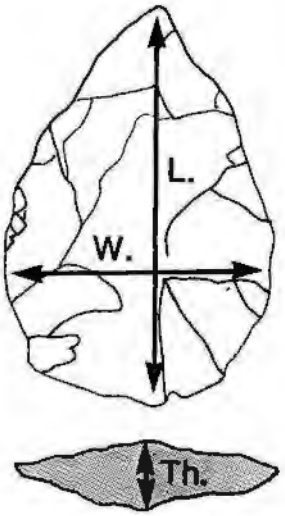
Each tool or tool fragment was weighed to the nearest tenth of a gram on an OHAUS Brainweigh B1500 electronic scale.

Bifaces and flake tools were assigned to one of five material type categories: cryptocrystalline silicate, (hereafter CCS), CCS with quartz, obsidian, basalt, and other. Virtually all CCS and CCS with quartz appearing in the collection is

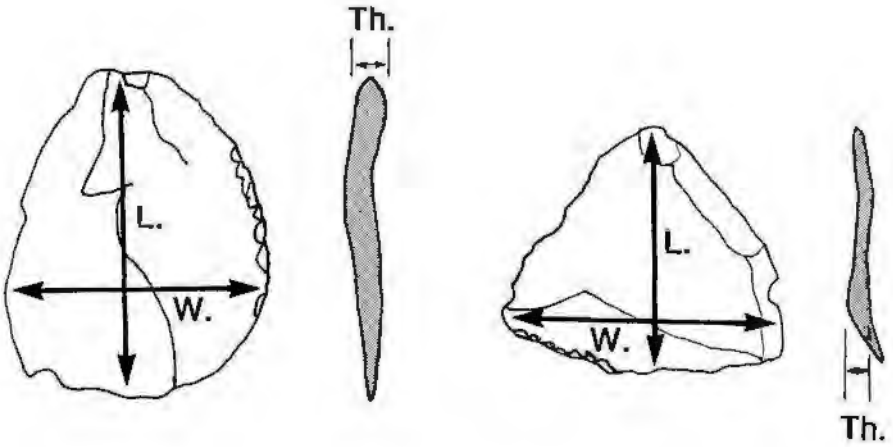
Figure 5. Measurement axes for three tool types.



Hammerstone



Biface



Flake Tools

Tosawihi opalite and jasper. For cores and percussion tools, the list of categories was expanded to include sandstone, quartzite, rhyolite, and tabular versus massive basalt.

Tosawihi opalite occurs in an array of colors and color may represent a key to particular quarry sources, to toolstone quality, and/or to prehistoric cultural preference. Observers recorded the color of each tool, regardless of material type, comparing the piece viewed under 60 watt incandescent lighting to color chips in the GSA Rock-Color Chart (1984 edition).

For cryptocrystalline artifacts, observers determined stone quality by degree of "flawedness" observed. "Excellent" toolstone has no observable flaws (i.e., vugs, cracks, or internal stress lines). "Good" material has few faults, none of which has proven fatal to tool completion. A piece with fatal flaws is graded "poor". Large vugs, unsilicified bands, fracture planes, and extreme potlidding and crenation from heat treatment are observed fatal flaws. The "degree of siliceousness" was also estimated for opalite tools. Tosawihi opalite grades from very white, shiny, hydated material, which is brittle and poorly silicified, to a more dense, resilient stone with grainy to waxy textures, found in numerous colors. The former is a poor opalite, the latter a good to excellent grade.

Observers noted presence or absence of heat treatment on cryptocrystalline specimens and identified obvious traits of thermal alteration such as crenation or pot-lidding, and suspiciously shiny versus dull surfaces on truncations and flake scars. We recognize that thermal alteration is not always detectable.

Additional data specific to the particular tool type under study were gathered. For example, special biface considerations included trajectory, reduction stage (Callahan 1979), fragment type, manufacture failure, and evidence of redirection/ reworking.

Areas of overlap in tool type assignments are recognized among Tosawihi specimens. For example, a bifacially reduced artifact exhibits the obvious attributes of an end scraper. In these preliminary analyses, this tool is not categorized as a biface but as a flake tool, functional class "end scraper". Conversely, a complete or partial biface may have utilized edges, created by cutting actions; it is categorized as a utilized biface.

A gray area exists between chunky Stage II quarry bifaces and spheroid cores. On many nodules, only recognized opposing faces determine that a piece is a biface, not a core. At the other extreme, a crude biface might be considered a stylized core; indeed, the reduction of a quarry trajectory biface

produced a large number of useful flakes. Too, the Tosawihi preform category is awkward in that it includes projectile point preforms as well as very small biface forms, the function of which is not known. For purposes of this report, preforms are discussed with projectile points (see Chapter 3), but are analyzed with biface forms.

Attributes important to flake tool analysis include blank type (i.e., flake type), fragment type, functional class, number and type of edge unit (eus), technological approach (unmodified, uniface, biface, etc.), and evidence of redirection/reworking. For purposes of analysis, the flake tool category includes scrapers, knives, drills and other perforators, gravers, spokeshaves, and multi-purpose cutting and scraping tools.

The term "edge unit" refers to any edge, or portion thereof, which has been modified through casual use, purposeful flaking (retouch), and/or resharpening. It is discussed in greater detail in Chapter 3.

Cores and assayed pieces are considered together, classified into six categories based on Callahan (1979): assayed piece, block core, spheroid core, split nodule core, core fragment, and other. Each is discussed in greater detail in Chapter 3.

Percussion tools include hammerstones and choppers. Attributes observed for the form were blank type, degree of use, and functional type. Degree of use (light, moderate, or heavy) is determined by extent of battering. A tool with light use has small, discontinuous areas of battering on edges and ends. A heavily-used hammerstone or chopper exhibits extensive and continuous battering and/or flaking sufficient to modify the overall shape of the tool.

Debitage

Debitage, the by-product of lithic reduction, includes shatter, flakes, and cores. These items are distinguished from non-debitage by the presence of attributes of positive or negative flake scars.

Herein, debitage refers to unmodified flakes and shatter; cores were isolated from debitage and cataloged as individual artifacts, along with modified and utilized flakes, as previously described. Debitage analysis employs two basic approaches: mass analysis and attribute analysis; each provides information different from the other about lithic reduction technology. Mass debitage analysis, following the methods described below, was initiated on behalf the present project and pursued through the data collection phase.

Mass Debitage Analysis

Mass analysis assumes that different reduction technologies produce debitage with different size distributions, and that these can be recognized in archaeological assemblages. Ahler (1988; Ahler and Christensen 1983), after discriminant analysis of 652 debitage assemblages generated by experimental replication, found significant differences in debitage size distribution among the following technologies: raw material testing, freehand core reduction, bipolar core reduction, large biface production, biface finishing/resharpening, flake tool production/resharpening, and small biface (pressure) reduction.

Samples of screened debitage from surface collections and excavations, and bulk samples from quarry features, were prepared for mass analysis in subsequent phases of study, generally following the methods of Ahler (1972, 1975a, 1986a, 1987) developed for his study of the Knife River Flint Quarries of North Dakota and related sites.

Selected debitage samples and bulk sediment samples containing debitage, were weighed and then sorted into as many as six size grades (1.0, 0.5, 0.25, 0.11, 0.046, and < 0.046 in.) each of which then was weighed, counted, and observed as described below. The data thus obtained were used to estimate the parameters of the total sample. Sorting was accomplished by pouring each sample through chicken wire to remove particles larger than 1.25 in., and thence into a stack of U. S. Standard sieves for 30 seconds of agitation in a mechanical shaker. Samples too large to be sorted in their entirety were poured through chicken wire and thence through a 16 chute box splitter to obtain randomly smaller fractions; the sample fraction then was run through the sieves, and material from each size grade combined.

Statistical Methods

For the present testing phase of work at Tosawihi, statistical manipulations remained largely descriptive, and analysis focused upon the biface collection.

Summary statistics (mean, range, sum, standard error, kurtosis, minimum, maximum, standard deviation, and skewedness) were used to analyze bifaces along a number of parameters. Length, width, thickness, and weight were described in this manner for the total population of bifaces and for the subpopulations of the three study areas. These data were obtained for all bifaces, and for the subgroups defined by stages. Biface caches were isolated and analyzed as well.

Width-thickness ratios were calculated by stage for the total population of bifaces and for each of the separate areas.

T-test and chi square statistics (Blalock 1979) were employed to evaluate differences between various samples of artifacts. The t-test statistic sought significant differences in the mean length of biface populations recovered from USX-East and USX-West areas, and for contrasting mean lengths between the quarry and small biface trajectories. The chi square statistic inquired whether or not quarry and small biface populations were composed differently in terms of stages.

Analysis of other tool types was more straightforward, crosstabulating the distribution of tools and assayed pieces across areas, sites, and features. Functional classes also were analyzed in terms of heat treatment, blank type, and other variables.

Counts and weights of debitage were summed for each size grade as well as totalled by reference number; flakes and shatter were treated separately. Average weight per individual was calculated. The results were displayed by site, feature, and material type to aid comparison.

Part II. Artifact Descriptions

In the following four chapters, artifacts are described according to their technofunctional classes. Chapter 3 deals with cores, bifaces, and flaked stone fabrication tools such as scrapers and perforators. Projectile point styles and chronology, are described in Chapter 4. Ground, battered, and scratched stone tools include plant processing tools, abraders, hammerstones, and tools used for platform preparation in lithic reduction; these are described in Chapter 5. Pottery, described in Chapter 6, includes both Fremont Grayware and Shoshone Brownware ceramics.

Chapter 3. CORES, BIFACES, AND FLAKE TOOLS

by C. Lynn Furnis, Margaret C. Brown, and Robert G. Elston

Most flaked stone tools in the present collection fall into one of three general categories: cores, bifaces, and flake tools. Each of these broad categories is in turn divided into classes. In the case of cores and bifaces, classes are thought to reflect technological approaches to procurement and reduction. In contrast, flake tool classes are based on morphological and functional distinctions. These classes are devised for the purposes of evaluating testing results; all such classes are tentative and subject to revision during more detailed analysis anticipated in connection with data recovery.

Cores

Two hundred thirty-one cores were collected, but many more were observed at the sites tested. The modus operandi was to collect all cores found within features, excavation units, and surface collection units; those located elsewhere on the sites were noted but left in situ. However, exceptional pieces were recovered regardless of location. The core assemblage, then, is limited intentionally.

Cores were recovered from 40 sites: 17 in USX-West, 3 in the North Access Corridor, and 20 in USX-East. Most cores are from USX-East (n=135), compared to 87 from USX-West and 9 from the North Access Corridor. Nearly all recovered cores are opalite, though a few specimens (n=18) are basalt, obsidian, rhyolite tuff, quartzite, and siltstone. For analytical purposes, we distinguish six core types: assayed piece, spheroid core, block core, split nodule, core fragment, and "other". The following text is organized according to these categories.

As pointed out by Callahan and others (Callahan 1979: 41-65; Zerga and Elston 1989), numerous quarry bifaces may actually be cores. We have chosen to categorize all tools with biface morphology as bifaces, recognizing the probable flake production function of large bifaces.

Core types and frequencies are arrayed in Table 3, below.

Table 3. Tosawihi Core Types Arrayed by Geographical Area.

	CORE TYPE												
	Assay		Spheroid		Block		Split Nodule		Core Fragment		Other		
Area	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
East	15	11	67	50	23	17	3	2	27	20	0	0	135
West	3	3	56	64	16	18	1	1	10	12	1	1	87
North	1	11	2	22	4	44	0	0	2	22	0	0	9
Total	19	8	125	54	43	19	4	2	39	17	1	0	231

Assayed Pieces

Testing a cobble or nodule by removal of a few flakes allows the knapper to examine the fresh, unweathered toolstone. If the stone is found unsuitable, the piece is rejected. The result is an assayed piece.

Nineteen assayed pieces are identified, composing 8.0% of cores. Toolstone sources are most abundant in USX-East of the three areas tested. We thus expected that area to yield an abundance of assayed pieces and, indeed, 79% of recovered assayed pieces are from USX-East. Approximately half all assayed pieces are weathered cobbles with a few flakes snapped from the surface, or are split cobbles with a few flakes removed from interior faces. The other half are "chunks", i.e., large angular pieces of shatter which have been tested.

All the assayed pieces are white or light-colored opalite, except for one of basalt (26Ek3271-1044-7) and another of buff-colored, poorly silicified tuff (26Ek3196-2003-1). Rhyolite tuff is a local material, interbedded with Tosawihi opalite. Assayed pieces measure between 75 mm and 185 mm maximum dimension, and weigh between 227 gm and 1602 gm. Only two specimens appear heat-treated; one is from the west (26Ek3104-500-4), the other from the north (26Ek3237-500-70).

Spheroid Cores

Definitions for spheroid and block cores are after Callahan (1979:41-63). Spheroid cores are very irregular polyhedral in shape. Flakes have been removed in a seemingly random pattern because the knapper has made use of all likely platform areas, removing flakes from numerous directions on one core. This is in contrast to block core appearance which is characterized by systematic, patterned flake removal. Spheroid core reduction requires a complex flint-knapping strategy which results in very little flaking waste according to Callahan (1979: 63, 65).

Spheroid cores account for 54% (n=125) of the collection. Proportionately, they are more abundant in USX-West (comprising 64% of cores there) than in the east, where they account for 50% of cores (cf. Table 3). These trends may reflect a greater need to consume raw material in the USX-West area which has relatively few toolstone sources.

Spheroid cores range from 43 mm to 238 mm maximum dimension, weighing from 63 gm to 1913 gm. Most are blocky, oblong, opalite chunks. They vary considerably in size, but not in overall morphology. None of the core blanks is a flake, and only a very few were made on weathered cobbles.

Four material types are represented among the spheroid cores: light (n=115) and dark (n=5) opalites, jasper (n=2), basalt (n=2), and siltstone (n=1). "Dark" opalite has a chromatic value between 1 and 6, while "light" opalite has values of 7, 8, or 9 in the GSA Rock-Color Chart (1984). All are local toolstones, with the exception of dark blue-gray siltstone. The latter resembles material observed near James Creek Shelter, in northern Eureka County (Robert Elston, personal communication), but it probably occurs closer to Tosawihi Quarries as well.

Of 125 spheroid cores, 17 (14%) appear thermally altered; 12 of these are from the west, accounting for 21% of spheroid cores there. Five are from the east, comprising 7% of eastern spheroid cores. Three utilized cores (26Ek3170-2023-3, 26Ek3185-1004-1, and 26Ek3204-500-2), all from the east, exhibit minimal scraping use wear on very steep edges. A fourth core, of basalt (26Ek3271-519-3), is from the west; moderate battering is apparent on two edges, perhaps the result of chopping or hammering action.

Block Cores

Block core reduction is characterized by systematic removal of blade-like flakes. As Callahan illustrates them, block cores have broad flat "tops" and bodies which either narrow to a point at the bottom (i.e., funnel-shaped) or are parallel-sided (Callahan 1979: 41-63). The Tosawihi specimens include block, funnel, and semi-domed shapes, always with broad, flat tops. The top is the flaking platform; parallel flakes are systematically struck from its perimeter down the sides of the bodies. Both long, parallel-sided flakes (blades) and broad, short flakes might be created from such a core. In the case of Tosawihi blocks, several examples have two opposing "tops" or platforms, with a series of parallel flake scars associated with each.

There are 43 Tosawihi block cores, accounting for 17% and 18% in east and west areas, respectively, and 44% (n=4) in north road sites, as shown in Table 3.

Block cores are made from four local toolstones, but most (n=34) are light-colored opalites. Two dark-colored opalites, five basalt, one jasper, and one quartzite core were also recovered. Quartzite cobbles are abundant in USX-East drainages. Basalt and quartzite cores retain large cortex surfaces, usually on the broad platform tops; all apparently were made from large weathered cobbles. Block core maximum dimensions range from 47 mm to 162 mm, and weigh from 52 gm to 1414 gm.

Split Nodules

This core type is made on a small, rounded pebble which has been split in half and then flaked. Four split nodules were recovered, all of them waterworn obsidian pebbles. One (26Ek3095-1045-1) is from USX-West, the remainder from USX-East sites. The obsidian is from an unknown source, but is black and translucent with a rough, pitted cortex that is present on all four nodules. The four cores are similar in size, ranging from 28 mm to 45 mm maximum dimension, weighing from 7 gm to 41 gm. They comprise 2% of all cores.

Core Fragments

This category includes 39 fragments of block and spheroid cores which are too small or too deficient in salient attributes to classify with confidence. All are light-colored opalite pieces of angular shape, measuring between 20mm and 125mm in length, and between 13gm and 543gm in weight. They account for 17% of the total collection.

Other Cores

One piece which does not fit any of the five categories described above is labeled "other". The specimen (26Ek3160-500-275) is a tabular piece of pale blue opalite, sandwiched between tuff strata which form the opposing faces. A few large flakes have been removed from each end. It measures 95.5 mm long, 64.0 mm wide, 27.9 mm thick, and 125.4 gm in weight.

Summary

Discounting assayed pieces, we know that four core types occur in the study areas: biface, spheroid, block, and split nodule. Bifacial cores are certainly most numerous, and are discussed later. About half of all remaining cores are spheroid. They may represent the second core type of choice for a couple of reasons. Initial chunk or nodule form is not strictly constrained; almost any opalite chunk with reasonable

striking edge and flake area will suffice. Callahan found during his Clovis biface experiments that less waste material is produced in spheroid core reduction (20-30%) than in block core flaking (40-60%) (Callahan 1979:65). While the Tosawihi Quarries are extensive, with a seemingly endless supply of opalite, individual knappers apparently chose to conserve their quality toolstone as much as possible.

The advantage of block cores over spheroids is that they produce lots of blade-like flakes. Since spheroid cores comprise 54% of the collection, and block cores account for only 19% of the total, production of blade-like flakes from block cores may have been a secondary goal.

Finally, there are split nodules, of which there are few specimens (n=4). All are obsidian pebbles with cortex. We do not know where they originated, though they all appear waterworn, as if gathered in drainages. There are no known obsidian sources in the vicinity of Tosawihi.

Bifaces

Biface implements constitute the largest category of tools (n=2509) collected from the 67 tested sites. As used here, "bifaces" include all bifacially worked tools, from large, chunky core-like nodules to small, very thin projectile point preforms. Functionally specific bifaces, such as projectile points and drills, are excluded from the biface category, though they are desired end products of biface reduction.

We imposed a "trajectory" system to handle the variety of observed form and size trends within the biface population. First organizing the specimens by trajectory, we hoped to isolate groups significantly different in size range and probable end product. The bifaces are organized into three trajectories for purposes of discussion. "Quarry" or "large" bifaces are treated first, then "Small" bifaces, "Preforms", and "Indeterminate" bifaces. In the present analysis, trajectory is based on the relative size of the original flake or nodule from which a tool has been fashioned.

Different trajectories have different end products (Muto 1971) and trajectories are organized by general size range; reduction stage defines the degree of reduction within each size group. Trajectories are more or less arbitrarily divided into one of five lithic reduction stages, based on Errett Callahan's "stages of manufacture for Clovis-like biface artifacts" (1979:9, 35-37). Callahan defines nine stages for the complete reduction of a blank to a finished, fluted and retouched Clovis projectile point, ready for hafting. While devised for Clovis tools, the first five reduction stages are applicable to biface reduction in general, covering the sequence from blank

acquisition to biface shaping stage. Thus, the same stage sequence is applied to all three trajectories described here even though blanks and end products are of different sizes in each.

Some discussion of the term preform is in order. For purposes of this report, "preform" refers to the smallest biface forms. Most are regarded as projectile point preforms, and others as small tools of unknown purpose. Callahan employs the term differently, using "rough preform" and "refined preform" to describe large Stage II, III, and IV bifaces equivalent in size to those in our quarry trajectory. He prefers "to call a biface a preform if it is at that stage of manufacture just preceding final specification of shape" (Callahan 1979: 36).

In the case of small bifaces and preforms, numerous Stage II artifacts have a flattened cross-section (i.e., plano-convex or flat with bevelled edges) even when only edge preparation has been completed. This occurs because the tool blank is a thin flake, requiring little or no thinning. Elston noted the same phenomenon among medium and small-sized bifaces from the Vista site; it "represents a special reduction technique...in which the tool is finished, but one (usually the ventral) or both faces are only marginally or partially reduced"(Zeier and Elston 1986: 141).

Our five reduction stages are defined as follow (after Callahan 1979: 36-37):

> Stage I: Obtaining the blank. Blanks are simply nodules or flake forms of suitable size and form for large biface manufacture. Stage I pieces were not identified systematically and segregated as such in the field or in the lab. Hence, few are counted in our collection, though more may lay hidden in the recovered debitage.
>
> Stage II: Initial edging. A blank is considered a Stage II biface when it has been edged, but neither face has been thoroughly flaked. Prepared edges are bevelled by percussion removal of relatively short, thick flakes from one or both faces. Such removal effectively prepares the edges for removal of well-formed thinning flakes in the Stage III sequence. With small bifaces, and especially preforms, the bevel is often created by "scrubbing" the margin of the flake blank with an abrader (Elston 1986b:148). When viewed edge-on, the edge line of a Stage II biface is irregular and sinuous, the length of flake scars on either face are generally less than half the width of the piece. Bevels created on small bifaces and preforms by abrasion may be only a few millimeters wide. In addition, the biface cross-section is a flattened hexagon or thick lenticular shape.

Stage III: Primary Thinning. This stage involves the removal of flakes which extend to, or slightly beyond, the center of the biface, producing a lenticular in cross-section. In plan view, the outline of Stage III biface is often irregular, with spurs between flake scars. At this stage, thinning of the biface body is most important. The edge line remains sinuous, though dips between arrises are less severe than with Stage II bifaces. The successful biface is reduced in thickness more than it is reduced in width or length at this point.

Stage IV: Secondary Thinning. A Stage IV biface is characterized by flake scars which cross the midline and considerably undercut those originating from the opposite edge of the same face. A successful piece is devoid of large humps, step-fractures and hinges, and its cross-section has a flattened biconvex shape. The outline is more regular, as most knobs and spurs have been removed. A side view reveals a much more regular, straighter edge line.

Stage V: Shaping. A Stage V biface is not only thin and thoroughly reduced on both faces, but the edges are manicured with fine flaking, giving a specified shape to the piece. In other words, by Stage V, the knapper has focused his attention on the biface outline. Thinning of the body is complete, so that refining of the tool perimeter to a desired shape is the primary focus.

Nearly all Tosawihi bifaces have been keyed to one of these five "stages of manufacture". Those which cannot be keyed are labeled "Indeterminate".

Quarry Bifaces

The single largest tool class from Tosawihi are quarry bifaces, consisting of 1632 items. The production of large bifaces appears to have been the major focus of prehistoric toolstone extraction and processing at Tosawihi Quarries. Bill Bloomer (personal communication) suggested that the size of these objects, and the reduction technology employed in their processing, set them apart from other bifacial tools found at Tosawihi. Quarry bifaces are large enough to have functioned as both tools and as cores for the production of flake blanks suitable for flake tools, small bifaces, and projectile points. As shown in Table 4, 298 specimens (18%) are complete, while 1334 range from exceedingly fragmentary to nearly complete; minimum, maximum, and mean dimensions of the group are given.

Summarizing the size range information provided in Table 4, we can say that quarry bifaces measure between 223.00 mm and

61.0mm in length, between 145.0mm and 34.0mm in width, and between 93.0mm and 11.0mm in thickness. Generally, they are made from blanks about the size of an extended hand and larger.

Some Stage II quarry bifaces are much like spheroid cores, except that they have two opposing faces, (i.e., a rough biface configuration) but great thickness in proportion to other dimensions.

Table 4. Minimum, Maximum, and Mean Dimensions for Quarry Trajectory Bifaces.

Dimensions	Complete n=298	Fragmentary n=1334
Length		
maximum	223.00 mm	160.00 mm
minimum	61.70 mm	8.10 mm
mean	116.12 mm	67.83 mm
Width		
maximum	135.50 mm	145.00 mm
minimum	34.50 mm	5.20 mm
mean	71.31 mm	57.97 mm
Thickness		
maximum	93.00 mm	67.00 mm
minimum	11.00 mm	4.80 mm
mean	28.73 mm	19.23 mm
Weight		
maximum	1409.80 gm	1071.90 gm
minimum	39.50 gm	1.50 gm
mean	246.80 gm	88.09 gm

T-tests were performed on the mean lengths of bifaces to compare quarry biface and small biface trajectories within study areas, and to contrast biface dimensions of the same trajectory across areas. At the .01 level, quarry bifaces and small bifaces differ significantly from each other in both areas (west t-score 7.255 > 2.62, east 13.8 > 2.58). Quarry bifaces from USX-East, closer to quarry sources, were also significantly larger than quarry bifaces from USX-West at the .01 level (3.57 > 2.58). Small bifaces from the two areas were not found to be significantly different.

We have observed a variety of quarry biface shapes (cf. Figure 6). Although this variation suggests a continuum, wide bipointed and leaf-shaped bifaces appear to be the most common forms.

Figure 6. Observed shapes of quarry bifaces.



Elongate



Square-based



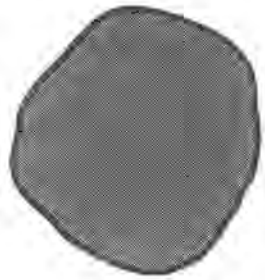
Leaf-shaped



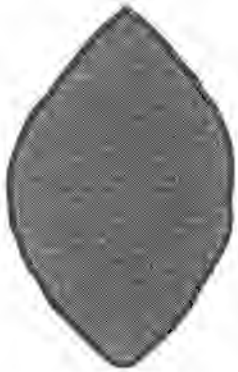
Triangular



Ovoid



Round



Bipointed



Bipointed (Asymetrical)

Some trends are apparent in the data provided in Table 5. Grouped by reduction stage, most quarry bifaces fall into Stage II and Stage III categories. Together, the two groups account for 81% of all quarry bifaces in the collection. The next largest category is Stage IV, comprising 9.4% of all bifaces. Only six individuals of the 1632 recovered are Stage I or Stage V quarry bifaces, representing the extremes of the reduction spectrum. Although the dearth of Stage I quarry blanks may be due, in part, to a failure to seek them out systematically, few really large well-formed flakes were recovered. Consider that such items were the object of the quarrying effort. Since any modification to a blank immediately qualifies it as a Stage II biface, few blanks are expected. The two Stage V quarry bifaces recovered are broken. The data suggest that quarry bifaces usually were transported from Tosawihi Quarries in Stage III or IV. Thus, any further reduction must have taken place during the time the biface was used to produce flake tool blanks and to perform various tasks. The few broken bifaces at the quarries probably represent tools used up elsewhere and discarded as new tools were procured.

Table 5. Selected Attributes of Quarry Trajectory Bifaces.

	Reduction Stage						
	I	II	III	IV	V	Indeterm.	Total
Dimensions in mm.							
Mean length (c)	120.53	116.55	115.62	125.50	0	0	116.13
Mean length (f)	74.40	76.08	66.75	62.26	56.95	53.37	67.84
Mean width (c)	83.13	72.15	69.68	47.30	0	0	71.31
Mean width (f)	94.75	63.73	57.58	52.75	43.95	47.40	57.92
Mean thickness (c)	32.96	31.12	24.62	12.60	0	0	28.73
Mean thickness (f)	34.05	24.92	17.35	11.11	8.30	18.11	19.23
Mean weight (c) (in grams)	299.57	270.10	207.41	81.20	0	0	246.80
Mean weight (f)	274.05	133.05	76.77	42.13	23.50	45.19	87.89
	n %	n %	n %	n %	n %	n %	n %
Heat treated specimens	2 50	306 49	388 55	104 68	2 100	88 59	888 54
Whole specimens	3 75	187 30	107 15	1 >1	0 0	0 0	298 18
Total No.	4 0.2	626 38.3	697 42.7	154 9.4	2 0.1	149 9.1	1632 99.8

(c)= complete specimens
(f)= incomplete specimens

The two Stage V quarry bifaces were recovered from Bitterroot Ridge in USX-West, some distance from the main quarrying area. Both bifaces are broken. The first (26Ek3160-2001-3) had been heat-treated and thoroughly flaked after heating. Still, an internal material flaw caused it to fail during reduction. The second piece (26Ek3095-500-40) was broken much sooner after heat-treatment, as the only shiny surface resulting from heat-treatment occurs on the mechanical truncation, created by end shock. No flakes were removed from the extant biface half (proximal) after heating.

Intentional thermal alteration is a significant variable in the reduction of opalite bifaces. As shown in Table 5, more than half the total assemblage (54%) has been heat-treated. Approximately 50% of the quarry bifaces in Stages I through III are thermally altered, with increasingly higher proportions in Stages IV and V. This is reasonable since pieces that survive intentional heating will be reduced further and refined.

Only 18% (n=298) of quarry bifaces are complete. Tracking the ratio of complete versus incomplete specimens from early to late stages, we observe that nearly all complete bifaces are contained within the early stages; only one is recorded for the Stage IV group and there are none in Stage V. Many Stage II and Stage III artifacts are quite thick in proportion to their lengths and widths, and probably rejected because they could not be thinned sufficiently. The lack of complete late stage bifaces also supports the notion that the thinner a biface becomes, the more likely it is to break during manufacture.

Overall size reduction occurs throughout the 5-stage biface manufacturing sequence. Table 5 indicates that mean length of whole and fragmentary bifaces tends to diminish with greater stage reduction. Mean width, thickness, and weight steadily decrease from Stage II to Stage IV. The large mean length for Stage V quarry bifaces is due to the presence of a single large individual. Too few Stage I and Stage V quarry bifaces exist for comparison. Although there are staged, incomplete bifaces reflect similar trends, but with more modest differences between stages, as shown in Table 6.

Table 6. Relative Mean Size Change from Stage II to Stage IV Quarry Bifaces.

	% Change	
Dimensions	Complete	Incomplete
Width	34 decrease	17 decrease
Thickness	60 decrease	55 decrease
Weight	70 decrease	68 decrease

Table 6 also shows that Tosawihi bifaces are thinned at nearly twice the rate than they are narrowed.

Callahan (1979:35) discusses his long-time struggle to advance his own flint-knapping skills, finding at last the key to successful biface reduction by controlling the rate of thinning and reducing biface thickness at a faster rate than width. With regard to Tosawihi bifaces, we assume that prehistorically desirable biface forms have greater width/thickness ratios than rejected implements. In other words, substantial body thinning is a primary goal of prehistoric quarriers who intend to transport, trade, and further reduce large numbers of bifaces.

Four biface caches were discovered in the course of fieldwork. Together, they yielded 83 quarry bifaces and one small biface, comprising 5% of the total quarry biface collection. Since 63 of the 83 specimens are complete, the whole specimens account for a disproportionate fraction (21%) of all complete quarry bifaces (n=298). Unlike those in the other caches, opalite bifaces in the 26Ek3184 cache are all fragments, seemingly selected for similarity in size and shape. The one intact specimen is a chunky obsidian biface. Assuming the cached tools are prized, curated examples and most other quarry bifaces are rejected pieces, we should observe differences in width/thickness ratios between the two populations. In Table 7, we compare the mean w/t ratios of the total biface population from tested sites, the population in each cache, and the total biface population from all sites, excluding cached bifaces. The mean W/T values by stage for Tosawihi cached bifaces are essentially the same as those derived by Callahan (1979) in his experiments. With the exception of the obsidian specimen in the cache from site 26Ek3184, all cached bifaces have greater mean w/t ratios than do Tosawihi bifaces in general, intact or not. In fact, the fragmentary specimens in 26Ek3184 have the greatest mean w/t ratio of all, suggesting purposeful selection of items with a high potential for reworking.

Material Types

Of the 1612 opalite specimens, most are white, gray, or grayish blue opalite, but pink, pale purple, salmon pink, and yellow opalites appear as well. These are "light" opalites, with chroma values of 7, 8, or 9 on the GSA Rock-Color Chart (1984). Eight opalite bifaces are fashioned from very dark purplish red to golden brown varieties of Tosawihi stone, with chromatic values of 1 through 6 on the same Color Chart.

Tosawihi opalite varies considerably in quality and texture, as well as in color. The most common variety encountered during 1988 fieldwork is a massive, yellowish-white to grayish-white material. In quality, it grades from good, or nearly flawless, to extremely "vuggy"; in many USX-East quarry

pit sites, this type of opalite is riddled with vugs 5 mm to 50 mm in diameter. Its texture ranges from smooth and waxy to matte and grainy.

Table 7. Mean Width/Thickness Ratios of Selected Quarry Biface Populations, by Reduction Stage.

Biface Population		Reduction Stage I n	%	II n	%	III n	%	IV n	%	V n	%	Indeterm. n	%	Total Mean	
All Quarry Bifaces (n=1632)	(c)	2.60	(3)	2.50	(187)	3.00	(107)	3.90	(1)	0	(0)	0	(0)	2.68	(298)
	(f)	3.39	(1)	2.81	(439)	3.62	(590)	4.94	(153)	5.34	(2)	2.93	(149)	3.43	(1334)
26Ek3095 cache (n=11)	(c)	0	(0)	1.82	(1)	3.18	(7)	3.90	(1)	0	(0)	0	(0)	3.11	(9)
	(f)	0	(0)	0	(0)	4.66	(1)	0	(0)	0	(0)	1.59	(1)	3.13	(2)
26Ek3184 cache (n=14)	(c)	0	(0)	2.20	(1)	0	(0)	0	(0)	0	(0)	0	(0)	2.20	(1)
	(f)	0	(0)	3.59	(1)	3.94	(10)	5.02	(2)	0	(0)	0	(0)	4.08	(13)
26Ek3192 cache (n=41)	(c)	4.56	(1)	3.34	(9)	3.48	(28)	0	(0)	0	(0)	0	(0)	3.48	(38)
	(f)	0	(0)	2.95	(1)	2.96	(2)	0	(0)	0	(0)	0	(0)	2.96	(3)
26Ek3197 cache (n=17)	(c)	0	(0)	2.65	(11)	2.36	(3)	0	(0)	0	(0)	0	(0)	2.59	(14)
	(f)	0	(0)	2.50	(2)	3.35	(1)	0	(0)	0	(0)	0	(0)	2.78	(3)
All Tosawihi Bifaces not in Caches (n=1549)	(c)	2.65	(2)	2.40	(165)	2.85	(69)	0	(0)	0	(0)	0	(0)	2.54	(236)
	(f)	3.39	(1)	2.81	(435)	3.60	(576)	4.95	(151)	5.34	(2)	2.93	(148)	3.43	(1313)
Callahan's (1979) W/T (c) Ratio, derived from experimental replication		0	(0)	2.00-3.00		3.00-4.00		4.00-5.00		4.00-6.00		N/A		N/A	

(c)= complete specimens
(f)= incomplete specimens

Resembling concrete, many specimens of gray brecciated opalite contain small to large gray, angular opalite inclusions. Bifaces of this material dominate the caches from sites 26Ek3095, 26Ek3192, and 26Ek3197. Most are complete and few have been heat-treated. This toolstone is generally high-quality. In texture, it varies from waxy and smooth to grainy and rough.

Another toolstone remarkable for its rarity and high quality has a bluish-gray, translucent matrix with opaque white blotches and smooth waxy to grainy texture. The few implements manufactured from this material are eye-catching.

Opalites of pink, purple, and red hue tend to be shiny and smooth in texture, and very limited in distribution at Tosawihi. Few quarry bifaces are made of these materials, which commonly are used for flake tools, preforms, and small bifaces.

Eleven bifaces are made of jasper, another local material quarried at site 26Ek3084. Five are leaf-shaped, three are ovoid, and three are indeterminate in shape. Seven implements, five of them complete, were retrieved from USX-West sites (26Ek3092 and 26Ek3271); one is from USX-East (26Ek3185), and two are from a North Road Corridor site (26Ek3238). Complete specimens vary in length from 61.0 mm to 103.0 mm.

During survey of USX-West (Budy 1988), a Stage II jasper biface (26Ek3084-38-1) was collected from a pile of quarry waste at site 26Ek3084. Shown in Figure 7, the specimen, is a quite large, leaf-shaped artifact measuring 225.0 mm long, 107.0 mm wide, 40.7 mm thick, and 1206.6 g in weight. However, it is longitudinally curved, like a banana, probably the cause of its discard. A very large flake scar on one face is evidence that flake blanks of sufficient size for small quarry bifaces or larger small bifaces could have been struck from bifacial cores of this size.

One basalt biface (26Ek3095-515-1) occurs in the collection, a complete Stage II biface of roughly lanceolate shape, measuring 160.0 mm long, 74.7 mm wide, and 30.7 mm thick. Basalt is a local Tosawihi toolstone, from which numerous other large tools are made, such as planers, scrapers, cores, choppers, and hammerstones.

Evidence of Utilization

During biface analysis, utilized edges were observed and noted. Only 19 quarry bifaces are recorded as utilized. One (26Ek3170-502-3) has a scraper edge, three others have perforating features (26Ek3115-501-1, -1004-1, and -1008-1). The remainder have more generalized utilized edges.

Biface Caches

Four biface caches were discovered in the course of fieldwork. One from site 26Ek3095 is the only cache from USX-West. The others are from USX-East sites, 26Ek3184 and 26Ek3192 in the Hole Plug region, and 26Ek3197 in the Undine region. Each cache is discussed below, and within its site context in later chapters.

Figure 7. Large jasper biface from 26Ek3084, specimen 38-1.


0
5
cm

Site 26Ek3095, Feature 24

The smallest biface cache was recovered from site 26Ek3095. Eleven specimens were collected from the test excavation, but excavators suspect, from probing the outlying area, that more bifaces are buried at Feature 24. All specimens were discovered from 2 to 12 cm below ground surface. Three specimens from the cache are shown in Figure 8.

Table 8 summarizes various attributes of cache implements. Three toolstone varieties are present in the Feature 24 cache. The first nine bifaces listed are made of Type #1 opalite, matte opaque, yellowish white to light gray groundmass speckled with darker gray angular inclusions. None appears to have been thermally altered. The first seven on the list are complete specimens, comprising a graduated "set" of wide, bipointed bifaces. Alike in shape, material, and reduction stage, they regularly decrease in size. Their shared traits, particularly material type, suggest a single reducing event for this group. Specimen 26Ek3095-2081-3 (Figure 8a) is in the small biface size range, apparently made on a biface thinning flake, removed, perhaps, from one of the larger bifaces in the cache at an earlier stage of reduction.

One anomalous biface (26Ek3095-1081-7), an odd-shaped Stage II, was found in the cache, made of the same speckled gray opalite. In plan view, it is leaf-shaped, rather than bipointed. Viewed from the side, the distal portion is at a 45 degree angle to the proximal half. It apparently is a rejected failure, bearing a band of unsilicified tuff. At mid-point, a protruding edge was prepared for removal of the proximal half.

The final two bifaces listed in Table 8 are small implements, different from the rest in terms of material and shape. One (26Ek3095-2081-5) is a small, leaf-shaped jasper implement (Type 3). The other (26Ek3095-2081-2 and 6) the only Stage IV in the cache, is an elongate biface fashioned from pale bluish-gray opalite (Type 2).

Site 26Ek3192, Feature 1

The largest biface cache recovered consists of 41 quarry trajectory bifaces. All are considered complete, although seven specimens are missing small lateral portions the absence of which would not impede further reduction (Figures 9 and 10). Four shapes are represented in the cache: leaf-shaped (n=19), wide bipointed (n=11), square-based (n=7), and ovoid (n=4). Feature 1 specimens are all fashioned from one of four varieties of opalite. As all biface shapes are found in nearly all material variations, we can see no correlation or special preference for a particular shape in a particular opalite. Pertinent data are offered in Table 9.

Figure 8. Selected quarry bifaces from the Feature 24 cache, 26Ek3095.

a. specimen 2081-3
b. specimen 1081-1
c. specimen 2082-2

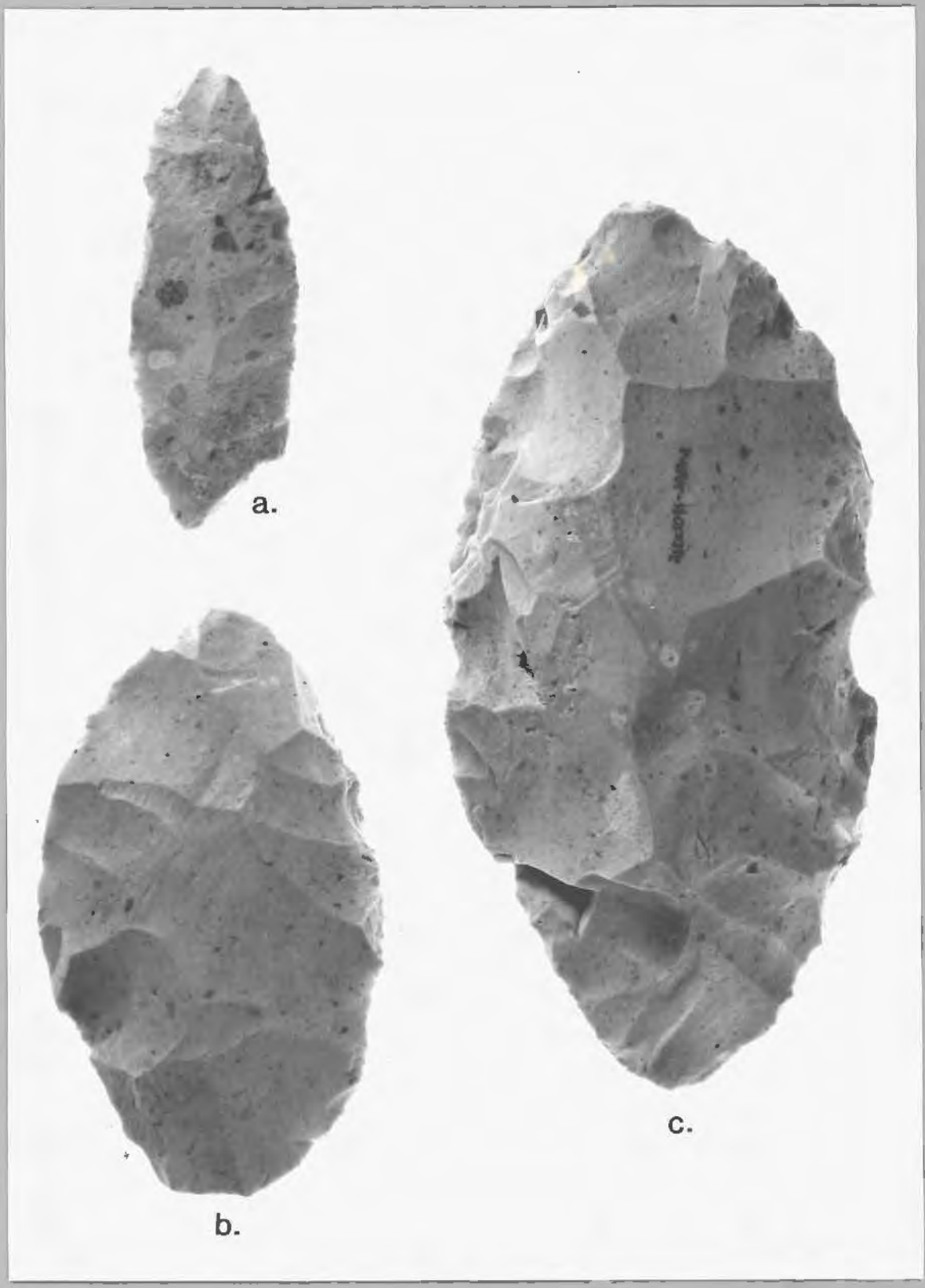

a.
b.
c.
0
5
cm

Figure 9. Selected quarry bifaces from the Feature 1 cache, 26Ek3192.

a. specimen 2021-13
b. specimen 2021-1
c. specimen 1012-2

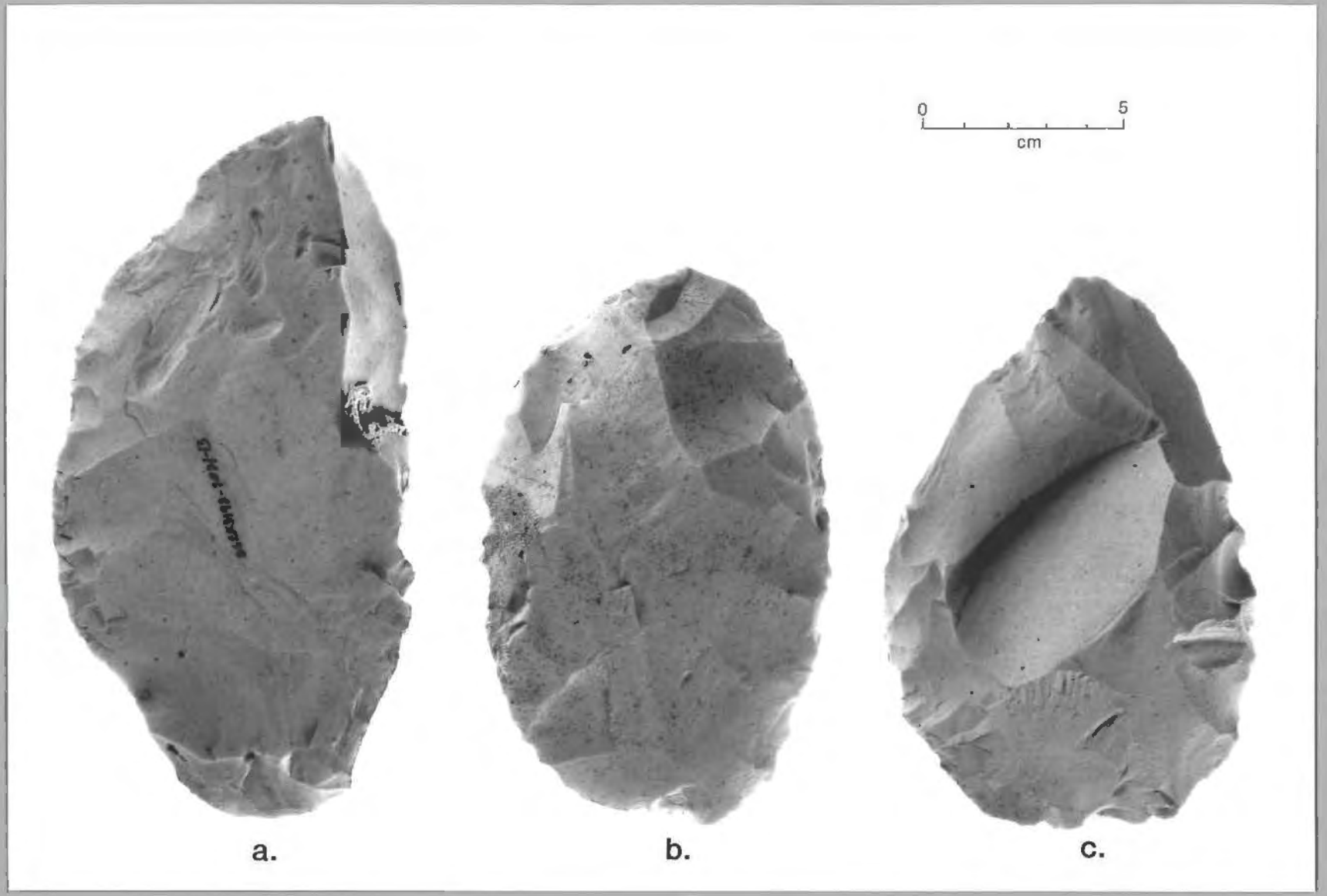

0
5
cm
a.
b.
c.

Figure 10. Selected quarry bifaces from the Feature 1 cache, 26Ek3192.

a. specimen 2022-23
b. specimen 2022-20
c. specimen 1010-9
d. specimen 2022-2

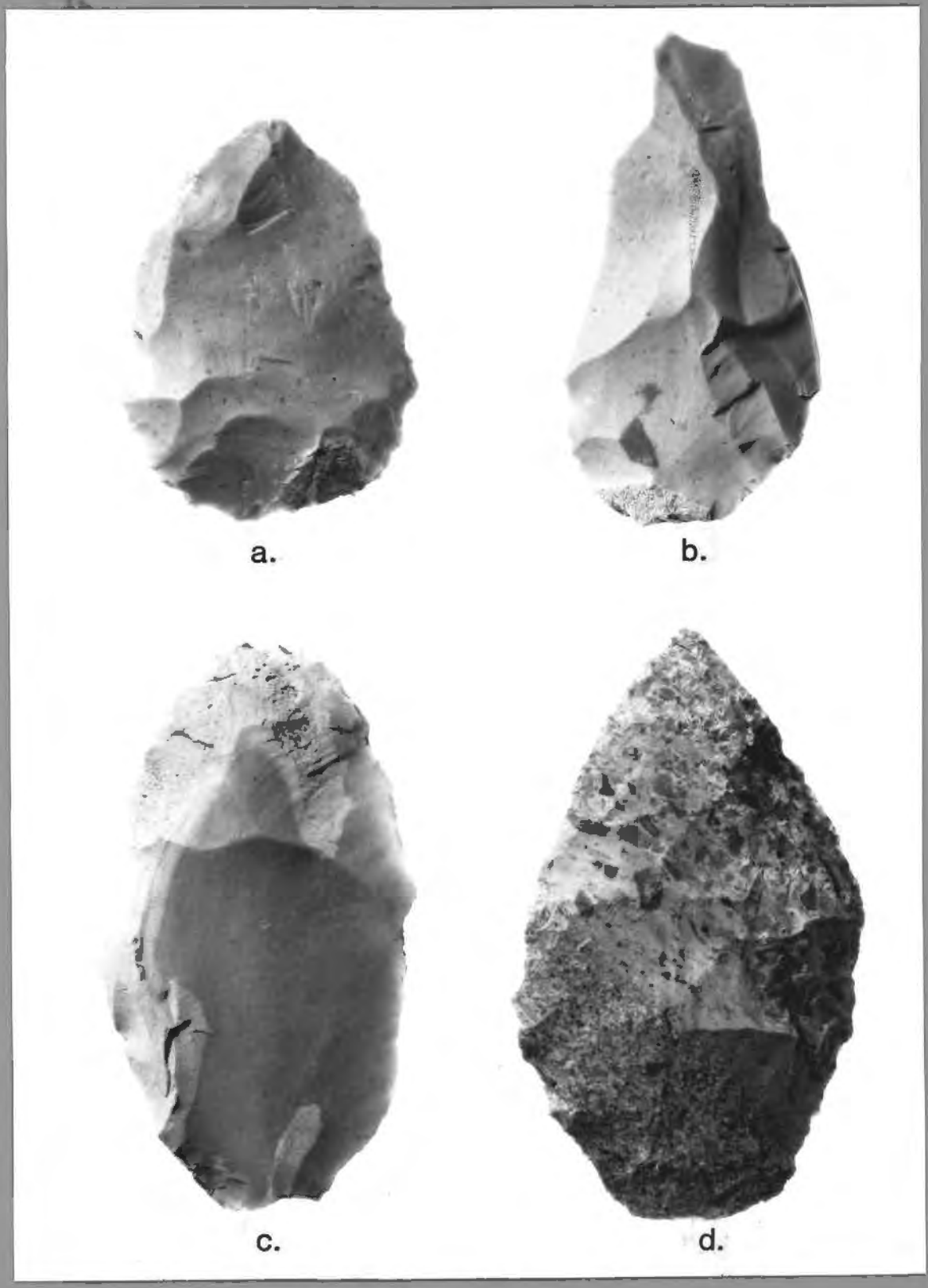

a.
b.
c.
d.
0
5
cm

Table 8. Selected Attributes of Eleven Bifaces from Site 26Ek3095, Feature 24 Cache.

Reference Number	Shape	Material Type/Color	Reduction Stage	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)
2082-2	bipointed	#1 opalite - 5Y9/1	III	223.0	111.0	44.3	941.0
2081-1	bipointed	#1 opalite - 5Y9/1	III	205.0	97.7	34.4	701.2
2082-1	asymmetrical bipointed	#1 opalite - N8	III	174.0	96.3	25.1	451.3
2081-4	asymmetrical bipointed	#1 opalite - 5Y9/1	III	168.0	90.0	30.2	427.4
1081-1	asymmetrical bipointed	#1 opalite - 5Y9/1	III	151.0	89.0	26.1	353.8
2082-3	asymmetrical bipointed	#1 opalite - 5Y9/1	III	147.0	78.8	28.4	300.0
2081-3	bipointed	#1 opalite - 5Y9/1	III	118.2	44.4	11.2	59.8
2081-9*	indeterminate	#1 opalite - N8	Indeterminate	104.9	52.6	32.9	117.3
1081-7	leaf-shaped	#1 opalite - 5Y9/1	II	140.4	63.7	35.0	278.4
2081-5*	leaf-shaped	#3 jasper - 5R2/6	III	41.5	42.0	9.0	18.6
2081-6}			IV				
2081-2}	elongate	#2 opalite - 5B8/1	crossmend	126.7	48.4	12.4	81.3

* = incomplete specimen
#1 = Type 1 opalite
#2 = Type 2 opalite

Color Designations from GSA Rock-Color Chart (1984)
5Y9/1 = yellowish-white
N8 = very light gray
5B8/1 = very light bluish-gray
5R2/6 = very dark red

Only one specimen had been heat-treated. One-fourth (n=10) of the tools are Stage IIs; one is Stage I, a biface blank. The remainder are Stage III bifaces. As with the caches from 26Ek3095 and 26Ek3197, this assemblage may have been prepared and stored in anticipation of heat-treatment en masse. All are thin in relation to their width, even at Stage III reduction, suggesting they are choice specimens.

Of the four opalite varieties present in the cache, two are very similar to Types 1 and 2 from the 26Ek3095 cache. Colors range from white, yellowish-white, and gray, to light bluish gray.

Opalite Type 1 is very light gray, opaque, matte, grainy textured, with many small quartz crystal inclusions, occasional vugs of 1.0 mm to 6.0 mm diameter, and speckled throughout with darker gray, angular splotches of 1.0 mm to 4.0 mm length. Twenty bifaces are composed of the material; two are exceptional pieces because of their coloring. The first (26Ek3192-2022-1) is the basic opalite described here, with the addition of a secondary coloring of grayish pink (5YR 8/4). The other (26Ek3192-2022-2) consists of banded stone, each band of which contains a different size grade of dark gray angular inclusion, ranging from 1.0 mm to 3.0 mm diameter in one band, and from 2.0 mm to 11.0 mm in another.

Table 9. Selected Attributes of Forty-One Quarry Bifaces from Site 26Ek3192, Feature 1 Cache.

Reference Number	Shape	Material Type/Color	Reduction Stage	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)
1012-2	leaf-shaped	#1 opalite - N9	II	146.0	97.5	28.0	361.5
1010-6	leaf-shaped	#1 opalite - 5Y9/1	IIh	137.0	90.3	27.8	324.8
2022-2	leaf-shaped	#1 opalite - N7	III	141.4	82.2	19.5	219.6
2021-14	leaf-shaped	#2 opalite - N8	III	136.7	85.2	20.6	268.8
2022-1	leaf-shaped	#1 opalite - N8 pink	II	132.0	86.2	28.2	327.7
2021-5	leaf-shaped	#1 opalite - N8	III	127.5	87.6	24.1	261.0
1010-4	leaf-shaped	#3 opalite - 5Y9/1	III	132.4	76.9	25.4	238.2
2022-8	leaf-shaped	#3 opalite - N8	II	131.3	77.6	22.0	289.0
1010-5	leaf-shaped	#1 opalite - N8	III	122.9	77.3	25.5	266.0
2021-8	leaf-shaped	#3 opalite - N8	II	121.5	88.1	22.1	226.0
2021-6	leaf-shaped	#3 opalite - N8	II	122.6	80.5	25.5	241.0
1010-3	leaf-shaped	#1 opalite - 5Y9/1	III	126.9	81.2	28.3	239.0
1010-8	leaf-shaped	#3 opalite - 5Y9/1	III	129.1	76.6	28.0	291.2
2021-2	leaf-shaped	#1 opalite - N8	II	121.2	82.6	28.0	234.0
2022-16	leaf-shaped	#3 opalite - N8	III	115.7	65.1	23.4	183.8
2022-18	leaf-shaped	#1 opalite - N8	III	112.0	70.3	18.8	152.6
2022-12	leaf-shaped	#3 opalite - N8	III	113.8	76.9	17.0	157.0
2022-7	leaf-shaped	#3 opalite - N8	III	104.3	72.5	21.1	173.7
2022-20	leaf-shaped	#1 opalite - N8	II	117.0	62.1	19.1	122.2
2021-13	bipointed	#1 opalite - N8	III	186.0	92.2	28.2	582.4
2021-12	bipointed	#2 opalite - N7	III	153.0	88.1	19.8	264.1
2021-11	bipointed	#1 opalite - N8	III	146.0	96.0	24.5	361.3
1010-7	bipointed	#3 opalite - N8	III	136.4	81.0	28.3	270.6
2022-5	bipointed	#4 opalite - N8	III	132.9	70.1	24.2	233.7
2022-9	bipointed	#3 opalite - N8	III	114.5	77.0	24.4	239.4
2021-15	bipointed	#3 opalite - N8	III	120.5	74.0	21.8	205.3
2021-7	bipointed	#3 opalite - N8	III	126.6	70.5	20.1	173.2
2022-21	bipointed	#1 opalite - N8	III	116.8	73.1	18.0	159.2
2022-22	bipointed	#1 opalite - N8	III	119.1	63.8	19.5	180.6
2022-14	bipointed	#1 opalite - 5B8/1	II	129.2	72.9	24.7	188.0
2021-1	square-base	# opalite - N8	III	149.0	92.8	32.2	430.0
2021-10	square-base	#1 opalite - N8	III	116.9	88.7	28.7	310.0
2021-4	square-base	#3 opalite - N8	III	118.3	74.7	20.5	210.2
2022-19	square-base	#1 opalite - N8	III	128.6	77.3	24.2	253.9
2022-10	square-base	#3 opalite - N8	III	120.1	68.8	21.7	168.5
2021-3	square-base	#2 opalite - N8	III	111.9	75.5	23.9	180.4
2022-13	square-base	#1 opalite - N8	II	108.4	79.5	21.4	221.9
2021-9	ovoid	#1 opalite - N8	III	110.6	85.2	29.1	291.7
2022-15	ovoid	#3 opalite - N8	III	106.2	78.9	17.2	160.0
2022-23	ovoid	#1 opalite - N8	II	96.2	71.9	19.0	127.4
1010-9	ovoid	#4 opalite - N7	I	134.5	74.8	16.4	177.4

Color Designations from GSA Rock-Color Chart (1984)

N9 = white
N8 = very light gray
N7 = light gray
5B8/1 = very light bluish-gray
5Y9/1 = yellowish-white

h = heat-treated

Opalite Type 2 is translucent, very light gray to light gray, with a waxy texture, occasional blotches and swirls of white, and occasional small vugs. Three implements in the cache are fashioned from it.

Type 3 is very light gray to yellowish-white opalite, opaque, with a grainy texture. It includes a high proportion of small quartz crystals (1.0 mm to 2.0 mm diameter) and varying amounts of tiny (ca 1.0 mm diameter) vugs. Sixteen bifaces are made from this material.

Material Type 4 is also light gray in color, with large swirls of white. It is translucent and has a sugary or grainy texture. It is high in quartz crystal inclusions, as with the first two types described. Two specimens, a bipointed biface (26Ek3192-2022-5) and an ovoid Stage I biface (26Ek3192-1010-9), are composed of the light gray translucent toolstone.

Site 26Ek3197, Feature 5

The third biface cache consists of 17 Stage II and Stage III bifaces, presented in Table 10; representative specimens are shown in Figure 11. Three shapes are represented: leaf-shaped (n=6), bipointed (n=9), and square-based (n=1). All are complete or nearly so, with three missing only small lateral pieces. In each case, the truncation has been partially flaked (i.e., repaired).

Two opalite types appear in the cache, one of which composes 15 of the 17 artifacts. The predominating Type 5 opalite resembles cement. It is very light gray in color, opaque, smooth (waxy) to very grainy in texture. Small vugs, tiny quartz crystals (1.0 mm in diameter), and dark gray angular specks are numerous. This toolstone does not resemble closely the toolstones from any of the other caches. While it shares color and inclusion types with Types 1 and 3 from 26Ek3095 and 26Ek3192, it has different proportions of the same ingredients.

The second stone type (Type 1 in all caches) is a gray to gray with pink opalite, opaque, with smooth texture, matte surface, occasional quartz crystals, and large angular dark gray blotches (4mm to 25mm long). Two leaf-shaped bifaces (26Ek3197-2001-2 and 26Ek3197-2001-13) are made of this material.

Table 10. Selected Attributes of Seventeen Bifaces from Site 26Ek3197, Feature 5 Cache.

Reference Number	Shape	Material Type/Color	Reduction Stage	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)
505-1	leaf-shaped	#5 opalite - N8	II (f)	150.0	80.5	38.1	375.2
2001-3	leaf-shaped	#5 opalite - 5B7/1	III	141.8	71.5	31.6	297.3
2001-4	leaf-shaped	#5 opalite - N8	II	138.2	71.7	34.2	334.3
2001-13	leaf-shaped	#1 opalite - N8	II	135.0	81.9	26.7	246.3
2001-6	leaf-shaped	#5 opalite - 5B7/1	II	122.1	76.1	37.6	289.4
2001-2	leaf-shaped	#1 opalite - 5R8/2	III (f)	115.9	71.8	21.4	202.7
2001-5	bipointed	#5 opalite - N8	II	148.6	71.5	29.4	269.7
505-4	bipointed	#5 opalite - N8	II	140.4	70.0	16.7	227.4
505-3	bipointed	#5 opalite - N8	II (f)	133.5	74.0	25.5	295.7
2001-11	bipointed	#5 opalite - N8	II	137.2	74.2	28.5	285.2
2001-10	bipointed	#5 opalite - 5B7/1	II h?	131.4	76.2	27.1	282.5
505-2	bipointed	#5 opalite - 5YR8/1	III	127.9	79.8	31.1	285.5
2001-12	bipointed	#5 opalite - N8	II	136.2	88.1	33.6	313.8
2001-1	bipointed	#5 opalite - N8	II	135.2	75.0	32.5	290.9
2001-7	bipointed	#5 opalite - 5B7/1	III	122.6	73.0	31.9	273.4
2001-8	bipointed	#5 opalite - N8	II	143.3	72.5	32.5	295.9
2001-9	square-base	#5 opalite - N8	II	130.8	74.3	26.4	293.7

(f) = incomplete specimen
h = heat-treated

Color Designations from GSA Rock-Color Chart (1984)
N8 = very light gray
5B7/1 = light bluish gray
5YR8/2 = pale grayish orange pink
5YR8/1 = pinkish gray

Site 26Ek3184, Feature 1

A cache consisting of 15 bifaces was recovered from site 26Ek3184, Feature 1. Differing from all others, the cache consists of mostly incomplete bifaces (n=13), includes one obsidian small biface, and contains nine (60%) heat-treated implements. Pertinent data on the group are compiled in Table 11. Each fragment is an "end", representing approximately half a biface. Because of their very high W/T ratios, it is conceivable they were salvaged items for which further working was planned. On the other hand, the feature was very close to a road, and the cache may represent a pothunter's cache.

As shown in Table 11, the majority of bifaces in Feature 1 (n=11) are wide, with pointed ends. We cannot determine if they are proximal or distal fragments, or a mix of both. They may have been wide bipointed bifaces similar to the complete specimens from the 26Ek3095 cache. Six of the eleven "ends" are heat-treated; two are Stage IVs, and nine are Stage III artifacts. Four specimens are complete elongate, ovoid, round, and leaf-shaped tools.

Figure 11. Selected quarry bifaces from the Feature 5 cache, 26Ek3197.

a. specimen 2001-8
b. specimen 2001-1
c. specimen 2001-6
d. specimen 2001-11

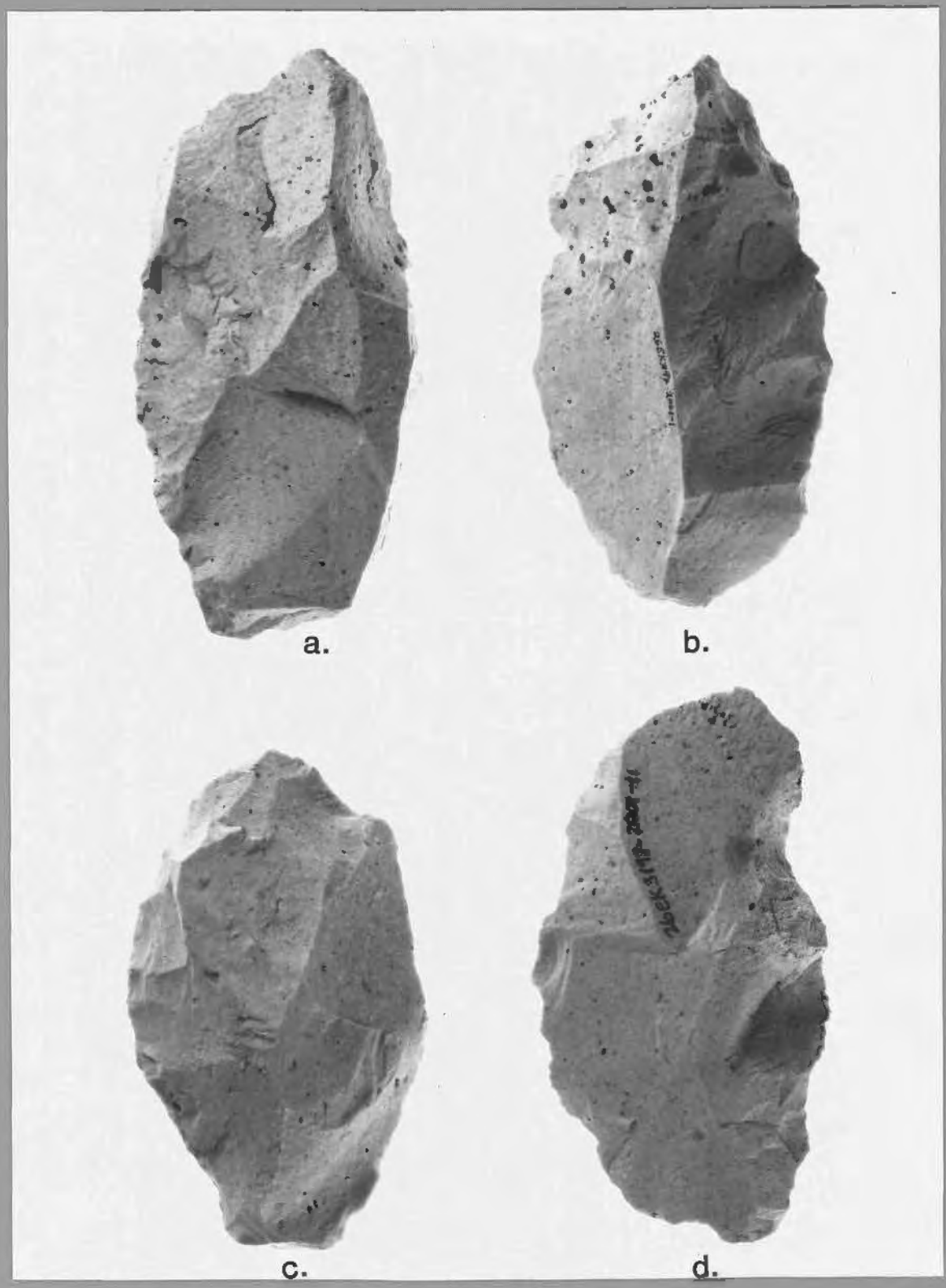

a.
b.
c.
d.
0
5
cm

Table 11. Selected Attributes of Fifteen Bifaces from Site 26Ek3184, Feature 1.

Reference Number	Shape	Material Type/Color	Reduction Stage	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)
1001-6*	pointed end	#4 opalite - 5B9/1	III h	133.5	71.7	17.1	141.8
1001-3*	pointed end	#4 opalite - 5B8/1	III h	112.0	55.9	16.9	94.8
1001-2*	pointed end	#2 opalite - N8	III h	67.1	70.5	13.8	76.2
1001-8*	pointed end	#2 opalite - 5B9/1	III h	60.8	71.8	14.5	58.2
1001-11*	pointed end	#2 opalite - 5B9/1	III h	59.3	77.8	22.3	79.6
1001-4*	pointed end	#1 opalite - 5Y8/1	III	56.6	58.4	13.5	40.3
1001-10*	pointed end	#1 opalite - 5Y9/1	IV	70.5	56.1	12.9	51.3
1001-12*	ovoid	#1 opalite - N8	II h	77.5	57.5	16.0	74.2
1001-14*	elongate	#1 opalite - N8	III h	85.8	46.5	18.5	67.5
1001-7*	pointed end	#3 opalite - 5GY8/1	III	71.8	62.5	17.0	75.9
1001-15*	pointed end	#3 opalite - 5R8/2	III h	80.0	65.0	16.2	82.2
1002-1	leaf-shaped	#3 opalite - 5Y8/1	II h	89.4	48.0	21.8	95.2
1001-5*	pointed end	#4 opalite - 5B9/1	III	62.4	76.8	19.5	107.7
1001-13*	pointed end	#6 opalite - N8	IV	62.5	57.6	10.1	38.8
1001-9	round	obsidian - N1	III s	59.3	53.0	14.7	39.1

* = incomplete specimen
h = heat-treated
s = small biface vs. quarry biface

Color Designations from GSA Rock-Color Chart (1984)
5B9/1 = bluish-white
5B8/1 = very light bluish-gray
N1 = black
N8 = very light gray
5Y8/1 = yellowish-gray
5GY8/1 = light greenish-gray
5R8/2 = grayish-pink

Five varieties of opalite are distinguished in this cache. Types 1, 2, 3, and 4 as described in the previous cache sections are present. One specimen (26Ek3184-1001-13) is made of a bluish-gray, translucent stone, with a smooth matte texture, occasional large white blotches and innumerable white specks, called Type 6 opalite. It resembles quartzite in appearance, but not in texture. The small, complete round biface is made of obsidian, a transparent black glass devoid of swirls, bands, or phenocrysts. As seen in Table 11, no one opalite variety predominates in the 26Ek3184 biface cache.

Summary

To summarize our general observations about quarry trajectory bifaces, virtually all (99%) the implements are composed of Tosawihi opalite. Most (82%) large bifaces are broken, slightly more than half are thermally-altered, and 81% are reduced to Stage II (edge preparation) and Stage III (primary thinning) levels. Apart from those in caches, most recovered bifaces are incomplete rejects representing manufacturing failures left at the quarry. Most successful, complete tools were probably carried away from Tosawihi.

The frequent incidence of heat-treating among early stage bifaces means that much intentional heating occurred at the quarry or its immediate vicinity. This may have been done to enhance workability for subsequent biface reduction as well as for production of usable flakes from bifacial cores. The low incidence of thermal alteration among the cache population, considered prize bifaces by us, is puzzling when contrasted to heat treatment for the total population. Perhaps cache bifaces from sites 26Ek3095, 26Ek3192, and 26Ek3197 have been heated, but never were flaked afterwards, making thermal alteration difficult to detect now. If they were not heated prior to being cached, then what lay in store for them? Did they await thermal alteration in a batch? Were people reluctant to invest the time in heat-treating a group of objects that might not be retrieved? Are they made of opalite varieties which do not require heating for successful reduction? Since most recovered bifaces from all sites are not composed of the speckled gray opalite that dominates the caches, perhaps frequency of heating correlates in some way with toolstone quality.

The bulk of quarry trajectory bifaces are Stage II or Stage III tools. The absence of Stage I bifaces (large blanks) suggests that blanks were not stockpiled for later knapping. Rather, shortly after being created, they were reduced to at least a Stage II state. The dearth of Stage IV implements in general, and the recovery of only one complete (in 2 pieces) Stage IV biface, suggests that most bifaces were not reduced beyond Stage IV before transportation. In other words, some secondary thinning work took place at Tosawihi, but virtually all successful Stage IV bifaces were taken elsewhere.

Other observations stem from internal differences in the collection as a whole. In Table 12, complete bifaces are compared by geographical area; these data can be compared to those for bifaces in caches presented in Table 7.

The comparisons are useful, pointing out some trends we expected to see. The greater the distance from the quarry, the smaller the biface. The biface cache implements (excepting 26Ek3184 which is mostly incomplete "ends") are generally longer, wider, and heavier than area and total population bifaces.

Table 12. Comparison of Complete Quarry Biface Dimensions by Geographical Area.

		Dimensions			
	No. of	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)
Area	Items	mean / st.dev.	mean / st.dev.	mean / st.dev.	mean / st.dev.
East	196	119.46 / 18.84	74.02 / 13.52	29.26 / 11.09	265.28 / 158.36
West	100	110.25 / 28.64	66.30 / 16.34	27.92 / 8.35	213.08 / 146.58
North Road	2	83.50 / 13.86	56.10 / 28.85	17.70 / 6.08	121.90 / 116.53
Total *	298	116.13 / 23.09	71.31 / 15.06	28.73 / 10.26	246.80 / 156.16

Small Bifaces

Small bifaces are artifacts made on relatively small flake blanks produced during the reduction of quarry bifaces and small cores. The smaller size of small bifaces means that, in contrast to quarry bifaces, their reduction produces few, if any, flakes suitable for use as flake tools. Aside from a generally small size range, small bifaces are also contrasted with quarry bifaces by a greater range of morphological variability.

Such artifacts are often referred to as knives in the Great Basin literature (Fowler and Matley 1979; Thomas 1983b; Zeier and Elston 1986). A photograph of 19 hafted stone knives from Southern Paiute (Southern Utah) ethnographic collection (Fowler and Matley 1979: Fig. 3, p. 156), as well as a photograph of two Northern Paiute stone knives (one hafted) collected from Pyramid Lake (Fowler and Liljeblad 1986: Fig. 3, p. 439), appear to contain examples of analogous artifacts, although the haft elements on most are obscured by the hafts themselves. Leaf-shaped, triangular and elongate small biface forms similar to those in the present collection have been recovered from James Creek Shelter (Elston and Budy 1990), and South Fork Shelter (Heizer et al. 1968; Spencer et al. 1987); both are stratified sites within 50 km of the Tosawihi Quarries.

We do not automatically assume that small bifaces were intended for use as knives, since many specimens could have served as preforms for dart points, and several used specimens exhibit scraper-like wear. Teasing apart the significance of the considerable morphological and functional variability in this artifact class is a task which will be left to analysis during data recovery.

Small bifaces were divided into reduction stages according to Callahan's (1979) scheme. Mean dimensions, weights and certain other attributes for each stage are presented in Table 13.

Most (96.8%) small bifaces are made of opalite. Obsidian artifacts make up the remainder (N=18) with no jasper, basalt or exotic chert small bifaces present. As expected, the proportion of thermally altered pieces (possible heat treatment) increases with stage. Relatively few pieces (N=18) show unambiguous signs of utilization.

Morphological variants among small bifaces include lanceolate, leaf-shaped, elongate, triangular, square based, ovoid/round. and constricting end, as described below. Two miscellaneous bifaces do not conform to these classes. Both specimens are irregular early reduction stage pieces. In addition, small biface fragments (N=338) are not assignable to any morphological class due to their small size.

Table 13. Selected Attributes of Small Bifaces.

Dimensions in mm	Reduction Stage I	II	III	IV	V	Indeterm.	Total
Mean Length (c)	-	72.3	66.4	56.6	93.8	29.8	
Mean Length (f)		44.5	42.3	40.6	51.53	30.2	
Mean Width (c)		52.3	42.4	40.3	33.6	21.4	
Mean Width (f)		37.9	33.2	32.7	32.2	31.2	
Mean thickness (c)		16.9	14.5	8.1	8.0	8.9	
Mean thickness (f)		9.8	8.6	7.1	6.2	7.8	
Mean weight (c)		66.4	46.2	21.4	26.8	5.7	
Mean weight (f)		19.6	13.4	10.5	12.4	6.8	
heat treated specimens		23	334	36	18	24	435
utilized specimens		3	14	1	-	-	
whole specimens		7	37	4	1	1	50
TOTAL No.		37	426	42	20	33	558

Lanceolate bifaces (n=3, 0.5 %) are either bipointed or have one end slightly larger than the other. One highly stylized Stage V specimen (26Ek3237-500-42, Figure 12e) is made on a flake blank with a large potlid on the dorsal and ventral surfaces. Fine oblique collateral flake patterning is evident on both faces, with unifacial edge wear perpendicular to the edge, indicating the tool was used as a scraper. All three lanceolate biface specimens are complete.

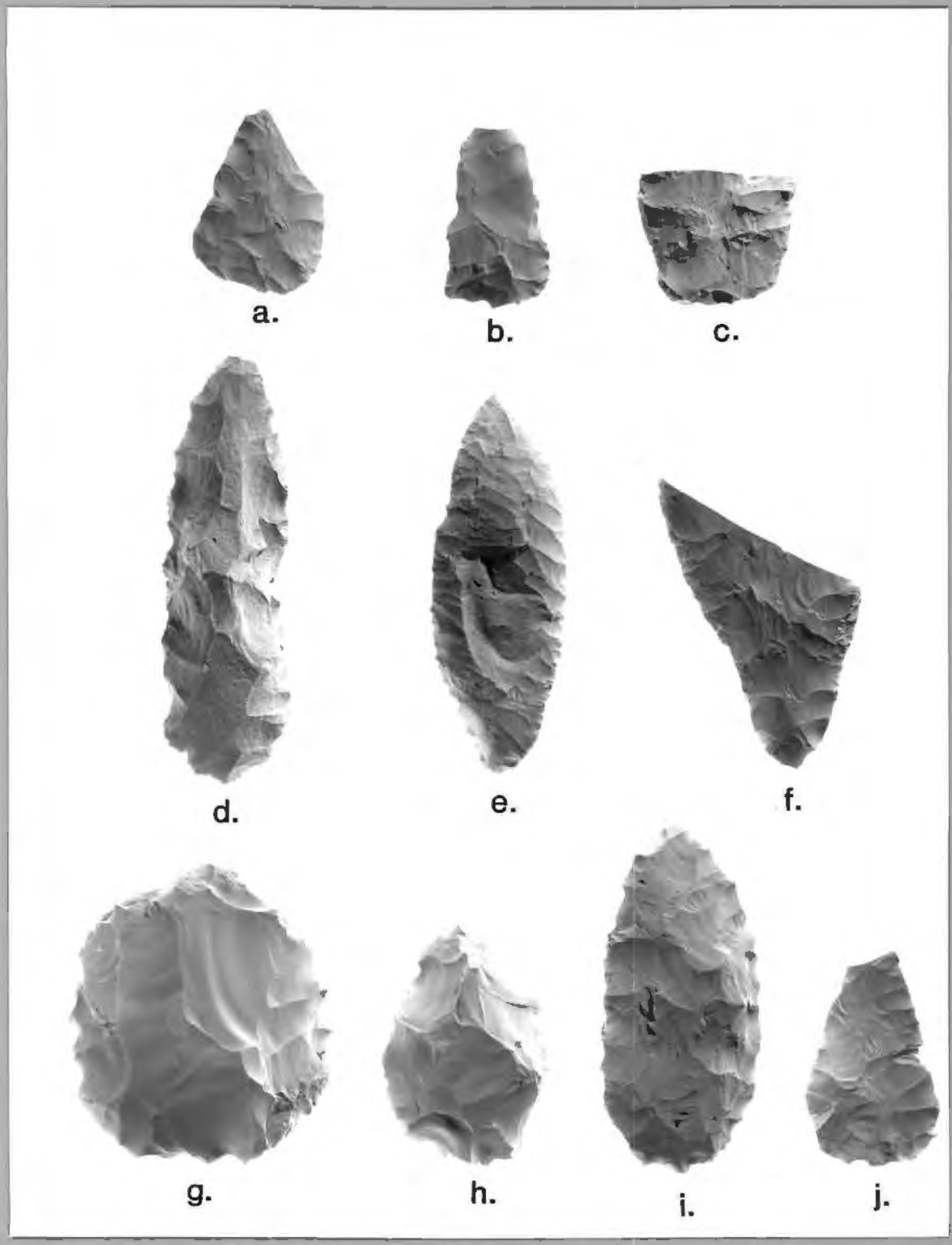
Leaf-shaped bifaces (n=82, 14.6%) are defined by a wide round base with a pointed to blunt distal end. The lateral margins are straight to slightly convex (Figure 12i, j). One late stage specimen (26Ek3190-505-1) is pressure retouched and has been utilized intensively on the proximal end, which exhibits unifacial edge wear, rounding, and polish. It strongly resembles an end scraper.

Elongate bifaces (n=46, 8.2%) have round bases with parallel lateral margins. These tend to be at least twice as long as they are wide, are thick in cross section, and, as a result, may represent thinning failures (Figure 12d).

Triangular bifaces (n=31, 5.5%) grade into leaf-shaped bifaces, although they are characterized by square bases rather than round ones. Distal ends are pointed to blunt, with straight, convex, or slightly concave lateral margins (Figure 12a, b). One highly stylized Stage II specimen (3102-500-5) is made on a wide, very thin flake blank, with fine pressure flake

Figure 12. Selected small bifaces; Triangular (a-b), Square-based (c), Elongate (d), Lanceolate (e), Constricting End (f), Ovoid (g-h), and Leaf-shaped (i-j).

a. 26Ek3160, specimen 523-1
b. 26Ek3160, specimen 500-161
c. 26Ek3160, specimen 500-226
d. 26Ek3160, specimen 517-11 and 12 (refitted)
e. 26Ek3237, specimen 500-42
f. 26Ek3095, specimen 500-14
g. 26Ek3204, specimen 500-63
h. 26Ek3271, specimen 500-131
i. 26Ek3271, specimen 1021-3
j. 26Ek3160, specimens 500-137 and 140 (refitted)


a.
b.
c.
d.
e.
f.
g.
h.
i.
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5
cm

scars along both lateral margins. The proximal end, though partially obscured by a break, has been modified to create a concave base.

Square based bifaces (n=9, 1.6%) are a slight variation of triangular bifaces. They exhibit flat bases with expanding lateral margins. All specimens are proximal fragments (Figure 12c).

Ovoid/round (n=33, 5.9%) specimens are primarily early stage bifaces and may be reduced cores or have been discarded as failures as they tend to be thick in cross-section (Figure 12g, h). Most have percussion flake scars ending in hinge fractures and have been utilized as scrapers, as demonstrated by unifacial edge wear on a strong, steep edge. One late stage specimen (26Ek3184-500-7) is thin in cross-section and has been resharpened and heavily used. Several discreet edge units on this tool are rounded and glossy with polish.

Constricting end bifaces (n= 14, 2.5%) exhibit the common characteristic of intentional narrowing of a terminal end (Figure 12f). These may be haft elements, though microscopic examination revealed no evidence of edge wear or hafting. They are utilized primarily as scrapers, and may be resharpened distal ends of hafted bifaces.

Flake Tools

A total of 514 artifacts from the Tosawihi assemblages are classified as flake tools. This general category consists of tools made on flakes, with limited shaping. When bifacial or unifacial shaping is present, it usually has been applied to create a particular type of edge or outline rather than as a means of thinning. Thus, flake tools range from utilized flakes without modification to specialized tools such as end scrapers, drills, and backed knives. However, Table 14 shows that only 16.7% of flake tools are simple utilized flakes without purposeful modification. The Tosawihi collection includes 39 reworked and utilized bifaces that have functional similarities with flake tools as defined above. Because biface analysis focuses on reduction stage, with little emphasis on use wear, these utilized bifacial artifacts are characterized by functional class and technological approach along with flake tools in Table 14.

Table 14. Comparison of Functional Class by Technological Approach.

	Unmodified Flake		Modified Flake		Uniface		Biface		Indeterminate		Other		
	n	%	n	%	n	%	n	%	n	%	n	%	Total
Scraper	55	18.3	206	68.4	6	2.0	15	.5	21	6.7	10	3.3	313
End Scraper	0	0	32	91.4	0	0	2	5.7	0	0	1	2.9	35
Knife	6	35.3	10	58.8	0	0	0	0	0	0	0	5.9	17
Graver	2	9.5	16	76.2	0	0	2	9.5	1	4.8	0	0	21
Perforator	0	0	24	54.6	0	0	17	38.6	3	6.8	0	0	44
Concave EU	0	0	10	100.0	0	0	0	0	0	0	0	0	10
Mutipurpose	22	40.7	31	57.4	0	0	1	1.9	0	0	0	0	54
Indeterminate	1	5.5	7	38.8			2	11.1	8	44.4	0	0	18
Other	0		2	100.0									2
Total	86	16.7	338	65.7	6	1.2	39	7.6	33	4.0	12	2.3	514

The method used for identification of use wear on tools first was developed by Knudson (1973) and defines an area of use, or employable unit as:

> ...that implement segment or portion (continuous edge or projection) deemed appropriate for use in performing a specific task, e.g. cutting, scraping, perforating, drilling, chopping. The unit is identified by deliberate retouch and/or apparent post production utilization modification, and its boundaries are defined subject to the analyst's concept of habitual use.

In the present analysis, a modified definition of EU, as employed by Elston, Davis, and Townsend (1976:27), is applied. Elston and his associates use EU as an Edge Unit which is "a segment of an edge which has been used, as demonstrated by the presence of obvious damage flake scars, polish or edge rounding." Zeier and Elston (1986:176) elaborate "... in that edges exhibiting modification without use wear are excluded (e.g. retouch, platform preparation). Further, EUs must show evidence of human use in the form of edge damage."

The present analysis was restricted, for the most part, to macroscopic observations and is considered to be preliminary. Functional assignments of EU(s), based on shape, location, and gross wear patterns (if any), include Scraper, End Scraper, Knife, Graver, Perforator, Spokeshave, Multipurpose, Indeterminate, and Other.

Table 15 gives the number of formed and resharpened EUs by functional class. Formed EUs are those created by flaking, while resharpening occurs after the EU has been utilized.

Table 15. Frequency of Formed and Resharpened EUs by Functional Class.

	Formed		Resharpened		
	n	%	n	%	Mean EUs
Scraper	253	81.1	9	2.9	1.93
End Scraper	35	100.0	3	8.6	3.62*
Knife	11	64.7			1.66
Graver	18	85.7			2.67
Perforator	44	100.0			2.27
Spokeshave	10	100.0			1.61
Multipurpose	32	59.2	1	1.9	2.70
Indeterminate	12	80.0			2.61
Other	2	100.0			

* This high value reflects hafting wear and damage on proximal lateral margins.

Raw material of flake tools is predominately local opalite (n=468, 91%), with 49.4% (n=231) showing evidence of thermal alteration. Frequencies of functional class by material type are given in Table 16.

Table 16. Frequency of Functional Class by Material Type.

	Opalite		Obsidian		Basalt		Exotic CCS		
	n	%	n	%	n	%	n	%	Total
Scraper	287	91.7	19	6.0	4	1.3	3	1.0	313
End Scraper	35	100.0	0		0		0		35
Knife	17	100.0	0		0		0		17
Graver	17	81.0	4	19.0	0		0		21
Perforator	41	93.2	3	6.8	0		0		44
Spokeshave	9	90.0	1	10.0	0		0		10
Multipurpose	45	83.3	9	16.7	0		0		54
Indeterminate	15	83.3	3	16.7	0		0		18
Other	2	100.0	0		0		0		2
Total	468						514		

Scrapers

Three hundred thirteen specimens are categorized as scrapers, representing a wide variety of flake type and sizes (Figure 13a-c). They tend to be unshaped, with appearance in planview determined by original flake shape, regardless of modification. When modified (retouched) prior to use, the result is a more substantial, steeper edge. Use wear, when present is unifacial and perpendicular to the edge.

End Scrapers

Thirty five artifacts fall into this class of more highly stylized tools. End scrapers are characterized by plano-convex cross-section and steep, unifacially modified EU which is commonly the distal termination of a flake (Figure 13d-g). The scraper edge is convex in planview, with modification (retouch) limited to the dorsal surface. In many cases, the flake has a slight longitudinal curvature and is distally expanding, with maximum thickness below the midsection. This flake type has lateral margins that constrict toward the platform. Hafting is suggested by frequent edge wear or damage on the proximal lateral margins. Several specimens made on large, thick flake blanks are quite hefty, and have been heavily utilized as evident in rounded, crushed EUs. Specimen 26Ek3173-2001-1 is unique in that it is a modified opalite cobble fragment, severely battered on two edges in addition to having been utilized as a scraper.

Knives

Seventeen artifacts are categorized as knives. These are small to medium size flakes, and, when retouched, the modification is limited to discreet edges with no significant alteration of the original flake shape. Use wear is generally bifacial, at an oblique angle to the edge.

Gravers

A total of 21 artifacts are gravers, or tools used to engrave or incise soft material such as wood or bone Figure 14a-c). Many of these are flakes with a pronounced longitudinal dorsal ridge and slight ventral curvature, modified on the margins to produce a stout, short unifacial projection. There is little or no retouch on the ventral surface.

Perforators

Forty-four artifacts are perforators, tools used to produce holes; drills and awls are not distinguished from this class. Perforators include a wide variety of forms, from simple flake tools to finely retouched bifaces (Figure 14d-k). They range from the classic shape (a wide proximal end with a drastic constriction near the distal end which produces the bit) to a delicate, lanceolate form. Bits vary from thick and triangular, to thin and lenticular in cross section. One unusually large specimen (26Ek3095-519-1, Figure 14g) is a reworked, Stage III quarry biface. Specimen 26Ek3271-500-263 is unique in that it is an end or lateral edge fragment of a quarry biface, reworked on the truncation to produce a very thick, triangular puncturing tool.

Figure 13. Selected Scrapers (a-c), and End Scrapers (d-g).

a. 26Ek3095, specimen 2022-11
b. 26Ek3237, specimen 500-14
c. 26Ek3160, specimen 2041-2
d. 26Ek3192, specimen 502-35
e. 26Ek3184, specimen 518-2
f. 26Ek3171, specimen 506-2
g. 26Ek3095, specimen 500-27

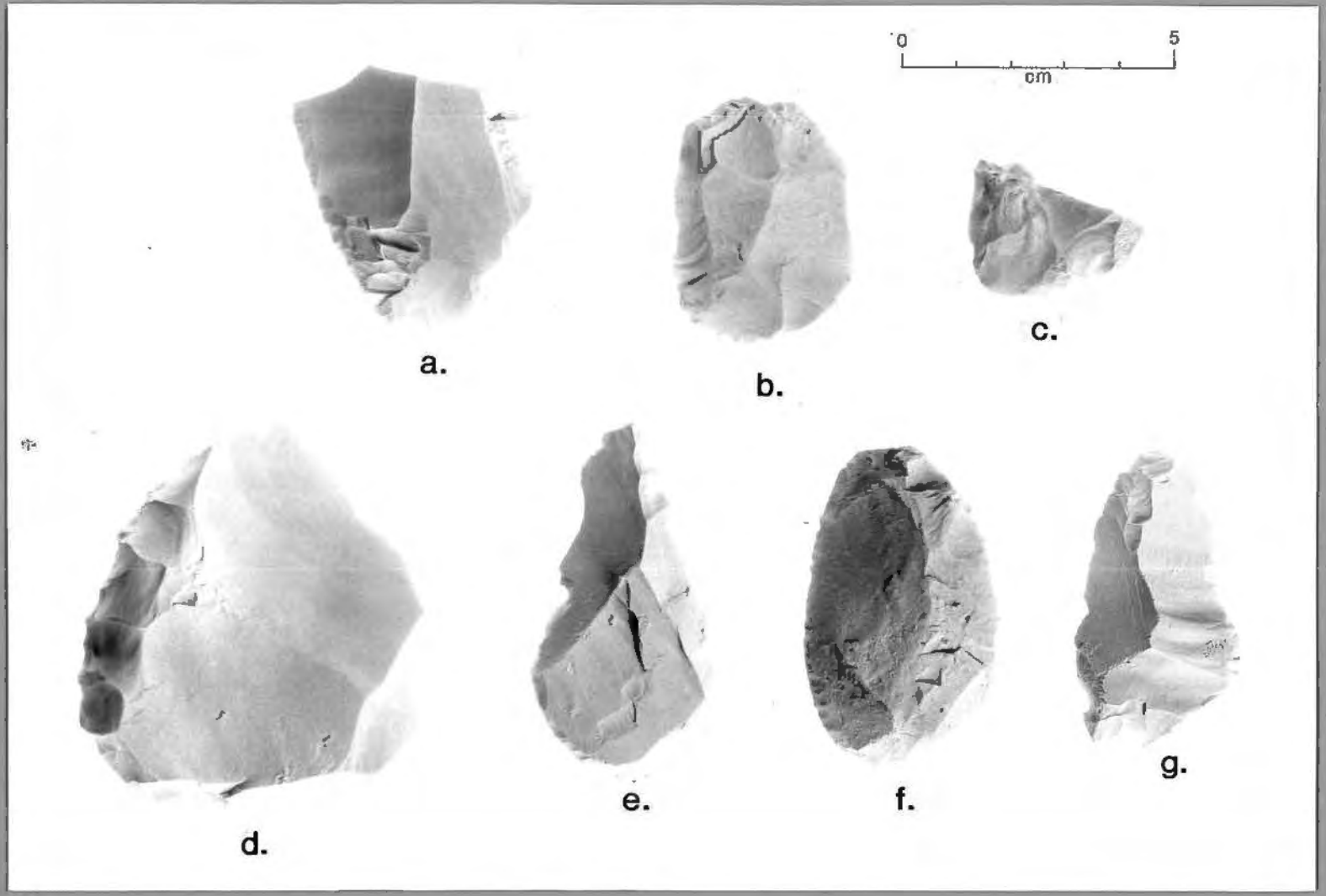
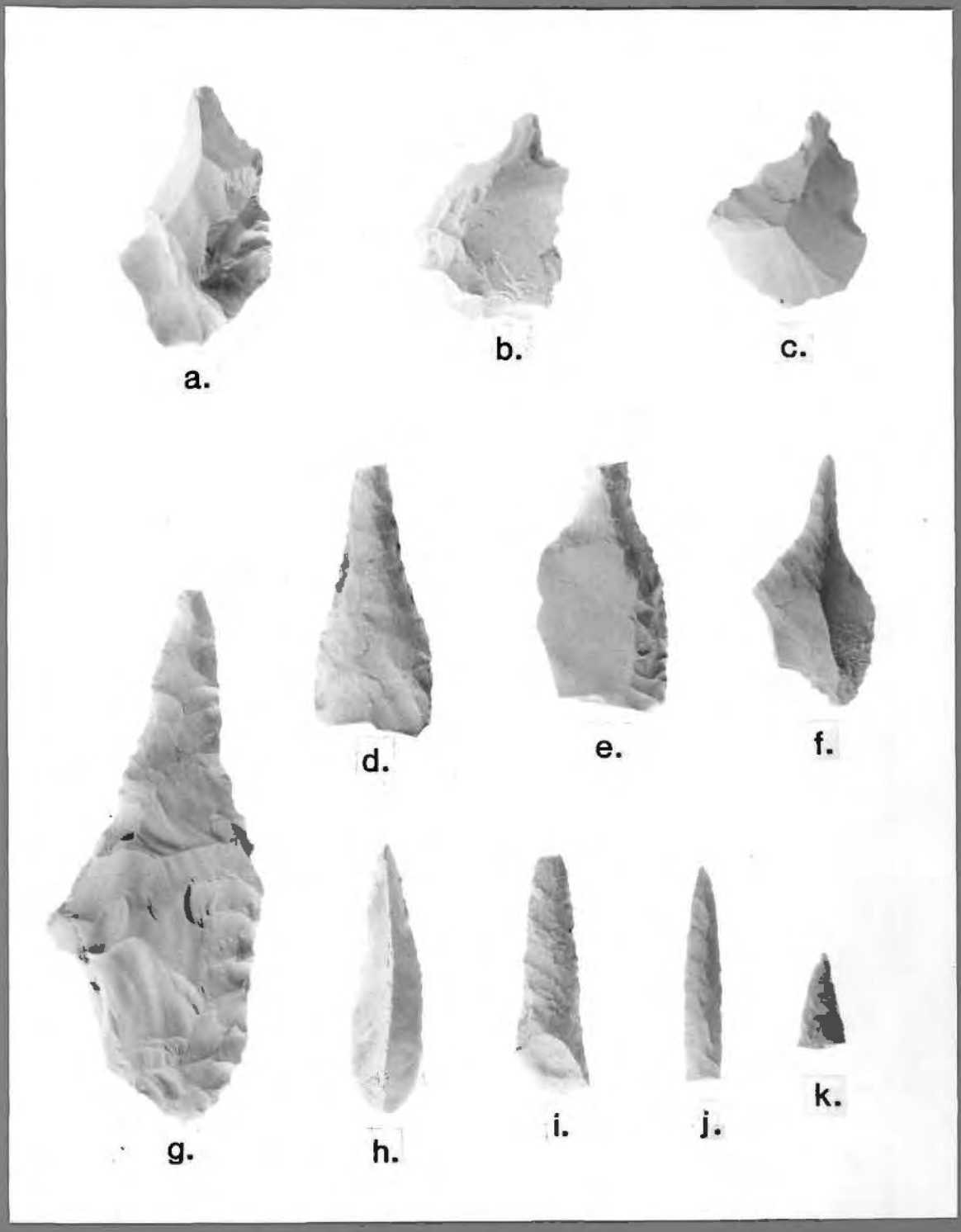

0
5
cm
a.
b.
c.
d.
e.
f.
g.

Figure 14. Selected Gravers (a-c) and Perforators (d-k).

a. 26Ek3149, specimen 1001-1
b. 26Ek3116, specimen 1006-4
c. 26Ek3271, specimen 1038-5
d. 26Ek3170, specimen 500-20
e. 26Ek3160, specimen 512-12
f. 26Ek3160, specimen 500-128
g. 26Ek3095, specimen 519-1
h. 26Ek3095, specimen 1043-5
i. 26Ek3192, specimen 1022-3
j. 26Ek3095, specimen 510-11
k. 26Ek3198, specimen 1017-5


a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
0
5
cm

Spokeshave

Ten tools are characterized by a wide notch, or concave EU(s). These EUs are steep, and exhibit unifacial retouch and utilization, with crushing on the extreme edge indicating use as scraping tools. Flake shape and size is variable; none of the specimens has been shaped or stylized, though several have cutting and scraping EUs in addition to the concave EUs.

Multipurpose Flake Tool

These 54 artifacts represent a combination of scrapers and cutting tools, or knives. Nearly half (44.4%) are fragments with no assignment to technological class. The remainder are primarily modified, medium to large flakes.

Indeterminate

Eighteen fragments of flake tools retain no diagnostic characteristics.

Other Flake Tools

Two artifacts are not assigned to functional class as they show no sign of use wear. Both are minimally shaped, with pressure retouch on the edges.

Chapter 4. PROJECTILE POINTS

by Michael P. Drews

Projectile points have proven accurate temporal indicators in the western and central Great Basin (Heizer and Baumhoff 1961; Heizer and Hester 1978; O'Connell 1967; Clewlow 1967; Thomas 1971, 1981). Here, 237 artifacts recovered during testing are discussed as projectile points; 111 of these are classifiable as to type, 61 are fragmentary, and 104 are projectile point preforms.

Typological criteria and temporal constraints employed in the present analysis follow those outlined by Thomas (1981). In this system, projectile point types are defined through a series of morphological observations including length, width, thickness, weight, basal width, and notch angles. In addition to Thomas's parameters, notations are also made concerning completeness and reworking or resharpening. For analytical purposes, reworking is defined as post production modification directed toward repair of a broken margin, while resharpening relates to edge maintenance. Both forms of modification can be identified by a change in flaking pattern, notch execution, or outline.

Phase names and chronological sequences throughout this section refer to the regional chronology for the Upper Humboldt Valley based upon stratified radiocarbon dated deposits at James Creek Shelter (Elston and Budy 1990).

Table 17 provides provenience, and typological data, and attributes of 111 typed projectile points. Thomas's key (1981), addresses six of the seven temporal classifications appearing below. Chronological and morphological attributes for Great Basin Stemmed Series follow Layton (1979), Clewlow (1968), and Frison (1978).

Great Basin Stemmed Series

The Great Basin Stemmed series combines variants of Cougar Mountain and Lake Parman types into a contemporaneous series (Layton 1979). They are long shouldered forms with square to contracting bases. Edge grinding along stem and basal margins is a common and diagnostic trait. Points in this series usually are associated with pluvial lakes in the Great Basin (Bedwell 1973; Butler 1970; Clewlow 1968; Tuohy 1969; 1970). They date between 8000 and 6000 B.C. the Dry Gulch Phase.

Of seven points of this type recovered, two are basalt and five are obsidian. All are basal fragments broken well below the shoulder, and all exhibit extensive grinding along stem

Table 17. Attributes of Typed Projectile Points.

SPECIMEN NO.	REF. NO.	AREA	UNIT	LEVEL	DEPTH	FEA.	TYPE	MAT'L	CON-DITION	Lt	La	Lm	Wm	Wb	NECK WIDTH	THICK	WT	EST. WT.	DSA	PSA	NOI	La/ Lt	Lt/ Wm	Wb/ Wm	Lm/ Lt	RE-WORK	RE-SHARP
26EK3095	509-5	1	NA	NA	NA	SF9	CT	OBS	COM	23.0	23.0	8.0	15.5	15.1		3.4	1.5	1.5				1.00	1.48	0.97	0.35	NO	NO
26EK3160	500-326	1	NA	NA	NA	NA	CT	OBS	INC	24.9	24.9	0.0	17.8	17.8		4.0	1.0	1.2				1.00	1.39	1.00	0.00	NO	NO
26EK3170	2002-1	2	EU1	2	10-20	NA	CT	OBS	COM	21.2	20.1	0.0	16.3	16.3		2.7	0.8	0.8				0.94	1.30	1.00	0.00	YES	NO
26EK3198	1018-1	2	18	1	0-2	SF1	CT	OBS	INC	26.0	25.5	0.0	14.7	14.7		2.8	0.7	0.7				0.98	1.77	1.00	0.00	NO	NO
26EK3198	1025-1	2	25	1	0-2	SF1	CT	OBS	COM	26.7	26.0	0.0	13.5	12.8		3.1	0.9	0.9				0.97	1.97	0.94	0.00	NO	NO
GRID	2672-1	2	DSC1	NA	NA	N-14	CT	OBS	INC	25.1	25.1	4.1	12.8	12.4		2.9	0.6	0.8				1.00	1.96	0.96	0.16	NO	NO
26EK3095	514-1	1	NA	NA	NA	IF14	CT	OPL	INC	17.7	14.9	14.7	9.5	9.5		2.4	0.3	0.4				0.84	1.86	1.00	0.17	NO	NO
26EK3106	2001-4	1	EU1	1	2-10	1	CT	OPL	COM	16.8	15.2	0.0	11.8	11.8		3.0	0.5	0.5				0.90	1.42	1.00	0.00	YES	NO
26EK3160	1003-9	1	NA	NA	NA	NA	CT	OPL	COM	29.8	29.0	7.9	14.8	13.6		2.5	1.1	1.1				0.97	2.01	0.91	0.26	NO	NO
26EK3184	503-28	2	NA	NA	NA	IF3	CT	OPL	INC	29.7	29.7	3.7	15.7	15.7		3.1	1.2	1.3				1.00	1.89	1.00	0.12	NO	NO
26EK3185	1003-2	2	NA	NA	NA	SF1	CT	OPL	INC	29.0	29.0	7.6	15.9	15.9		2.3	1.4	1.4				1.00	1.82	1.00	0.26	NO	NO
26EK3192	2067-1	2	*EU4*	7	60-70	*SF2*	CT	OPL	INC	28.4	27.7	8.3	17.1	15.8		2.5	1.2	1.8				0.98	1.66	0.92	0.29	NO	NO
26EK3198	1017-1	2	17	1	0-2	SF1	CT	OPL	COM	24.5	23.6	4.6	14.2	14.2		2.4	0.7	0.7				0.96	1.73	1.00	0.19	NO	NO
26EK3198	1018-4	2	18	1	0-2	SF1	CT	OPL	INC	30.0	29.3	0.0	16.0	16.0		2.3	0.7	1.2				0.98	1.88	1.00	0.00	NO	NO
26EK3251	500-19	3	NA	NA	NA	NA	CT	OPL	INC	26.1	26.1	0.0	17.7	17.7		3.2	1.2	1.2				1.00	1.48	1.00	0.00	NO	NO
26EK3251 16	1003-1	3	NA	NA	NA	3	CT	OPL	INC	26.5	26.5	3.5	18.3	18.3		3.2	1.1	1.3				1.00	1.45	1.00	0.13	NO	NO
26EK3095	2023-1	1	EU2	3	20-30	19	DSN	CHA	INC	31.2	27.6		12.4	12.3	6.9	2.4	0.7	0.9	185	182	3	0.88	2.53	1.00		NO	NO
26EK3171	505-2	2	NA	NA	NA	IF5	DSN	CHA	INC	31.2	26.9		15.0	15.0	5.6	3.1	0.8	1.0	204	175	29	0.86	2.08	1.00		NO	NO
26EK3116	1002-1	1	NA	NA	NA	1	DSN	OBS	INC	24.3	21.8		14.7	14.7	9.5	3.0	0.4	1.0	202	159	43	0.89	1.65	1.00		NO	NO
26EK3160	1003-4	1	NA	NA	NA	NA	DSN	OBS	INC	21.6	19.6		10.8	10.8	7.8	2.3	0.2	0.6	201	171	30	0.90	2.00	1.00		NO	NO
26EK3178	502-1	2	NA	NA	NA	IF2	DSN	OBS	INC	15.4	13.7		10.6	10.6	6.1	2.9	0.4	0.4	214	168	46	0.89	1.45	1.00		YES	NO
26EK3192	2061-6	2	EU4	1	0-10	SF2	DSN	OBS	INC	19.1	17.8		13.8	13.8	9.2	3.1	0.7	0.8	254	153	101	0.93	1.38	1.00		NO	NO
26EK3192	502-8	2	NA	NA	NA	IF2	DSN	OBS	INC	22.9	18.8		13.7	13.7	7.8	3.8	0.6	1.1		163		0.82	1.67	1.00		NO	NO
26EK3198	1016-1	2	16	1	0-2	SF1	DSN	OBS	COM	21.4	17.4		14.2	14.2	8.5	2.9	0.7	0.7	210	181	29	0.81	1.51	1.00		NO	NO
26EK3198	508-1	2	NA	NA	NA	IF8	DSN	OBS	INC	32.0	29.6		11.8	11.8	6.0	2.4	0.5	0.7	186	181	5	0.93	2.71	1.00		NO	NO
26EK3271	522-1	2	NA	NA	NA	IF22	DSN	OBS	INC	16.5	13.6		13.3	13.3	7.0	2.5	0.3	0.7	241	164	77	0.82	1.24	1.00		NO	YES
26EK3092	500-2		NA	NA	NA	NA	DSN	OBS	INC	32.0	29.7		14.9	14.9	7.4	3.4	1.0	1.4	180	180	0	0.92	2.14	1.00		NO	NO
26EK3092	2024-2	1	EU2	4	30-40	T1	DSN	OPL	COM	23.5	21.1		13.8	13.8	7.2	2.8	0.7	0.8	204	186	18	0.89	1.70	1.00		NO	YES
26EK3092	2042-14	1	EU3	2	10-20	T3	DSN	OPL	INC	25.1	19.7		12.3	12.3	5.9	2.0	0.2	0.9	179	174	5	0.78	2.04	1.00		NO	NO
26EK3095	510-38	1	NA	NA	NA	SF10	DSN	OPL	COM	23.4	20.5		11.7	11.7	6.2	2.6	0.5	0.5	182	168	14	0.87	2.00	1.00		NO	NO
26EK3114	1010-1	1	NA	NA	NA	1	DSN	OPL	INC	8.0	17.3		12.8	12.8	9.5	2.3	0.5	0.6	225	144	81	0.92	1.46	1.00		YES	NO
26EK3116	1007-1	1	NA	NA	NA	1	DSN	OPL	INC	21.3	19.1		12.7	12.7	7.5	2.5	0.5	0.8	191	179	12	0.89	1.67	1.00		NO	YES
26EK3160	1002-3	1	NA	NA	NA	NA	DSN	OPL	INC	21.5	18.7		13.4	13.4	9.5	2.5	0.4	0.5	206	163	43	0.86	1.60	1.00	0.00	NO	NO
26EK3160	1005-7	1	NA	NA	NA	NA	DSN	OPL	INC	23.4	19.4		13.6	13.6	9.3	2.0	0.2	0.5	191	135	56	0.82	1.72	1.00		NO	NO
26EK3271	500-87	1	NA	NA	NA	NA	DSN	OPL	COM	25.2	22.2		12.0	12.0	7.2	2.8	0.7	0.7	182	178	4	1.14	2.10	1.00		NO	NO
26EK3170	2001-1	2	EU1	1	2-10	NA	DSN	OPL	INC	28.3	25.6		15.9	15.9	10.0	2.6	1.2	1.3	169	166	4	0.90	1.78	1.00		NO	NO
26EK3170	2001-6	2	EU1	1	2-10	NA	DSN	OPL	INC	30.8	28.1		13.2	12.4	8.7	2.5	0.6	1.2	163	155	8	0.91	2.33	0.93		NO	NO
26EK3178	501-7	2	NA	NA	NA	1	DSN	OPL	INC	30.0	26.1		16.4	16.4	7.4	2.8	0.9	1.2	178	178	0	0.87	1.83	1.00		NO	NO
26EK3185	1015-1	2	NA	NA	NA	SF1	DSN	OPL	INC	27.8	24.6		13.4	13.4	6.7	2.8	0.6	1.0	182	164	17	0.88	2.10	1.00		NO	NO
26EK3185	1004-2	2	NA	NA	NA	SF1	DSN	OPL	INC	32.9	28.6		16.8	16.8	7.2	3.3	1.2	1.3	207	169	38	0.87	1.96	1.00		NO	NO
26EK3190	1003-1	2	NA	NA	NA	SF1	DSN	OPL	INC	25.9	22.8		14.2	14.2	5.3	3.2	0.5	1.0		150		0.88	1.82	1.00		NO	NO
26EK3190	508-2	2	NA	NA	NA	IF8	DSN	OPL	INC	27.8	24.8		11.8	11.8	6.4	2.4	0.5	0.8	191	183	8	0.89	2.34	1.00		NO	NO
26EK3192	1054-1	2	14	1	0-2	SF2	DSN	OPL	INC	26.0	24.8		12.4		8.3	2.7	0.6	0.8	194	160	34	0.95	2.10			YES	NO
26EK3198	503-7	2	NA	NA	NA	IF3	DSN	OPL	COM	28.3	24.9		12.6	12.6	7.0	3.0	0.9	0.9	178	163	15	0.88	2.25	1.00		NO	NO
26EK3251 29	500-27	3	NA	NA	NA	NA	DSN	OPL	INC	24.8	21.5		12.4	12.4	5.5	2.1	0.4	0.6	188	171	17	0.87	2.00	1.00		NO	NO
26EK3271	513-4	2	NA	NA	NA	IF13	RSG	CHA	INC	34.1	34.1		19.5	7.3	5.6	3.4	1.3	1.6	130	105	25	1.00	1.75	0.37		NO	YES
26EK3095	519-12	1	NA	NA	NA	IF19	RSG	OBS	INC	22.6	20.9		12.5	9.2	7.4	3.0	0.6	0.7	190	117	73	0.92	1.80	0.73		YES	NO
26EK3271	1046-5	2	NA	NA	NA	SF12	RSG	OBS	INC	28.5	28.5		14.6	9.8	8.2	2.6	0.7	1.2	123	111	12	1.00	1.95	0.67		NO	NO
26EK3271	500-191	2	NA	NA	NA	NA	RSG	OBS	INC	35.0	35.0		21.4	8.7	10.5	4.0	1.7	1.8	158	110	48	1.00	1.64	0.41		YES	NO
26EK3239	500-1	3	NA	NA	NA	NA	RSG	OBS	INC	26.3	26.1		11.5	5.8	5.5	2.8	0.7	0.9	174	109	65	0.99	2.28	0.50		NO	NO
26EK3095	500-45	1	NA	NA	NA	NA	RSG	OPL	INC	26.6	26.6		17.0	7.5	5.6	2.8	0.7	1.3	129	124	5	1.00	1.56	0.44		NO	NO
26EK3102	500-10	1	NA	NA	NA	NA	RSG	OPL	INC	25.3	25.3		11.8	6.5	5.7	3.4	0.9	1.0	146	98	48	1.00	2.14	0.55		NO	YES
26EK3160	1009-2	1	NA	NA	NA	NA	RSG	OPL	COM	20.8	20.8		11.1	6.8	3.9	2.3	0.4	0.4	130	115	15	1.00	1.87	0.61		NO	NO
26EK3160	517-1	1	NA	NA	NA	NA	RSG	OPL	COM	26.8	26.8		15.5	5.3	4.7	3.2	1.3	1.3	126	105	21	1.00	1.72	0.34		NO	NO
26EK3160	500-103	1	NA	NA	NA	NA	RSG	OPL	INC	37.4	37.4		14.5	6.4	4.2	3.7	1.2	1.5	139	118	21	1.00	2.57	0.44		NO	YES
26EK3160	500-310	1	NA	NA	NA	NA	RSG	OPL	INC	38.6	38.6		15.0	7.0	6.5	3.4	1.6	7.0	137	110	27	1.00	2.57	0.46		NO	NO
26EK3160	500-259	1	NA	NA	NA	NA	RSG	OPL	INC	41.3	41.3		12.6	6.4	4.7	3.2	1.4	1.7	120	104	16	1.00	3.27	0.50		NO	YES
26EK3271	500-138	1	NA	NA	NA	NA	RSG	OPL	INC	28.9	28.9		19.8	8.8	6.4	3.7	1.3	1.7	135	118	17	1.00	1.46	0.44		NO	YES
26EK3204	2002-1	2	EU1	2	10-20	SF1	RSG	OPL	INC	35.7	35.7		14.7	6.4	5.0	3.1	1.3	1.4	140	112	28	1.00	2.43	1.00		NO	NO
26EK3271	500-146	2	NA	NA	NA	NA	RSG	OPL	COM	20.9	20.9		10.0	8.0	6.7	3.0	0.5	0.5	151	125	26	1.00	2.09	0.80		YES	NO
26EK3271	500-301	2	NA	NA	NA	NA	RSG	OPL	INC	29.2	29.2		16.5	7.7	5.8	3.3	1.0	1.2	123	118	5	1.00	1.77	0.47		NO	YES
26EK3271	500-293	2	NA	NA	NA	NA	RSG	OPL	INC	32.7	32.7		12.9	10.0	7.9	3.7	1.1	1.3	152	112	40	1.00	2.53	0.78		NO	NO
26EK3271	1050-1	2	NA	NA	NA	SF12	RSG	OPL	INC	34.0	34.0		20.3	6.7	6.5	2.8	1.4	1.5	123	96	27	1.00	1.67	3.02		NO	NO
26EK3231	500-1	3	NA	NA	NA	NA	RSG	OPL	INC	29.5	29.5		19.0	7.9	7.6	3.7	1.3	1.6	133	104	29	1.00	1.55	0.41		YES	NO
26EK3237	1544-1	3	NA	NA	NA	DSC4	RSG	OPL	INC	31.5	31.5		14.3	7.9	6.9	3.3	1.2	1.5	159	98	61	1.00	2.20	0.55		NO	NO
26EK3237	500-56	3	NA	NA	NA	NA	RSG	OPL	INC	35.3	35.3		21.5	8.7	7.4	2.9	1.1	1.5	123	109	14	1.00	1.64	4.00		NO	YES
26EK3251 22	1022-3	3	NA	NA	NA	2	RSG	OPL	INC	29.5	29.5		13.3	8.2	5.0	2.4	0.7	1.3	158	115	43	1.00	2.21	0.61		NO	NO
26EK3239	500-5	3	NA	NA	NA	NA	ECN	OBS	INC	34.8	33.8		18.0	10.6	9.3	4.5	1.9	2.3	146	120	26	0.97	1.93	0.58		NO	NO
26EK3095	510-19	1	NA	NA	NA	SF10	ECN	OPL	INC	55.9	53.8		35.3	17.4	15.7	4.3	5.5	6.0	151	115	36	0.96	1.58	0.49		NO	NO
26EK3160	500-260	1	NA	NA	NA	NA	ECN	OPL	INC	42.8	42.8		21.6	12.0	9.6	3.9	2.8	3.0	139	110	29	1.00	1.00	0.55		NO	YES

Table 17, continued.

SPECIMEN NO.	REF. NO.	AREA	UNIT	LEVEL	DEPTH	FEA.	TYPE	MAT'L	CON-DITION	Lt	La	Lm	Wm	Wb	NECK WIDTH	THICK	WT	EST. WT.	DSA	PSA	NOI	La/ Lt	Lt/ Wm	Wb/ Wm	Lm/ Lt	RE-WORK	RE-SHARP
26EK3160	500-63	1	NA	NA	NA	NA	ECN	OPL	INC	53.6	53.6		17.7	13.7	10.7	5.5	4.2	5.0	167	110	57	1.00	3.02	0.77		YES	NO
26EK3160 5	500-26	1	NA	NA	NA	NA	ECN	OPL	INC	57.8	57.8		22.5	16.3	11.7	5.1	4.3	5.0	150	135	15	1.00	2.56	0.72		NO	NO
26EK3160	500-78	1	NA	NA	NA	NA	EE	OPL	INC	32.5	27.2		28.0	18.8	14.3	4.3	3.0	3.5	127	126	1	0.83	1.16	0.67		YES	YES
26EK3160	500-131	1	NA	NA	NA	NA	EE	OPL	INC	47.5	43.5		29.2	19.3	15.6	4.9	4.1	4.5	125	111	14	0.91	1.62	0.66		YES	NO
26EK3271 3	500-159	2	NA	NA	NA	NA	EE	OPL	INC	33.2	30.6		21.4	12.6		4.2	1.7	2.1	160	136	30	0.92	1.54	0.59		NO	NO
26EK3092	2009-2	1	EU1	9	80-90	T2	GSS	OBS	INC	43.4	42.0		21.7	10.7	11.2	4.7	3.0	4.0	190	95	95	0.96	2.00	0.50		YES	NO
26EK3095	516-10	1	NA	NA	NA	IF16	GSS	OPL	INC	51.3	49.5		21.8	11.5	11.5	4.7	3.2	4.0	179	93	86	0.96	2.35	1.00		YES	NO
26EK3095	500-8	1	NA	NA	NA	NA	GSS	OPL	INC	65.1	59.6		20.0	11.4	11.3	4.9	4.5	5.0	198	95	74	0.91	3.25	0.57		NO	YES
26EK3160	500-308	1	NA	NA	NA	NA	GSS	OPL	INC	55.4	52.4		24.2	17.5	15.2	4.5	3.4	7.0	169	96	73	0.94	2.28	0.72		NO	NO
26EK3198	500-4	2	NA	NA	NA	NA	GSS	OPL	INC	7.0	50.3		24.3	11.4	10.4	5.9	4.5	5.1	155	98	57	0.91	2.25	0.20		NO	YES
26EK3237	500-74	3	NA	NA	NA	NA	GSS	OPL	INC	53.7	49.7		23.7	11.0	13.2	5.8	6.0	6.2	184	97	87	0.92	2.26	0.46		NO	NO
26EK3238 7	500-1	3	NA	NA	NA	NA	GSS	OPL	INC	52.7	49.6		25.5	11.8		6.1	6.7		195	94	101	0.94	2.06	0.46		YES	NO
26EK3116	2500-1	1	NA	NA	NA	NA	HS	OBS	INC	42.4	38.1	10.4	17.9	15.7		5.3	3.7	3.9				0.90	2.36	0.87	0.25	NO	YES
26EK3160	500-267	1	NA	NA	NA	NA	HS	OPL	INC	49.6	47.6	20.9	18.8	15.9		5.2	4.3	4.8				0.95	2.63	0.84	0.42	NO	NO
26EK3192	2203-2	2	EU11	3	20-30	SF1	HS	OPL	INC	27.3	26.7	17.9	18.4	13.6		5.3	2.8	4.0				0.97	1.48	0.73	0.65	YES	NO
26EK3198 4	1012-4	2	12	1	0-2	SF1	HS	OPL	INC	51.6	49.4	18.8	23.3	20.3		3.2	1.3	4.5				0.95	2.21	0.87	0.36	NO	NO
26EK3093	505-4	1	NA	NA	NA	IF5	LSN	OPL	COM	41.4	38.3		15.5	15.5	6.6	3.1	15.5	15.5	172	177	5	0.92	2.67	1.00		NO	NO
26EK3184	524-2	2	NA	NA	NA	IF24	LSN	OPL	INC	49.3	46.6		24.9	24.9	11.8	3.7	3.5	5.0	202	182	20	0.94	1.97	1.00		NO	NO
26EK3271	500-270	2	NA	NA	NA	NA	LSN	OPL	COM	34.7	31.2		19.3	17.6	10.1	4.4	3.2	3.2	165	165	0	0.89	1.80	0.91		YES	NO
26EK3237	500-43	3	NA	NA	NA	NA	LSN	OPL	INC	31.4	31.0		17.0	17.0	7.9	4.2	1.3	1.5	189	184	5	0.98	1.84	1.00		NO	NO
26EK3238 5	500-37	3	NA	NA	NA	NA	LSN	OPL	INC	43.6	41.6		16.7	16.7	9.2	4.3	2.5	3.0	180	152	28	0.95	2.61	1.00		NO	NO
26EK3107	500-2	1	NA	NA	NA	NA	STM	BAS	INC	52.3			18.8			7.4*											
26EK3192	502-20	2	NA	NA	NA	SF2	STN	BAS	INC	28.2			25.1			6.6	6.1									NO	NO
26EK3170	500-31	2	NA	NA	NA	NA	STM	OBS	INC	25.3			21.5			8.0	4.1										
26EK3170	500-67	2	NA	NA	NA	NA	STM	OBS	INC	25.4			23.1			7.1	3.9									YES	NO
26EK3237	500-21	3	NA	NA	NA	NA	STM	OBS	INC	20.2			17.3			8.5	3.4										
26EK3238	500-25	3	NA	NA	NA	NA	STM	OBS	INC	22.5			21.3			7.8	4.3										
26EK3238 7	500-23	3	NA	NA	NA	NA	STM	OBS	INC	25.3			19.3			7.9	4.0										
26EK3106	2002-1	1	EU1	2	10-20	1	OO	CHA	COM	16.3	14.2	1.4	9.4	9.4	6.8	3.0	0.4	0.4	252	120	132	0.87	1.73	1.00	0.09	YES	NO
26EK3092	2500-1	1	NA	NA	NA	T1	OO	OBS	INC	24.4	223.2		10.0	9.8	7.0	3.0	6+	0.7	225	111	114	0.95	2.44	0.98		YES	NO
26EK3095	510-46	1	NA	NA	NA	SF10	OO	OBS	INC	18.8	18.8		9.5	9.5	6.8	3.8	0.6	0.8	183	116	67	1.00	0.37	1.00		NO	NO
26EK3171	504-7	2	NA	NA	NA	IF4	OO	OBS	INC	35.0	33.5	4.4	12.1	11.8		2.8	1.1	1.4				0.95	1.04	0.97	0.12	NO	NO
26EK3093	505-11	1	NA	NA	NA	IF5	OO	OPL	INC	38.0	37.2	0.0	17.1	17.1		2.8	1.5	1.5				0.98	2.22	1.00	0.00	NO	YES
26EK3095	510-44	1	NA	NA	NA	SF10	OO	OPL	INC	34.5	32.8	0.0	14.3	14.3		2.3	0.8	1.2				0.95	2.41	1.00	0.00	NO	NO
26EK3095	510-49	1	NA	NA	NA	SF10	OO	OPL	INC	37.7	36.8		20.0	17.3	13.1	5.4	4.3	4.4	195	128	67	0.97	1.88	0.88		YES	NO
26EK3160	520-2	1	NA	NA	NA	NA	OO	OPL	INC	27.6	25.0	0.0	17.7	17.7		4.0	2.2	2.3				0.90	1.55	1.00	0.00	YES	NO
26EK3160	500-2	1	NA	NA	NA	NA	OO	OPL	INC	46.9	41.9	0.0	20.2	20.2		4.3	3.0	3.2				0.89	2.32	1.00	0.00	NO	NO
26EK3177	2001-10	2	EU1	1	2-10	NA	OO	OPL	COM	16.1	16.1		10.2	5.9	7.0	3.5	0.1	0.1	228	75	53	1.00	1.58	0.58		YES	NO
26EK3177	2001-1	2	EU1	1	0-10	1	OO	OPL	COM	43.5	41.8		18.0	17.6	15.7	4.4	3.0	3.0	242	140	102	0.96	2.46	0.97		NO	NO
26EK3190	1004-5	2	NA	NA	NA	SF1	OO	OPL	INC	34.3	31.8		17.9	17.9		2.9	1.2	2.0				0.93	1.91	1.00	0.00	NO	NO
26EK3237 13	500-17	3	NA	NA	NA	NA	OO	OPL	INC	49.2	49.2		20.4	12.5	9.6	4.8	2.6	3.0	188	106	82	1.00	2.41	0.61		NO	YES
26EK3160	1062-1	1	NA	NA	NA	NA	UN	CHA	INC	31.8	30.5	9.1	14.7	14.7		4.2	2.0	2.3				0.95	2.16	1.00	0.29	YES	YES
26EK3160	500-97	1	NA	NA	NA	NA	UN	OBS	INC	18.1			12.0			3.3	0.5										
26EK3173	1010-1	2	10	NA	NA	SF10	UN	OBS	INC	19.2			15.0			3.2	1.0										
26EK3184	503-14	2	NA	NA	NA	IF3	UN	OBS	INC	20.8			13.8			3.1	0.7										
26EK3192	502-11	2	NA	NA	NA	IF2	UN	OBS	INC	14.0			19.5			2.8	0.6										
26EK3198	1017-3	2	17	1	0-2	SF1	UN	OBS	INC	8.2			10.0			2.5	0.2										
26EK3198	1018-3	2	18	1	0-2	SF1	UN	OBS	INC	26.4			16.8			3.7	1.4										
26EK3116	1010-1	1	NA	NA	NA	1	UN	OPL	INC	10.8			10.6			2.7	0.4										
26EK3160	500-242	1	NA	NA	NA	NA	UN	OPL	INC	24.6			17.1			5.2	2.3										
26EK3173	1011-1	2	11	NA	NA	SF1	UN	OPL	INC	20.8			14.0			2.2	0.5										
26EK3198	1014-4	2	14	1	0-2	SF1	UN	OPL	INC	14.5			7.3			1.7	0.2									NO	NO
26EK3271	500-203	2	NA	NA	NA	NA	UN	OPL	INC	23.0			11.8			3.0	0.6										
26EK3271	1045-2	2	25	0	S	SF12	UN	OPL	INC	25.9			17.1			4.8	2.2										
26EK3237 14	2081-3	3	3	1	0-10	NA	UN	OPL	INC	27.3	22.6	18.2	11.2	11.2		3.2	0.4	1.0				0.82	2.43	1.00	0.66	NO	NO

NOTE: UNTYPABLE specimens are basal point fragments that retain basal morphology but, nevertheless, cannot be typed.

Key:

Area 1 = USX-West
Area 2 = USX-East
Area 3 = North Access Corridor

Type
CT = Cottonwood Triangular
DSN = Desert Side-notched
RSG = Rosegate
ECN = Elko Corner-notched
EE = Elko Eared
GSS = Gatecliff Split Stem
HS = Humboldt Series
LSN = Large Side-notched
STM = Stemmed
OO = Out of Key
UN = Untypable

Material
OBS = Obsidian
OPL = Opalite
CHA = Chalcedony
BAS = Basalt

Condition
COM = Complete
INC = Incomplete

margins (Figure 15). Most appear to be contracting stem forms; two (Figure 15c, d) have square bases. While they bear some resemblance to the more rectangular bases of the Lake Parman type, their characteristics are more typical of square based Eden points. This point type has a similar age range to Stemmed Points, and is associated commonly with bison kill sites in the Great Plains (Frison 1978).

Large Side-notched Points

This broad category includes Northern Side-notched, Bitterroot Side-notched, Madeline Dunes Side-notched, Elko Side-notched, and Rose Spring Side-notched types (Gruhn 1961; Swanson 1966; Riddell 1960; O'Connell 1975; Clewlow 1968; Hester and Heizer 1973). They are triangular in form with straight, concave, or notched bases. Margins are notched along the side rather than at the corner. Few morphological distinctions are evident between types, leading Thomas (1981) to combine all into this broadly defined, temporally distinct series. Large Side-notched points pre-date A.D. 1300, and may occur as early as the No Name Phase (5000 B.C.).

Five Large Side-notched points were identified during analysis, two of which are complete specimens (Figure 16e,f). All are opalite; the tip of one (Figure 16f) has been reworked.

Humboldt Series

The Humboldt Series was defined by a surface assemblage at the Humboldt Lakebed Site by Heizer and Clewlow (1968). Humboldt points are lanceolate forms of variable size. Bases are slightly to deeply concave (Figure 15g, h). Morphological variability within the series renders it a relatively poor time marker in the Great Basin. Dating between 3000 B.C. and A.D. 700 (Thomas 1981), the series spans several chronological phases of the Upper Humboldt Valley cultural sequence.

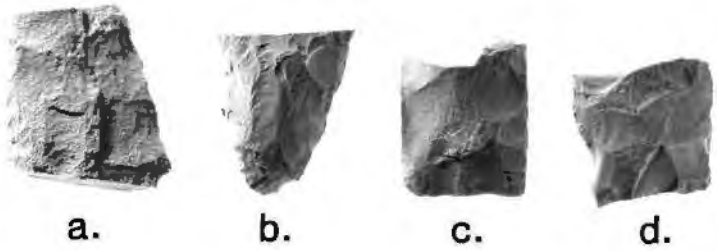
Four projectile point fragments, two from USX-East and two from USX-West were identified in the sample. One is obsidian and three are opalite. Two of the specimens appear to have been reworked or resharpened.

Gatecliff Series

Combined in the Gatecliff Series are a number of contracting and split stem forms previously identified as "Elko Contracting Stem" (Heizer and Baumhoff 1961), "Gypsum Cave" (Harrington 1933; Fowler, Madsen and Hattori 1973; Heizer and Berger 1970), and "Pinto Points" (Clewlow 1967; Hester and Heizer 1978; Thomas 1971). On the basis of morphology, these

Figure 15. Projectile points, specimens a-m.

a. 3192-502-20
b. 3170-500-31
c. 3238-500-25
d. 3238-500-23
e. 3093-505-4
f. 3271-500-270
g. 3116-2500-1
h. 3160-500-267
i. 3095-500-8
j. 3238-500-1
k. 3160-500-26
l. 3160-500-260
m. 3160-520-131



a. b. c. d.



e. f. g. h.



i. j. k. l. m.

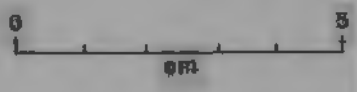
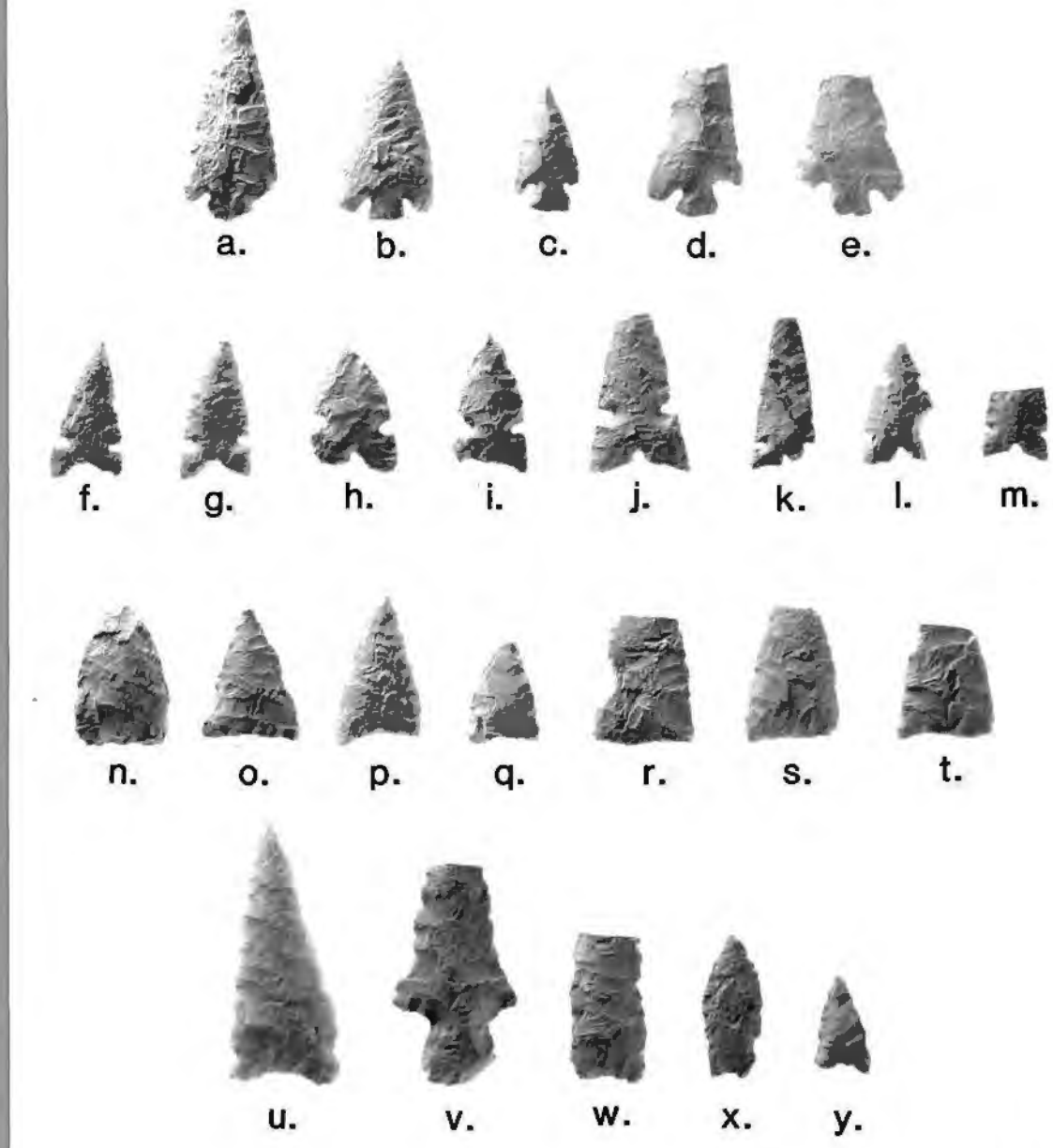
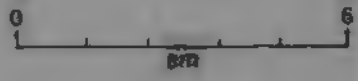


Figure 16. Projectile points, specimens a-y.

a. 3160-500-310
b. 3160-517-1
c. 3160-1009-2
d. 3160-500-103
e. 3271-513-11
f. 3095-510-38
g. 3271-500-87
h. 3198-1016-1
i. 3092-2024-2
j. 3185-1004-2
k. 3198-508-1
l. 3160-1002-3
m. 3160-1003-4
n. 3095-509-5
o. 3170-2002-1
p. 3198-101701
q. 3106-2002-4
r. 3184-503-28
s. 3198-1018-4
t. N-14 2672-1
u. 3177-7001-1
v. 3237-500-17
w. 3171-504-7
x. 3092-2500-1
y. 3106-2002-1


a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.
m.
n.
o.
p.
q.
r.
s.
t.
u.
v.
w.
x.
y.


0
6
cm

types are assigned to Gatecliff Split Stem (Pinto) or Gatecliff Contracting Stem (Elko Contracting Stem and Gypsum Cave) types (Thomas 1981). Gatecliff Series points are relatively large, triangular forms with sloping to deeply notched shoulders. Bases are parallel to contracting, and the split stem form is notched basally (Figure 16i,j). The Gatecliff Series is dated between 3000 B.C. and 1300 B.C. (Thomas 1981:22), falling within the latter part of the No Name Phase and most of the South Fork phase in the Upper Humboldt Valley cultural sequence.

Seven points, all Gatecliff Split Stem variants are present in the collection. One was manufactured from obsidian, while the remainder are opalite. Reworking or resharpening is evident on all but two of the points.

Elko Series

The Elko Series combines Elko Eared and Elko Corner-notched point styles into a single temporal type. They may be distinguished by a deeply notched (Elko Eared) or a relatively straight (Elko Corner-notched) base (Figure 16k-m). Flenniken and Raymond (1986) warn that reworking of Elko points often obscures typological boundaries. The type and its variants were defined previously by several researchers (Heizer and Baumhoff 1961; Heizer, Baumhoff and Clewlow 1968; Lanning 1963).

The utility of Elko points as time markers in the western Great Basin has been established firmly by O'Connell (1967). Occurring within the latter portion of the South Fork Phase and the entirety of the James Creek cultural phase, the series dates between 1300 B.C. and A.D. 700 (Thomas 1981).

Eight Elko Series points are present in the collection. Five are morphologically similar to Elko Corner-notched types and three are Elko Eared. Opalite is the most common material; only one point was made from obsidian. None of the Elko Series points is a complete specimen.

Rosegate Series

Within this series, Rose Spring and Eastgate projectile point styles are combined into a single contemporaneous type. Rose Spring Corner-notched points, named for the Rose Spring site in Owens Valley first were defined by Lanning (1963). Wagon Jack Shelter, near Eastgate, Nevada is the type locality for Eastgate points (Heizer and Baumhoff 1961). Both types are small, triangular forms with relatively deep corner notching (Figure 16a-e). Notches are generally finer and bases slightly expanding among Eastgate variants.

Thomas (1981) recognizes that the two types may be regionally differentiated, but remain temporally indistinct. Both types occur within a relatively short time span, dating between A.D.700 and A.D. 1300. Rosegate points are assigned to the Maggie Creek phase of the Upper Humboldt sequence.

Twenty-two points, only three of which are complete, key to the Rosegate Series. Opalite is the predominate material type (n=17); four points are obsidian and one is chalcedony. The margins of four Rosegate points are reworked and seven are resharpened.

Desert Series

Three coeval types, Desert Side-notched, Cottonwood Triangular, and Cottonwood Leaf-shaped, comprise the Desert Series. The types, although morphologically dissimilar, fall within the Eagle Rock phase of the Upper Humboldt cultural chronology and date from A.D. 1300 to the Historic Period (Thomas 1981).

Desert Side-notched points, originally defined by Baumhoff and Byrne (1959), are divided into four subtypes on the basis of basal treatment: General, Sierra, Delta, and Redding. They are distributed throughout southern and central California and the Great Basin. The Cottonwood variants have a similar spatial distribution and are named for the Cottonwood Site in Owens Valley, are described by Riddell (1951) and Lanning (1963).

Desert Side-notched points are small, triangular in outline, with a shallow notch high along each lateral margin. They can be distinguished from Large Side-notched types by weight (< 1.5 gms) and by acuteness of proximal shoulder angle (Figure 16f-m). Twenty-nine Desert Side-notched points appear in the collection. Eighteen are opalite, two are chalcedony, and nine are obsidian. Five are complete, three are reworked and two have been resharpened. One point (Figure 16l) has shallow notches at two locations along each lateral margin.

Cottonwood Triangular points are small (< 30mm long and 4mm thick) and triangular in outline. Notching is absent on lateral margins, and bases are straight to slightly concave (Figure 16n-t). Sixteen points from the collection are classified as Cottonwood Triangular. Of these, six are complete specimens; ten are made from opalite and six from obsidian. Two appear to be reworked. A broad notch along the margin of one point (Figure 16t) appears to have functioned as a spokeshave. No Cottonwood Leaf-shaped points were identified in the collection.

Other Projectile Points

In addition to the projectile points described above, 13 other specimens were manufactured or modified in a such a way that they fall out of Thomas's (1981) key. Of the 13 artifacts that slip through the key, five resemble Cottonwood Triangular forms (Table 18). Of these, four are rejected by the key due to excessive length (Figure 16w), and one by shallow notches on its reworked margins (Figure 16x). Similarly, reworking along margins and notches cause one probable Rosegate point and two probable Elko Series points to be rejected by the key (Figure 16v), and excessive basal width/maximum width ratios affect two probable Humboldt forms. Shallow side notching on two more points create anomalous Cottonwood/Desert Side-notched (Figure 16y) and Elko/Large Side-notched (Figure 16u) forms. Finally, a small, ovate, stemmed point that has been reworked extensively and utilized does not key.

Table 18. Probable Affiliations for Out of Key Projectile Points.

Site No.	Ref. No.	Type	Probable Type	Remarks
26EK3092	2500-1	Out of Key	Cottonwood	Reworked margin
26EK3093	505-11	Out of Key	Cottonwood	Too long
26EK3095	510-46	Out of Key	Rosegate	Reworked notch
26EK3095	510-44	Out of Key	Cottonwood	Too long
26EK3095	510-49	Out of Key	Elko	Reworked notch
26EK3106	2002-1	Out of Key	Cottonwood/DSN	PSA too small
26EK3160	520-2	Out of Key	Humboldt	Wb/Wm too large
26EK3160	500-2	Out of Key	Humboldt	Wb/Wm too large
26EK3171	504-7	Out of Key	Cottonwood	Too long
26EK3177	2001-1	Out of Key	Elko ?	PSA too small
26EK3177	2001-10	Out of Key	?	Extensive rework
26EK3190	1004-5	Out of Key	Cottonwood	Too long
26EK3237	500-17	Out of Key	Elko	PSA too small

Projectile Point Fragments

Sixty-one artifacts from the collection are classified as projectile point fragments. These consist of tips, midsections, bases, and lateral margins of small, thin bifacially worked artifacts lacking sufficient morphology to attempt typing. Fourteen of the 61 retain most basal morphology but, nevertheless, cannot be typed.

Projectile Point Preforms

One hundred and four artifacts are classified as projectile point preforms (Table 19): small, bifacially modified flakes,

Table 19. Attributes of Projectile Point Preforms.

Site (26Ek)	Ref.	Length	Width	Thick	Weight	Mat'l	Frag.
3090	2001-3	33.7	25.8	5.8	5.4	1	2
3092	500-5	37.1	18.7	5.5	4.9	1	2
3093	503-3	31.5	26.2	5.2	4.1	1	1
3093	1011-2	26	16.6	3.5	1.1	1	2
3093	1016-2	18.2	16.8	3.7	1.3	1	2
3093	1023-5	14	14.6	2.9	0.5	1	2
3093	1037-2	21.3	16.5	3.8	1.4	1	2
3095	500-18	47.1	21.4	6.6	7.9	1	2
3095	500-94	28	17	4.1	2.2	1	2
3095	510-3	26.4	13.7	3.5	1.2	3	2
3095	511-8	14	14.1	1.7	0.4	3	2
3095	516-7	22.2	17.9	3	1.3	1	2
3095	1002-3	28.4	19.4	4.3	1.9	1	1
3099	500-3	62.5	23.6	6.3	7.6	1	2
3251	1010-2	13.8	19.2	3.5	1.1	1	2
3101	500-7	42	32.7	10.5	17.5	4	2
3101	500-11	44.9	35.2	9.6	16.9	5	2
3160	500-87	17.4	17.8	2.3	0.8	1	2
3160	500-90	23.2	20	3.7	1.2	1	2
3160	500-228	29.6	13.4	3.3	1.2	1	2
3160	500-251	30	27.3	4.3	3.2	1	2
3160	500-303	22.4	15.5	4.2	1.5	1	2
3160	500-311	31.5	23.6	4	3	1	2
3160	512-2	38.3	22.2	6.1	5.7	1	2
3160	513-2	17.1	23.9	5.1	2.6	1	2
3160	517-4	22.1	13.6	4.8	1.6	1	2
3160	520-1	53.3	21.1	6.3	6.1	1	1
3160	523-12	21.6	19.5	5	2.2	1	2
3160	523-13	14.9	11.5	4.3	0.5	1	2
3160	1002-2	20.6	17.5	4.2	1.2	1	2
3160	1021-1	25.2	25	3.7	2.4	1	2
3160	1068-1	21.3	21	2.8	1.4	1	2
3160	2104-1	23.7	12.6	5.1	1.6	1	2
3165	500-1	28.7	22.2	7.2	4	3	2
3165	1024-1	35.7	21.4	4.8	4	1	2
3170	500-61	42.1	21.2	5.2	4.7	1	1
3170	500-67	25.4	23.1	7.1	3.9	3	2
3170	2001-2	27	24.9	4	2.5	1	2
3184	503-29	23.9	17.4	3	1.7	1	1
3184	508-5	41.4	23.7	5.2	6	3	1
3185	506-1	21	18.9	6.3	2.3	1	2
3185	1009-1	31.3	16.5	3.4	1.4	1	1
3185	1010-10	41.3	28	5.9	4.4	1	1
3185	1010-11	31.4	17.5	3.5	1.5	1	2
3189	500-1	25.6	23.8	4.5	2.9	3	2
3190	507-1	20.4	16.7	4	1.6	3	2
3192	1009-4	33.2	21.6	4.1	3.1	1	1
3192	2061-15	20.8	23.2	2.6	1.7	1	2
3198	503-3	47.2	18.3	5.1	5.3	1	2
3198	1003-2	22	21.4	4.8	2.4	3	2
3198	1007-1	27.1	16.8	3.6	1.9	3	2
3198	1007-2	35.1	14.8	2	1.3	1	1
3198	1012-10	25.5	20.4	4.2	1.9	1	2
3198	1014-1	50.6	22	2.6	2.1	1	1
3198	1017-2	30.2	16.8	5.9	3	3	1
3198	1017-4	11.1	18.5	5.1	1.4	1	2
3198	1017-6	19.2	18.5	3	1.1	1	2
3198	1017-7	34.1	15.1	3.7	2.3	1	2
3198	1017-9	35.7	16.6	3	1.8	1	1
3198	1017-16	16.7	19	3.4	0.9	1	2
3198	1018-2	29.5	20.2	5.2	3.5	3	1
3198	1018-5	22.5	15.1	2.6	1.1	1	2
3198	2001-3	19.3	17	2.4	1.2	1	2
3204	500-74	16	15.3	2.4	0.8	3	2
3231	1001-1	31.4	18.5	4.9	2.7	3	1
3237	500-1	25.1	25.8	5.2	3.3	1	2
3237	500-8	25.4	16.3	5.8	1.8	3	2
3237	500-36	30.6	16.5	3.1	1.3	1	2
3237	500-44	40	25.7	6.5	7.7	1	1
3237	2141-1	11.9	9.7	4	0.2	3	2
3251	500-9	20.7	15.9	3.2	1.1	1	2
3251	500-10	30.3	32.3	5.5	4.7	1	2
3251	500-21	15.3	22.7	4.4	1.7	1	2
3251	501-3	15.8	20.6	2.6	1	1	2
3251	501-6	21.2	31	5.7	4.2	1	2
3251	503-2	26	24	2.9	2	1	2
3251	505-1	29.1	23.5	6.9	6.3	1	2
3251	506-2	22.7	20	3.9	1.9	1	2
3251	1004-3	19.8	21.6	3.5	1.4	1	2
3251	1005-1	34.1	25.3	4.7	4.3	1	1
3251	1005-2	11.2	18.2	5.9	1.2	1	2
3251	1006-3	18.7	16.8	3.2	1.1	1	2
3251	1007-2	18.8	15	4.4	1.3	1	2
3251	1009-2	17.3	21.2	6.5	2	1	2
3251	1025-1	36.9	11.9	2.5	1.2	1	2
3251	1028-2	22.8	22.4	2.4	1.8	1	2
3251	1029-1	19.4	18.8	3.2	1.1	1	2
3251	1030-1	30.2	14.5	2.8	1.1	1	2
3251	2001-3	11.1	14.8	1.8	0.4	1	2
3251	2002-1	28.1	15.8	2.8	1.3	1	1
3271	500-130	22.2	13.9	3.6	1.2	3	2
3271	500-134	22.4	15.9	3.9	1.7	1	2
3271	500-170	31.5	24	3.9	3.2	1	2
3271	500-252	34	20.7	6.4	4.8	1	2
3271	500-304	33	25.5	4.6	3.8	1	2
3271	503-5	36	21.9	4	2.8	1	2
3271	511-1	16.6	12	3.6	1	1	2
3271	511-4	14.5	17.4	3.1	1.1	1	2
3271	514-5	37.5	16.9	2.5	1.8	1	2
3271	1028-3	28	17.2	3	1.6	1	2
3271	1032-5	27	17	3.2	1.6	1	2
3271	1044-10	30.4	28.8	4.8	4.1	1	2
Grid	2671-1	21.5	16.8	3.4	1.1	1	2
Grid	2674-1	30.4	18.6	5.4	3.2	1	2

Key:

Material
1 = Opalite
3 = Obsidian
4 = Basalt
5 = Other

Fragment
1 = Complete
2 = Fragment

similar in outline to various projectile point styles, but lacking final notching and basal treatment. Only 18 preforms are complete specimens. Table 20, gives mean dimensions for preforms and typed points; Great Basin Stemmed Series points are excluded since lengths and weights were not estimated. While slightly larger than the mean for all points combined, preform dimensions consistently fall between those of Elko and Rosegate series points. Thus, most appear to be precursors of Rosegate or Desert Series points. Size ranges, however, show significant overlap and preforms for larger point styles may well be present in the sample.

Table 20. Mean Dimensions of Preforms and Typed Points (excluding Great Basin Stemmed).

Type	Mean Length	Mean Width	Mean Thickness	Mean Weight
Cottonwood Triangular	25.338	15.100	2.863	1.050
Desert Side-notched	24.883	13.330	2.714	.085
Rosegate	30.477	15.423	3.168	1.541
Preforms	35.617	20.600	4.456	3.394
Elko Corner-notched	48.980	23.020	4.660	4.260
Elko Eared	37.733	26.200	4.666	3.366
Gatecliff Split Stemmed	46.943	23.028	5.229	5.216
Humboldt	42.725	19.600	4.750	4.300
Large Side-notched	40.080	18.680	3.940	5.640
All	30.009	16.226	3.617	2.007

Chapter 5. GROUND, BATTERED, AND SCRATCHED STONE

by Dave N. Schmitt

Test excavations at sites peripheral to the Tosawihi Quarries retrieved a host of ground stone, striated stone, and battered and flaked cobble tools. Although some specimens appear to have been employed in two or more tasks and functional interpretations of a few others remain ambiguous, this chapter segregates assemblage components according to four analytic categories: ground stone (e.g., manos and metates), percussion tools (e.g., hammerstones), fabrication tools (e.g., abraders), and other modified stone (e.g., pipes and ornaments).

Each specimen was assigned its respective analytic category based on gross morphology, ethnographic observations, and comparison with specimens recovered from other Great Basin sites (e.g., Kramer and Thomas 1983; Juell 1990). Documentation of each artifact included type and degree of use-wear, raw material type, dimensions, weight, degree of completeness, and provenience, as well as additional salient characteristics pertaining to its use history (e.g., fire alteration). When possible, fragmented artifacts were reconstructed.

Ground Stone

Investigations at 21 sites recovered a total of 62 ground stone artifacts. Most are metates or metate fragments (n=36), followed by manos (n=17); occasional mortars, pestles, and undifferentiated ground stone appear in the assemblage.

Manos

Eleven of 17 manos were sufficiently intact to observe shape/type distinctions. Included are six shaped and two unshaped unifacial manos, one shaped and one unshaped bifacial mano, and one shaped handstone displaying surficial use-wear polish (Table 21). Shaped manos are commonly ovoid to sub-rectangular in plan outline (i.e., "breadloaf"; Kramer and Thomas 1983:234-235), possess slightly convex working surfaces, and have a mean thickness of 4.5 cm. While most (75%) of the shaped manos exhibit light use-wear, two shaped uniface types recovered from site 26Ek3160 (specimens 1005-2 [Figure 17b] and 2041-1) display rather extensive use-wear polish.

Clearly, the inferred function of manos (whether shaped or not) is seed/nut processing, but nine specimens (53% of the total assemblage) exhibit characteristics indicative of use at other tasks. Four manos (specimens 26Ek3095-510-10, 26Ek3192-2061-2, 26Ek3204-2500-8, and 26Ek3271-500-73 have battered ends

Table 21. Attributes and Provenience of Groundstone.

All Measurements are in centimeters.

Site No. (26Ek)	Spec. No.	Fea.	No. Frags.	Material	% Complete -ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Use Wear	Type	Length	Width	Thickness	Weight (gms)	Fire Affected
3093	500-2	-	1	RH	100	SR	-	U	CV	L	ME	22.5	22.0	5.0	4100.0	-
	1040-1	4	1	TF	?	IN	+	U	CN	L	GS	6.7	4.4	3.8	106.1	-
3095	500-22	-	1	RH	50	SR	+	U	CN	L	PE	9.9	6.8	4.7	470.5	-
	500-31	-	1	TB	?	IN	-	U	CV	L	GS	7.9	5.9	1.6	101.6	-
	500-46	-	1	TB	50	IR	-	U	CN	L	ME	9.0	15.8	2.8	998.1	-
	510-10	10	1	RH	50	OV	+	U	CV	L	MO	6.0	9.1	4.2	232.5	-
	515-9	15	1	MB	25	IN	-	U	PL	M	ME	8.0	15.0	12.2	4200.0	-
	519-20	19	1	SS	20	OV	+	B	CV	H	ME	19.0	12.5	1.2	535.1	-
	525-3	25	1	TB	25	IN	-	U	PL	L/M	ME	13.1	10.2	2.7	669.5	+
	1002-2	15/19	10	IG	?	OV	+	B	PL	L/M	ME	?	?	3.1	1459.3	-
	1023-1	15	25	TF	75	OV	+	B	ML	L/H	ME	(33.0)	(20.0)	1.8	1749.3	-
	1029-1	15	4	TB	60	IN	-	B	PL	L	ME	(34.0)	(30.0)	2.9	3458.4	-
	1032-5	15	1	TB	?	SR	-	U	PL	M	ME	15.4	10.0	3.0	955.7	-
	1044-1	22	4	TB	60	IN	-	U	PL	M	ME	(33.5)	(20.5)	5.9	3868.0	-
3096	1002-2	1	1	MB	100	OV	-	U	CV	L	MO	13.2	8.4	5.5	782.1	-
3106	1037-1	4	1	TB	?	IN	?	U	PL	L	ME	6.6	5.1	3.6	227.6	-
3149	500-6	-	1	MB	95	OV	?	U	PL	M	ME	30.0	24.5	14.0	9500.0	-
	500-7	-	1	RH	40	OV	?	B	CV	L	MO	5.9	8.7	4.3	220.2	-
3160	500-53	-	2	TB	100	SR	+	M	ML	M	PE	(19.5)	(6.8)	6.7	1431.2	-
	500-74	-	1	SS	10	OV	+	B	PL	L	ME	7.0	5.0	2.5	75.9	-
	500-110	-	1	TB	?	IR	-	U	PL	L	ME	21.2	12.0	2.0	682.1	-
	501-2	1	1	RH	100	SR	+	B	CV	L	MO	13.1	8.8	4.9	747.5	-
	520-7	20	1	TB	50	IR	-	U	CN	M	ME	28.1	19.0	3.0	2140.1	-
	519-8	19	1	TB	100	SR	-	U	PL	L	MR	28.5	15.0	9.5	6400.0	-
	523-14	23	1	TB	50	OV	-	U	CN	L	MR	20.5	12.3	9.9	3600.0	-
	1005-2	1	1	RH	40	SR	+	U	CV	M	MO	6.8	8.0	4.7	358.4	-
	2041-1	-	1	RH	75	OV	+	U	CV	M	MO	13.1	7.4	4.6	612.4	-
3165	501-1	1	1	TB	100	IR	+	U	CN	L	ME	41.4	26.9	2.5	4000.0	-
	502-1	2	1	TB	?	IR	-	U	CN	M	ME	24.7	20.0	3.4	3900.0	-
	A-1*	-	1	TB	100	IR	-	U	PL	L	ME	47.5	30.0	3.0	-	-
3170	500-5	-	1	QZ	50	OV	+	U	CV	L	MO	10.4	8.3	3.8	402.0	-
	2023-1	-	1	TB	25	IN	?	B	PL	M	ME	18.9	13.0	2.7	975.8	-
3171	2022-1	-	1	RH	75	SR	?	B	CV	L	MO	15.2	9.1	4.3	628.7	-
3181	1015-1	1	1	RH	100	OV	?	B	CV	L	MO	18.2	11.0	7.4	1627.0	+
3185	1010-2	1	1	RH	50	OV	+	U	CV	L	MO	12.5	8.9	4.8	500.9	-
3190	505-4	5	3	TF	25	IN	+	U	PL	L	ME	(14.3)	(8.9)	6.7	835.6	-
3192	1015-3	1	1	TB	?	IN	?	U	PL	L	ME	8.4	4.3	1.5	73.3	-
	2061-1	2	1	QZ	60	OV	-	B	ML	L	MO	6.3	9.9	3.4	327.9	-
3196	502-5	2	1	TF	100	SR	-	U	PL	L	GS	7.0	4.1	3.6	60.7	-
3201	502-15	2	1	RH	100	OV	?	U	CV	L	MO	13.2	9.0	5.8	956.6	-
	503-5	3	17	RH	50	IN	+	U	PL	L	ME	(36.0)	(22.5)	5.3	4077.4	+
3204	2500-8	-	1	QZ	50	OV	?	U	CV	L	MO	7.6	7.4	2.9	238.0	+
3228	1001-1	1	2	TB	95	IR	-	U	PL	L	ME	(22.7)	(19.6)	4.9	2191.3	-
3237	500-81	-	1	RH	10	IN	?	U	CN	L	ME	9.0	5.4	4.3	232.8	-
3238	500-16	-	1	RH	?	SR	+	U	CN	L	ME	9.1	8.2	4.6	541.7	-
3251	500-4	-	1	RH	25	OV	+	U	CN	M	ME	19.0	19.0	5.2	2108.9	-
	500-6	-	1	QZ	20	IN	?	U	CN	M	ME	10.8	9.3	5.9	558.4	-
	500-8	-	1	TF	?	IN	?	U	PL	L	ME	8.6	7.9	5.1	365.0	-
	500-11	-	1	TF	?	IN	?	U	PL	L	ME	4.8	5.3	2.1	62.1	-
	500-14	-	1	RH	20	SR	+	U	CN	L	ME	11.6	9.6	2.6	480.2	-
	500-15	-	1	TF	100	OV	+	U	CV	L	MO	14.4	8.4	6.7	1146.0	-

Table 21, continued.

All Measurements are in centimeters.

Site No. (26Ek)	Spec. No.	Fea.	No. Frags.	Material	% Complete -ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Use Wear	Type	Length	Width	Thickness	Weight (gms)	Fire Affected
3251	501-1	1	1	RH	25	OV	+	U	CN	L/M	ME	15.0	17.0	3.3	1006.4	-
(cont.)	501-4	1	1	RH	40	OV	-	U	CV	L	MO	9.8	6.5	4.4	384.7	+
	506-1	6	1	TF	?	IN	?	B	PL	L	ME	13.6	7.6	3.3	402.5	-
	506-5	6	1	RH	?	IN	?	U	PL	L	ME	12.2	5.8	2.6	211.0	-
	1006-5	1	1	TF	5	OV	+	B	PL	L	ME	5.8	4.6	3.7	123.8	+
3271	500-73	-	1	RH	75	SR	+	M	CV	L	MO	12.0	6.2	3.8	532.0	+
	500-133	-	1	TB	?	IN	?	U	PL	M	ME	11.0	10.3	2.9	481.0	+
	500-150	-	1	RH	40	SR	+	M	ML	L	PE	7.1	7.4	5.6	501.1	-
	500-273	-	2	TB	?	SR	?	U	PL	L	ME	(17.0)	(10.8)	2.8	882.8	-
	1008-1	2	1	RH	25	OV	?	U	CV	L	MO	7.4	5.1	2.4	108.3	-
	1101-2	18	1	MB	100	OV	-	U	PL	M	MR	22.0	18.5	11.0	2600.0	-

Key:

Material
IG = Brecciated Obsidian
MB - Mass Basalt
TB = Tabular Basalt
QZ = Quartzite
RH = Rhyolite
SS = Sandstone
TF = Tuff

Plan Outline
SR = Sub-rectangular
OV = Ovoid
IR = Irregular
IN = Indeterminant

Facial Use
U = Unifacial
B = Bifacial
M = Multiple

Use Surface Profile
CN = Concave
CV = Convex
PL = Planer
ML = Multiple

Use Wear
L = Light use; polished facets only on elevated areas of surface; retains characteristics of original surface.

M = Moderate use; thin layer of original surface of stone is removed by grinding; polished facets cover ca. 50% of surface area.

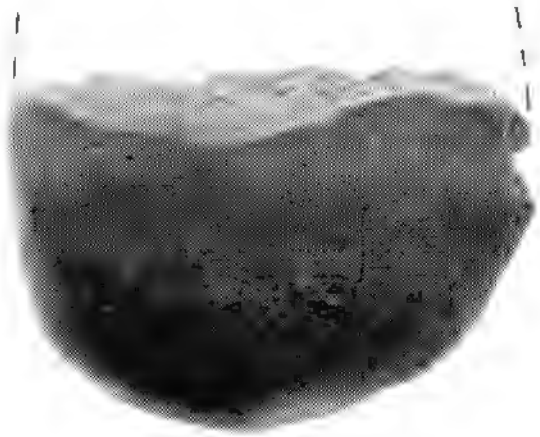
H = Heavy use; perceptible trough developed below original surface; ground facets over entire surface; often resharpened by pecking.

Type
MO = Mano
ME = Metate
PE = Pestle
MR = Mortar
GS = Undifferentiated Ground Stone

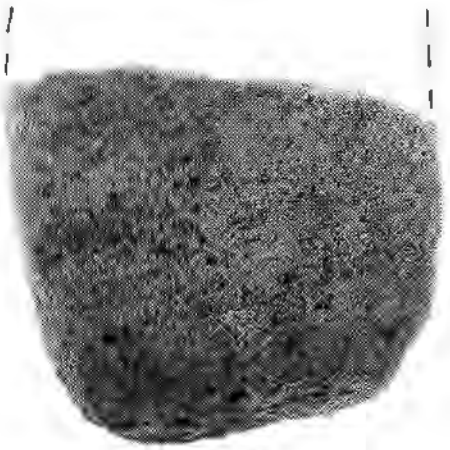
Parentheses denote measurement of two or more refitted pieces.

* Recorded and left in the field.

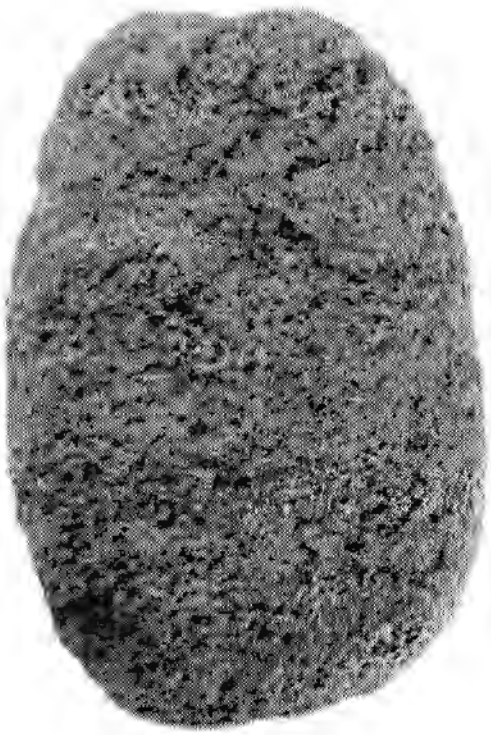
Figure 17. Selected manos.
a. 26Ek3251, specimen 501-4
b. 26Ek3160, specimen 1005-2
c. 26Ek3160, specimen 501-2
d. 26Ek3170, specimen 500-5



a.



b.



c.



d.



and/or margins suggesting percussion tasks; this type of damage probably accrued when the tools were used to resharpen other grinding surfaces (e.g., pecking a metate) to pound roots, bones, and/or dried meat, or perhaps from use as hammerstones employed in lithic reduction.

Collected from the surface of site 26Ek3170, unifacially shaped specimen 500-5 (Figure 17d) bears ochre staining on the working surface and along one margin, indicative of pigment manufacture (cf. Juell 1990; see also Drews 1986; Kramer and Thomas 1983). Finally, four specimens (see Table 21) are blackened and fire-cracked, suggesting re-use for lining roasting pits and/or hearths.

Metates

Represented largely by specimens displaying unifacial use-wear (n=28, 78%), a total of 36 metates was recovered (see Table 21). The metate assemblage contains both thin, "portable" tabular types, and thick, heavy boulder types (see, for example, attributes of specimens 26Ek3095-500-46 and 26Ek3095-1044-1 in Table 21, respectively. Twelve specimens were shaped by percussion flaking and abrasion, most of which (60%) was done to achieve an oval plan outline (see also Steward 1941:325).

Although raw material types vary, stone utilized as metates reflects locally available rocks. For example, the bedrock of Bitterroot Ridge area is tabular basalt. Although tabular basalt metates were found elsewhere in the study area, people occupying sites on Bitterroot Ridge favored this rock type, as demonstrated by a preponderance (n=12, 67%; 75% of the total assemblage) of tabular basalt metates.

The presence of metates (and/or other grinding implements) clearly testifies to subsistence resource processing in conjunction with toolstone acquisition and reduction in the study area. As observed in Table 21, metate wear patterns reveal predominantly light use (n=20). Many of these specimens were recovered from sites lacking discrete cultural features and/or additional artifact types suggestive of residential use (e.g., sites 26Ek3093 and 26Ek3228). Conversely, virtually all the implements exhibiting moderate to heavy use were collected from sites with discrete cultural features inferring residential occupation. In particular, specimens 519-10 and 1023-1 recovered from site 26Ek3095 display highly polished ground surfaces; the former also has a well developed trough and possesses numerous pecking marks, together indicative of a resharpened working surface that had become exhausted.

Metates displaying multiple, parallel use-wear striations were recovered from three sites: specimens 26Ek3095-500-46 and 26Ek3095-525-7, 26Ek3160-500-74 and 26Ek3160-520-7, and

26Ek3170-2023-1. While such linear grooves probably were produced during seed grinding, deep striae truncating light surface use-wear on specimens 26Ek3095-500-46 and 26Ek3095-500-74 may also suggest the artifacts were used as cutting slabs (cf. Juell 1990).

Fragments of the same distinctive ignimbrite* metate were recovered from site 26Ek3095 in features 15 and 19, ca. 25 meters apart. Based on context, it appears numerous fragments of a broken metate were scavenged from Feature 15 for use as boiling stones and/or hearth rocks by inhabitants of Feature 19 where angular fragments were found in association with an ashy hearth-like feature (Intermountain Research 1988b). The ignimbrite rock of which this artifact is made is highly distinctive; a geologist working in the area identified its source as an outcrop located approximately 3 km east of the site.

Use of metates for activities other than food processing is evident at sites 26Ek3201 and 26Ek3251. Surface collections at Feature 3, site 26Ek3201 retrieved 17 fragments of one metate (see Table 21): as illustrated in Figure 18, reconstruction of the artifact found approximately 75% of the refitted pieces extensively fire blackened, but the remaining pieces virtually unaffected, suggesting that some, but not all, fragments of the broken metate were scavenged and used as hearth rocks. Finally, specimen 500-4 recovered from the surface of 26Ek3251 displays red ochre residue indicating the metate was used for pigment manufacture, probably in addition to food processing.

Pestles

Three ground stone artifacts were classified as pestles (see Table 21). One specimen (26Ek3160-500-53) is complete in two refitted pieces. It is oval in cross section, and exhibits overall polish and striations perpendicular to its long axis; these modifications appear to be a result of manufacturing techniques (e.g., shaping by abrasion) rather than use-wear.

The two remaining pestles are represented by fragments; specimen 26Ek3095-500-22 is an end fragment and specimen 26Ek3271-500-150 is a midsection. Both implements display overall (superficial) polish, are oval in cross section, and subrectangular in outline. The working ends of specimens 500-22 and 500-53 are blunt and flat, suggesting use with stone mortars; the former is spalled from use.

* Ignimbrite, in this case, is not a glassy obsidian-like mineral; rather, it is comprised of macroscopic crystals of quartz, feldspar, and biotite in a glassy matrix (Prinz et al. 1977:349).

Figure 18. Refitted metate; 26Ek3201, specimen 503-5.


0
5
cm

Mortars

Testing at two sites on Bitterroot Ridge recovered three incipient mortars (see Table 21). Each specimen displays superficial use-wear and each also may have functioned as a metate and/or anvil.

At site 26Ek3160, surface collections at features 19 and 23 returned a mortar and mortar fragment, respectively. Specimen 26Ek3160-519-8 is a mortar manufactured on a tabular basalt cobble. The artifact possesses a circular (diameter ca. 6.5 cm), blackened, slightly polished facet central to its planar surface. Although fragmented, specimen 26Ek3160-523-14 displays a similar, centrally worn area (diameter ca. 6.0 cm) on a slightly concave surface.

Surface collections at Feature 18, site 26Ek3271 also yielded an incipient mortar. The artifact bears a circular, slightly battered area with polished margins (diameter = 6.5 cm) central to a relatively flat surface on a large basalt cobble. Because this use-wear truncates a striated, polished surface, it appears the artifact functioned as a mortar subsequent to its overall facial use as a grinding surface. We speculate that these artifacts probably were used in conjunction with pestles, and possibly with hopper baskets, to process plant foods including bitterroot and other tubers. Steward (1941:235) notes that "a few small mortars, adopted by the (Snake River) Shoshone from the Plateau or Northwest, were used only by toothless old people to grind their food".

Undifferentiated Ground Stone

An additional three specimens classified as undifferentiated ground stone (see Table 21) are small, fragmented artifacts lacking sufficient morphology to infer function. Each specimen exhibits light polish on one surface.

Percussion Tools

Percussion tools in the form of hammerstones, battered cobble fragments, and choppers were recovered from 30 of the 65 sites investigated. Hammerstones are presented first, followed by undifferentiated battered stone, then choppers.

Hammerstones

Not surprisingly, a wealth of hammerstones was recovered from sites peripheral to the Tosawihi Quarries. Most (61%) are from the USX-East area and were associated with the numerous quarry pits, opalite outcrops and cobble fields, and lithic

reduction features blanketing the region (see, for example, Chapter 16). The hammerstone assemblage contains an array of shapes and sizes (Table 22), but most abundant are fist-sized cobbles (Figure 19), exhibiting two or more extensively battered edges, that can be held and used with one hand (i.e., less than 1200 grams). A few hammerstones have been shaped via percussion flaking to achieve a "pointed" working edge(s), probably to facilitate controlled flake removal when applied to biface reduction.

Similar to the metate assemblage, raw material selection for hammerstones seemingly reflects exploitation of the immediate environment. For example, virtually all the hammerstones collected from sites along Undine Ridge are quartzite cobbles; aside from opalite, informal survey of the creek bottom in Undine Gorge during field operations found quartzite cobbles to be a common, often dominant rock type. Similarly, over one-half (54%) the hammerstones retrieved in the USX-West area are basalt, a rock type common in the Bitterroot Ridge area and, of course, in adjacent Basalt Canyon.

While the inferred function of these artifacts is reduction of toolstone and, to a lesser extent, processing resistant organics (e.g., wood, fiber), many may have been used in other percussion tasks (e.g., sharpening exhausted grinding surfaces). Two hammerstones (specimens 26Ek3192-2062-1 and 26Ek3204-500-22 exhibit such deviant employment in pigment manufacture, the evidence for which is ochre staining. Specimen 26Ek3237-500-331 recovered from the surface of site 26Ek3237 has a pitted, crushed area central to a slightly convex surface (Figure 19a), possibly from use as a percussor during bipolar core reduction (cf. Ahler 1986:60-63).

Undifferentiated Battered Stone

An additional six percussion tools were classified as undifferentiated battered stone (see Table 22). These fragmented artifacts display either spalling or battering along one edge or surface. Although they were utilized for some sort of rough percussion and may have served functions similar to the hammerstones presented above, there is distinctly less wear damage on them than on hammerstones (after Thomas and Bierwirth 1983:229-230).

Table 22. Attributes and Provenience of Hammerstones and Miscellaneous Battered Stone.

All Measurements are in centimeters.

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thickness	Weight (gms)	Type	Shaped	Complete
3084	502-1	2	MB	12.3	11.5	6.8	1253.2	HM	-	-
	502-2	2	RH	13.2	6.6	6.9	756.2	BS	?	-
	502-3	2	MB	10.2	3.4	3.8	163.2	BS	+	-
	502-4	2	MB	13.1	11.6	6.0	1032.9	HM	?	+
3085	508-1	8	MB	8.1	6.4	5.5	427.3	HM	-	+
3092	2041-1	-	OP	6.4	5.4	3.5	159.5	HM	+	+
3095	500-49	-	QZ	10.4	9.7	7.3	925.1	HM	-	+
	511-3	11	MB	17.5	13.3	6.4	3000.0	BS	-	-
	513-1	13	QZ	8.3	6.2	5.9	433.5	HM	-	+
	514-3	14	MB	8.6	7.3	4.8	283.9	HM	+	+
	514-4	14	MB	7.5	2.8	3.2	8.7	HM	?	-
	1004-3	19	MB	10.3	8.1	5.1	484.6	HM	-	+
	1006-1	19	MB	8.7	8.6	4.7	589.6	HM	-	-
3096	500-3	-	QZ	8.4	6.6	2.6	190.8	HM	-	+
	504-1	4	MB	6.7	5.2	3.8	221.0	HM	-	+
3099	501-1	1	OP	9.2	8.0	3.6	28.0	HM	+	+
3104	500-10	-	QZ	10.8	8.9	8.2	889.2	HM	-	+
3106	2021-4	5	MB	12.0	9.7	6.1	751.0	HM	+	+
3160	507-4	7	RH	6.7	6.0	5.5	280.2	HM	-	+
	2001-1	1	MB	9.4	6.6	2.6	162.0	HM	-	-
3170	500-11	-	QZ	6.3	2.7	2.6	51.7	BS	?	-
	500-50	-	MB	8.6	6.5	5.9	326.1	HM	-	-
3171	502-5	2	OP	7.7	7.6	7.3	480.7	HM	-	+
	502-8	2	QZ	17.6	14.5	12.4	2600.0	HM	-	+
	507-5	7	RH	9.2	8.1	3.4	299.9	HM	+	+
	507-9	7	QZ	20.0	14.0	9.2	2610.0	HM	-	+
	1004-2	1	QZ	15.7	11.0	10.2	2030.0	HM	-	+
3177	501-1	1	RH	13.2	8.3	5.6	746.9	HM	-	+
3184	2021-13	13	QZ	6.8	5.7	4.4	207.0	HM	-	+
3185	504-1	4	QZ	9.5	4.3	5.8	349.9	HM	-	+
	1012-1	1	QZ	9.2	9.1	8.0	832.2	HM	-	+
3192	2062-1	2	TF	11.4	9.6	4.6	615.6	HM	-	+
	2064-1	2	QZ	10.9	9.8	5.6	639.7	HM	-	+
	2122-1	1	QZ	8.0	7.4	6.5	390.5	HM	-	+
3195	502-1	2	RH	25.0	14.0	6.8	3600.0	HM	-	+
	502-2	2	RH	25.0	14.5	9.3	2440.0	HM	-	-
	503-1	3	QZ	6.1	4.8	1.9	73.4	HM	-	-
	507-1	7	QZ	5.7	5.8	3.6	155.4	HM	-	+
	507-2	7	QZ	10.6	7.1	6.0	627.5	HM	-	+
	507-6	7	MB	8.1	7.5	6.4	469.7	HM	-	+
3196	501-2	1	QZ	9.2	6.8	3.4	196.8	HM	-	-
	502-1	2	QZ	9.2	7.7	2.6	126.6	HM	-	-
	502-8	2	QZ	10.7	10.0	6.7	755.1	HM	-	+
	502-9	2	QZ	18.5	13.0	5.8	1497.1	HM	-	+

Table 22, continued.

All Measurements are in centimeters.

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thickness	Weight (gms)	Type	Shaped	Complete
3196	1007-1	1	QZ	8.6	7.5	5.2	391.4	HM	-	+
(cont.)	1033-1	2	QZ	9.5	9.3	4.3	354.3	HM	-	-
	2002-3	1	QZ	8.8	7.3	3.6	338.1	HM	-	-
3197	504-2	4	QZ	9.4	6.9	5.7	320.1	HM	?	-
	504-4	4	QZ	8.0	5.5	1.7	53.9	HM	-	-
	506-1	6	MB	6.8	6.6	3.9	191.4	HM	?	-
	506-2	6	OQ	7.6	6.0	3.4	158.4	HM	-	-
	507-2	7	QZ	11.9	6.8	4.4	361.0	HM	-	-
	509-5	9	QZ	9.0	8.4	3.8	263.1	HM	-	+
3198	514-5	14	QZ	6.7	5.1	3.1	104.3	HM	-	-
	514-6	14	QZ	4.7	5.1	1.2	38.5	HM	-	-
3200	501-2	1	QZ	16.8	14.4	3.0	1328.8	BS	?	?
	2500-1	-	QZ	9.1	8.8	5.1	500.4	HM	-	+
3201	500-1	-	QZ	11.4	7.0	6.9	827.4	HM	-	+
	502-14	2	QZ	8.1	8.2	4.3	382.7	HM	?	+
	503-4	3	QZ	13.8	9.7	5.0	928.5	HM	-	-
	504-1	4	MB	5.9	4.6	4.9	139.3	HM	-	-
3204	500-22	-	QZ	13.0	9.9	2.5	501.4	HM	-	-
	500-26	-	QZ	10.9	10.4	4.9	529.0	HM	-	+
	500-32	-	QZ	7.8	6.4	4.0	208.2	HM	-	+
	500-33	-	QZ	12.1	8.8	5.0	708.6	HM	-	+
	2005-12	-	OP	5.9	3.6	3.2	51.4	BS	-	-
	2500-7	-	MB	9.8	8.2	5.2	495.2	HM	-	+
3208	501-2	1	MB	18.6	12.3	11.0	2500.0	HM	-	+
	508-1	8	QZ	15.5	8.5	6.7	1259.0	HM	-	-
3237	500-6	-	OP	9.4	6.7	4.9	361.9	HM	-	+
3239	500-23	-	QZ	16.0	8.5	7.7	1109.7	HM	-	+
	500-24	-	MB	5.3	5.7	5.1	227.4	HM	-	+
3271	500-18	-	QZ	7.8	5.4	3.2	188.2	HM	-	+
	500-82	-	RH	7.5	5.9	3.6	184.0	HM	-	+
	500-261	-	MB	10.7	9.2	4.2	560.1	HM	-	+
	500-311	-	QZ	7.7	9.0	4.8	467.4	HM	-	-
	506-5	6	QZ	7.6	5.9	2.6	172.6	HM	-	-
	516-1	16	MB	20.0	17.0	11.9	4000.0	HM	-	+
	1026-1	12	OQ	7.5	6.0	5.0	379.4	HM	?	+

Key:

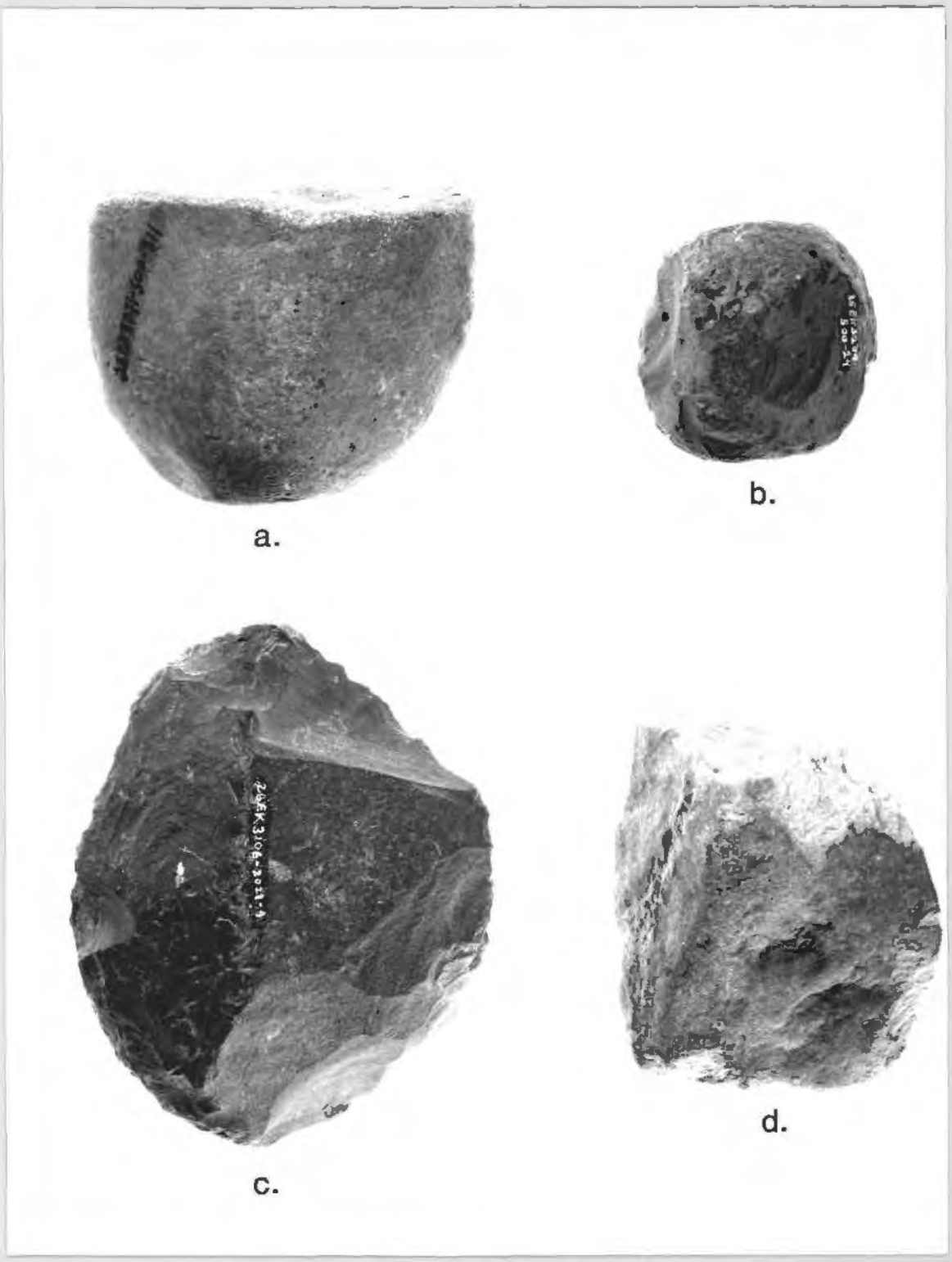
Material

MB = Mass Basalt
OP = Opalite
OQ = Opalite w/Quartzite
QZ = Quartzite
RH = Rhyolite
TF = Tuff

Type

HM = Hammerstone
BS = Undifferentiated Battered Stone

Figure 19. Selected hammerstones.
a. 26Ek3271, specimen 500-311
b. 26Ek3239, specimen 500-24
c. 26Ek3106, specimen 2021-4
d. 26Ek3196, specimen 1007-1


a.
b.
c.
d.
0
5
cm

Choppers

Testing at 16 sites yielded 31 choppers (Table 23). The assemblage contains a variety of shapes, sizes, and raw material types (including opalite, basalt, and rhyolite), but most were manufactured on cobbles or tabular slabs that easily can be manipulated with one hand (Figure 20). Although choppers may have been used in an array of processing tasks, they probably were employed most frequently in the processing of organic materials (e.g., wood, fiber, and dried meat) (cf. Elston 1986).

Manufacturing techniques involved removal of two or more flakes by percussion (commonly unifacial) to achieve a sharp, roughly linear working edge. Working edge angles vary between 20° and 80°, but most (n=21, 68%) are between 50° and 70° (mean = 57.7° +/- 12.1°). Differences in working edge angles may represent purposeful modification for a specific task(s), or they simply may be a function of raw material type (i.e., hardness and initial morphology); perhaps too, some may represent reuse of a spalled rough percussion tool for an expedient task. All of the implements display some degree of use-wear, but attrition is most apparent on opalite choppers where polish and extensive step fracturing is common.

One noteworthy specimen (26Ek3160-500-67) is a large tabular piece of basalt exhibiting unifacial manufacture and use-wear edge damage (i.e., flaking) along one long (30 cm), linear margin. Based on its size and overall morphology, this spatulate artifact may have functioned as a quarrying or digging tool.

Table 23. Attributes and Provenience of Choppers.

All Measurements are in centimeters.

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thickness	Weight (gms)	Working Edge Angle (°??)	Complete
3084	1021-1	2	OP	16.0	10.5	4.8	813.1	42	+
3085	508-2	8	TB	13.9	9.6	4.0	452.9	28	-
3093	505-9	5	OQ	11.8	7.8	3.6	401.2	42	+
3096	502-3	2	MB	10.4	7.8	5.5	568.0	64	+
3099	502-1	2	OP	8.0	8.0	3.1	161.9	46	+
3101	500-2	-	OP	10.2	6.0	2.9	211.5	60	+
3104	500-5	-	MB	11.2	10.5	8.0	2000.0	80	?
3107	1002-1	1	TF	13.6	10.4	4.7	663.0	80	+
3149	500-11	-	OP	9.7	7.0	3.7	269.4	64	+
3160	500-67	-	RH	7.6	6.9	3.3	227.6	66	+
	501-1	1	TB	30.5	25.6	2.6	2600.0	50	-
3170	500-12	-	OP	8.7	7.1	1.9	99.8	40	+
	500-21	-	MB	11.5	10.0	2.7	364.7	52	+
	500-51	-	OP	8.4	4.5	1.8	71.3	55	-
	500-52	-	OP	7.9	6.3	4.9	244.1	66	-
3184	503-3	3	OP	10.8	8.9	5.2	382.7	64	?
3208	501-1	1	MB	13.9	11.4	5.0	818.4	58	+
3238	500-33	-	QZ	18.1	12.7	4.2	1282.4	55	-
3239	500-22	-	TB	11.2	7.1	5.8	576.1	56	+
	500-27	-	OQ	5.9	4.8	3.4	77.1	45	+
	500-29	-	OP	10.4	10.2	3.6	412.9	64	+
3251	500-20	-	QZ	9.9	6.9	3.5	293.5	68	+
	1009-1	1	TB	12.4	7.7	3.3	449.0	48	+
3271	500-4	-	TB	13.5	8.5	3.4	601.9	68	+
	500-21	-	MB	13.8	9.5	2.8	494.8	62	?
	500-163	-	OQ	6.1	4.5	2.1	58.5	56	-
	505-2	5	OP	8.2	6.0	3.6	201.0	74	+
	516-2	16	OP	7.1	6.8	3.4	148.6	68	-
	1022-3	12	OP	11.1	7.5	4.7	344.9	50	+
	1023-2	12	OP	11.9	8.0	4.9	525.2	65	+
	1038-1	12	MB	8.3	5.2	3.1	155.0	52	?

Key:

Material

MB = Mass Basalt
OP = Opalite
OQ = Opalite w/Quartzite
QZ = Quartzite
RH = Rhyolite
TF = Tuff

Fabrication Tools

Fabrication tools (defined here as tools used to manufacture other tools) were recovered from 14 sites (Table 24). Clearly, hammerstones and choppers can be classified as fabrication tools, but this discussion focuses on more elaborate and/or task specific tools in order to highlight their attributes and functional interpretations. Fabrication tools include abraders, shaft abraders (or smoothers), scratched stone, and basalt planers.

Figure 20. Selected choppers.
a. 26Ek3170, specimen 500-52
b. 26Ek3160, specimen 500-67
c. 26Ek3251, specimen 1009-1
d. 26Ek3251, specimen 500-20



a.



b.



c.



d.

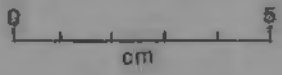


Table 24. Attributes and Provenience of Fabrication Tools.

All Measurements are in centimeters.

Site No. (26Ek)	Spec. No.	Fea.	Material	% Complete -ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Type	Length	Width	Thickness	Weight
3092	500-3	-	TF	100	RC	+	M	PL	AB	4.5	1.4	1.4	8.4
3095	500-57	-	RH	?	IN	-	U	PL	SS	10.0	7.9	2.6	252.0
	1002-7	19	SD	25	SR	+	U	GV	SA	3.2	4.1	1.9	27.6
	1025-1	15	SD	75	OV	+	U	GV	SA	11.7	6.6	2.0	203.1
3106	1050-1	4	TB	?	IN	-	U	PL	SS	12.1	7.1	3.5	280.8
3114	1007-5	1	TB	100	OV	?	B	IR	SS	10.9	10.0	3.2	447.8
3160	500-118	-	MB	100	SR	+	M	PL	PL	14.6	8.7	6.1	778.5
	501-15	1	MB	100	OV	+	M	PL	PL	11.4	8.5	4.4	441.9
	515-1	15	TF	50	OV	+	U	GV	SA	4.6	2.8	2.2	17.6
	1001-1	1	MB	100	OV	+	M	PL	PL	14.4	8.8	5.7	752.5
	1005-4	1	TB	95	OV	?	B	CN	SS	11.4	9.7	1.9	430.3
	1007-4	1	TB	?	IN	-	U	PL	SS	8.0	4.3	2.4	115.7
3171	500-4	-	TF	100	SR	?	U	CV	SS	11.6	12.9	3.0	447.6
3184	503-27	3	SD	100	OV	+	U	GV	SA	9.9	5.0	4.0	177.0
3185	1010-1	1	TF	90	OV	+	U	CV	SS	14.0	12.4	3.9	731.8
3190	1006-3	1	TF	100	IR	-	M	ML	AB	4.2	2.6	1.9	19.2
3193	506-1	6	TF	100	SR	-	U	PL	SS	4.3	3.2	0.9	14.6
3198	1003-1	1	SD	100	RC	+	M	GV	SA	5.5	2.6	1.7	33.9
3201	1002-1	1	TF	75	IR	?	B	ML	SS	13.0	10.9	3.5	387.8
3204	500-23	-	RH	80	SR	-	U	CV	SS	10.1	8.1	2.6	326.7
3271	500-62	-	TF	100	IR	+	U	PL	SS	7.7	7.2	3.4	137.8
	1047-2	12	TB	90	OV	-	U	PL	SS	12.6	7.0	2.7	410.5

Key:

Material
MB - Mass Basalt
RH = Rhyolite
SD = Sandstone
TB = Tabular Basalt
TF = Tuff

Plan Outline
OV = Ovoid
RC = Rectangular
SR = Sub-rectangular
IR = Irregular
IN - Indeterminant
IR = Irregular

Facial Use
U = Unifacial
B = Bifacial
M = Multiple

Use Surface Profile
CN = Concave
CV - Convex
PL = Planer
ML = Multiple
GV = Groove

Type
AB = Abrader
SA = Shaft Abrader
SS = Scratched Stone
PL = Planer

Abraders

Two abraders were recovered, one from site 26Ek3092 and one from 26Ek3190 (Table 24). The former has been modified extensively to create a rectangular shape while the latter is unshaped, but possesses five polished and striated planar facets from use-wear. Both specimens are small and easily can be employed in limation while held with two or three fingers. Although untested, these artifacts probably were utilized in the finishing stages of bone or wood tool manufacture (e.g., awls, needles).

Shaft Abraders

Five shaft abraders were recovered from four sites (Table 24). Four specimens are manufactured on sandstone and one on a piece of coarse-grained welded tuff. Groove width/diameters are similar, ranging between 7.1 mm and 8.0 mm (mean = 7.6 mm).

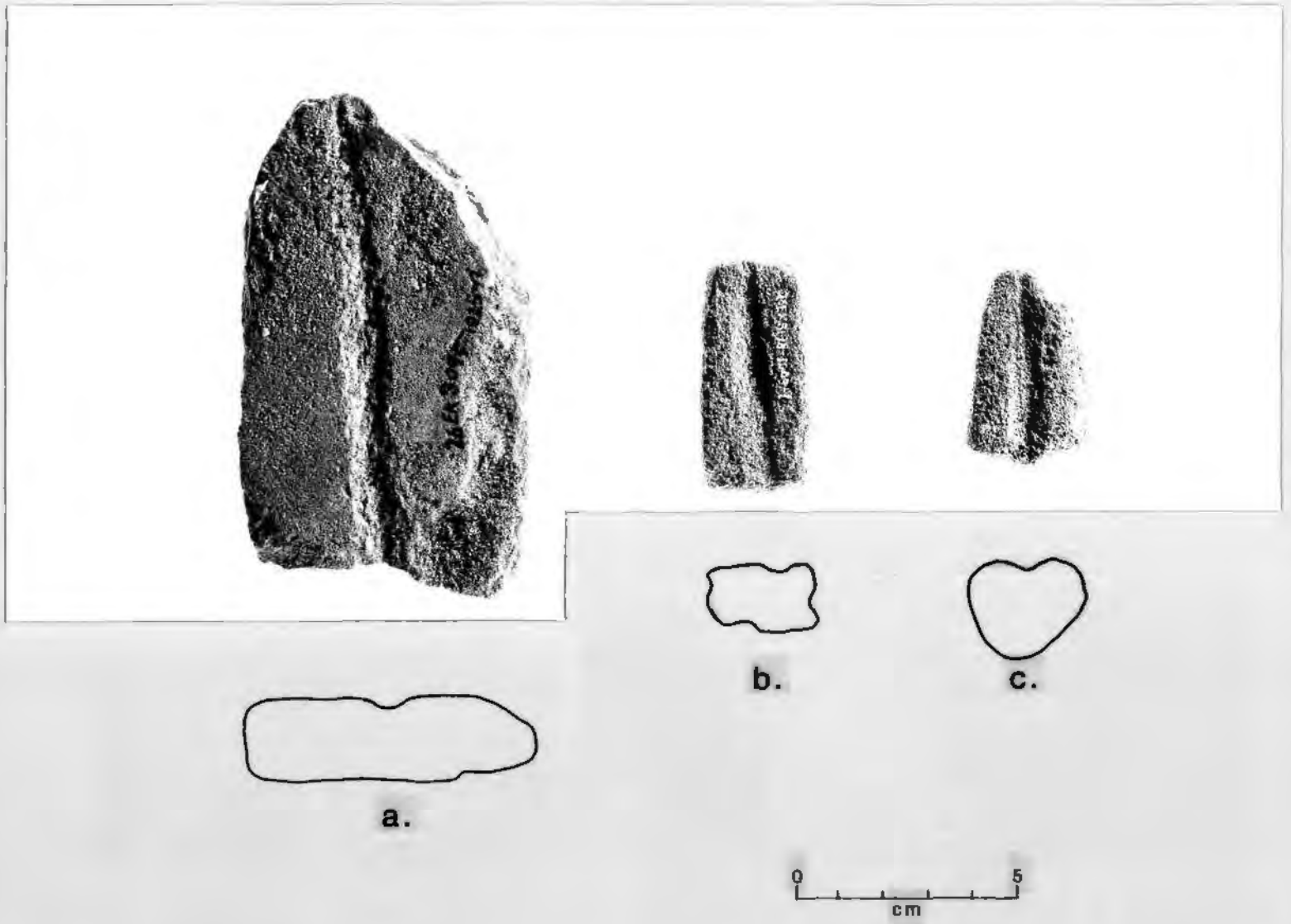
At site 26Ek3095, shaft abraders (n=2) were recovered from surface collections at features 15 and 19. Each is manufactured on sandstone and possess one linear groove. Specimen 26Ek3095-1025-1 is interesting in that it still retains manufacture (i.e., pecking) marks in the groove, suggesting minimal use (Figure 21a). While the other four specimens represent single artifacts, this groove, manufactured on a planate surface, may represent half of a paired abrader (see Flenniken and Ozbun 1988).

Surface collection at Feature 3, site 26Ek3184, recovered a sandstone shaft abrader with three linear grooves on one surface, two of which intersect near the middle of the working surface to form an "X" with the third groove offset to one side. Specimen 26Ek3198-1003-1 is a small rectangular piece of sandstone with linear grooves truncating each of its four flat surfaces (Figure 21b). Finally, specimen 26Ek3160-515-1, an ovate shaft abrader exhibiting one groove (Figure 21c), is very similar to a specimen recovered from Gatecliff Shelter (see Kramer and Thomas 1983: Figure 105). Arrow shaft abraders also have been recovered from Danger Cave (Jennings 1957), Swallow Shelter (Dalley 1976), Hogup Cave (Aikens 1970), and James Creek Shelter (Juell 1990).

Scratched Stone

A collection of 12 scratched stones comprise one of the more interesting artifact classes. These distinct artifacts possess numerous, often deep, parallel striations, probably from employment in edge preparation (i.e., weaken or strengthen biface margins) to facilitate flake removal in lithic reduction.

Figure 21. Selected shaft abraders.
a. 26Ek3095, specimen 1025-1
b. 26Ek3198, specimen 1003-1
c. 26Ek3160, specimen 515-1


b.
c.
a.
0
5
cm

Although some may have functioned as grinding implements (i.e., some have small polished facets), the number, extent, and morphology of scratches indicates that most were "dragged" repeatedly across sharp, undulating edges. Similar damage was experimentally produced on tabular basalt by such activities.

Further support to their inferred use in lithic reduction tasks is evident in their battered margins. Three specimens (26Ek3160-1005-4, 26Ek3114-1007-5, and 26Ek3271-1047-2 exhibit extensively damaged edges characteristic of percussion. Most of the scratched stones are tabular pieces (mean thickness = 3.3 mm) easily wielded with one hand. Two specimens (26Ek3160-1007-4 and 26Ek3106-1050-1 are fire-cracked and blackened indicating reuse as hearth rocks or boiling stones.

Planers

The planer assemblage consists of three nearly identical specimens collected from site 26Ek3160 (see Table 24). Each specimen is triangular in cross section and exhibits purposeful decortication on two surfaces to create sharp edges. Further flake removal along these edges is present in the form of small flake scars and step fractures that resulted from scraping and battering tasks, perhaps from use in wood working. Two specimens (26Ek3160-501-15 and 1001-1) display large polished areas on their flat "bottom" surfaces and adjacent flaked margins. Based on context (i.e., all are from Bitterroot Ridge), these artifacts may also have been utilized in the processing of bitterroot or other tubers; their polished surfaces resulted from occlusion with a hard grinding surface. Thomas and Bierwirth (1983:226-229) report similar artifacts from Gatecliff Shelter.

Other Modified Stone

The other modified stone assemblage incorporates extensively shaped, "exotic" artifacts. Two specimens are formed ornamental objects and three represent various stages of pipe manufacture.

Ornaments

Collected as an extra-feature surface find at 26Ek3160, specimen 500-31 is a fragment of an incised tuff disc (Figure 22a). The artifact bears evidence of numerous attempts to biconically perforate its center (i.e., three drilled pits truncate one surface and ca. four the other), one of which succeeded to create an aperture 6.5 mm in diameter. Numerous decorative linear striae are present on one surface, creating a "sunburst" pattern radiating from the perforation. The artifact is 17 mm thick and weighs 18.7 gms (estimated complete weight = ca. 80 gms).

Similar artifacts have been found in Great Basin sites, particularly in western Nevada (see Drews and Schmitt 1986 and references therein). These artifacts are functionally enigmatic, but may have been used as ornaments, charms, fishing sinkers, or spindle whorls employed in the manufacture of cordage.

Specimen 2142-1 was collected from subsurface deposits adjacent a hearth (Feature 2) at site 26Ek3237. The artifact possesses a scored neck near one end (maximum diameter = 12.7 mm) truncating an otherwise unmodified chalcedony nodule (Figure 22b). This enigmatic artifact probably served as an ornament/effigy, but might have been employed in fishing (e.g., a net sinker or lure weight). It weighs 11.2 grams and has a maximum diameter of 21.8 mm.

Pipes

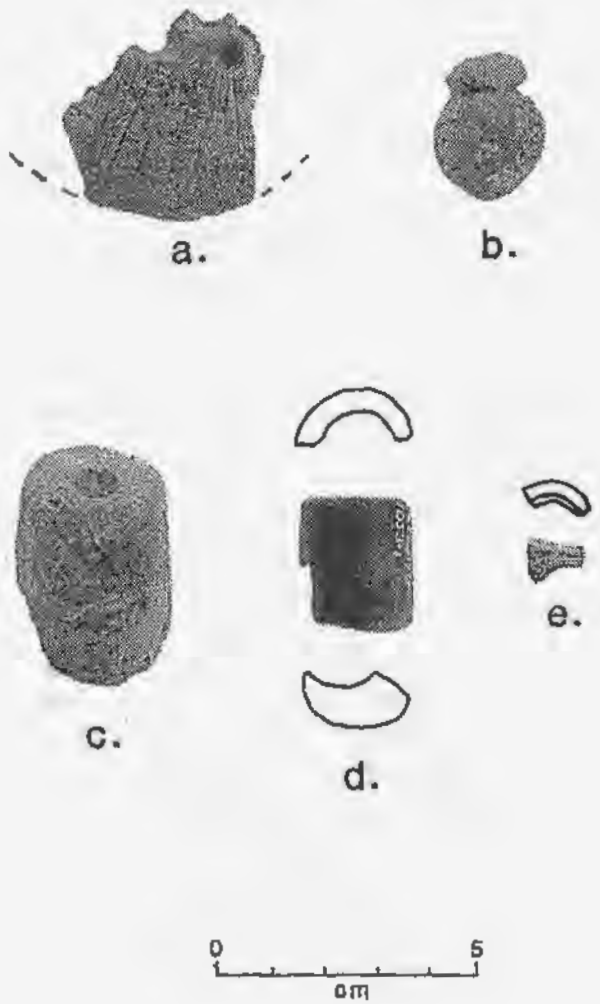
Two fragmented smoking pipes and an unfinished pipe (i.e., a preform) were collected. Shovel-skimming at Feature 19, site 26Ek3095, retrieved a shaped tuff cylinder with a small drilled pit in one end (maximum diameter = 8.4 mm; Figure 22c); the opposite end is truncated. This fragment probably represents a pipe preform that broke early in manufacture.

Specimen 26Ek3192-502-10 is a schist pipe in several fragments (outer diameter = ca. 22 mm) exhibiting multiple, longitudinal manufacture ("filing") striations within its aperture. The external surface is also striated (Figure 22d), but decoratively; the striations are isolated and circumscribe its short axis. The aperture is flared at one end, gradually tapering to a smaller opening at the other, a trait characteristic of ethnographic Shoshone pipes illustrated in Steward (1941:Figure 4 c-d).

A small pipe fragment (specimen 2021-20) was also recovered from test excavations at site 26Ek3184 (Figure 22e). Manufactured on a piece of welded tuff, the artifact possesses a small ridge adjacent to its aperture on one end indicating that it had been scored repeatedly and then snapped off a larger cylindrical segment, a technique commonly employed in the manufacture of bone tubes and beads (see Aikens 1970; Schmitt 1990). Its internal surface is blackened from use and its projected (i.e., estimated) outer diameter is 18 mm.

Unfinished pipes, complete pipes, and pipe fragments have been recovered from archaeological sites throughout the Great Basin (e.g., Budy 1987; Juell 1990; Kramer and Thomas 1983).

Figure 22. Ornaments and pipes.
a. Ornament; 26Ek3160, specimen 500-31
b. Ornament/effigy; 26Ek3237, specimen 2142-1
c. Pipe preform; 26Ek3095, specimen 1001-3
d. Pipe fragment; 26Ek3192, specimen 502-10
e. Pipe fragment; 26Ek3184; specimen 2021-20


a.
b.
c.
d.
e.
0
5
cm

Chapter 6. CERAMICS

by Dave N. Schmitt and Kenneth E. Juell

One hundred ceramic sherds were recovered by testing procedures in the Tosawihi Quarries vicinity. Most (n=55) were collected from five sites in the USX-East study area, while investigations at two sites in the USX-West study area and one site in the North Access Corridor yielded the remainder; 43 and 2 specimens, respectively. Four ceramic types are represented: Shoshone Brownware, Great Salt Lake Corrugated, Promontory Gray, and Snake Valley Gray.

Analytic Methods

Ceramics were described and typed according to observations of color, decorative technique and style, method of forming, shaping, and firing, and microscopic qualities of temper (after Juell 1987). Temper was identified by examining a freshly broken edge under a binocular microscope (25-30x). Following definitions reported in Madsen (1977), Fremont types were identified based on temper and mineral inclusions added to the paste. Shoshone Brownware sherds were identified by examining surface color, vessel wall thickness, surface manipulation, and temper. Each specimen was measured.

Brownware

Shoshone Brownware (n=82) appeared in four sites on the periphery of the Tosawihi Quarries (Table 25). Forty sherds were recovered at site 26Ek3192; 39 were collected from shovel-skimming and subsurface excavations at Feature 1, and 1 sherd was collected from the surface of Feature 2 (Table 25). Interior and exterior surface colors range from light brown to a medium reddish brown, indicating a poorly controlled oxidizing firing atmosphere. Most surfaces are deeply striated from smoothing/scraping prior to firing (Figure 23a-c). The composition and color of rock inclusions in the temper are similar to small gravels found in local drainages (e.g., rounded quartz grains, subangular rhyolite, and rounded white rock [opalite?]), suggesting that Brownwares found here may have been manufactured on or near-site.

Two Shoshone Brownware Sherds were recovered from Feature 1 at site 26Ek3181. The sherds have brown interior surfaces and medium reddish brown exterior surfaces, also indicative of firing in an uncontrolled oxidizing atmosphere. Provenience, overall morphology, and similarity in temper indicate these specimens are from the same vessel.

Table 25. Attributes and Provenience of Brownware Ceramic Sherds.

All Measurements are in Millimeters

Site No.	Reference No.	No. Sherds	Fea.	Unit Type	Level	(Mean) Length	(Mean) Width	Max. Wall Thickness	TYPE Style	TYPE Culture	SURFACE COLORS Interior	SURFACE COLORS Exterior	Temper
26Ek3160	1013	17	1	SFC	0	(23.7)	(18.3)	7.5	SBW	N	LB-RB	MB-RB	2
	1014	8	1	SFC	0	(24.8)	(19.9)	7.4	SBW	N	LB-RB	MB-RB	2
	1015	3	1	SFC	0	(21.0)	(17.0)	6.5	SBW	N	LB-MB	MB-RB	2
	1016	4	1	SFC	0	(26.1)	(18.2)	7.5	SBW	N	LB-RB	MB-RB	2
	1017	7	1	SFC	0	(30.2)	(19.8)	7.2	SBW	N	LB-MB	MB-RB	2
26Ek3174	502	1	2	IFC	S	29.9	28.9	9.4	SBW	N	KG	MB	1
26Ek3181	1010	1	1	SFC	0	20.4	19.4	6.6	SBW	N	MB	RB	2
	1011	1	1	SFC	0	14.7	10.1	6.5	SBW	N	MB	RB	2
26Ek3192	502	1	2	IFC	S	28.0	21.3	7.8	SBW	N	LB	MB	3
	1005	4	1	SFC	S	(33.4)	(24.9)	8.1	SBW	N	LB-MB	LB-RB	3
	1007	3	1	SFC	0	(31.3)	(24.6)	7.8	SBW	N	LB	LB-RB	3
	1016	1	1	SFC	0	24.1	22.5	6.8	SBW	N	LB	LB	3
	1022	10	1	SFC	0	(24.3)	(19.4)	7.8	SBW	N	LB-MB	LB-RB	3
	1024	1	1	SFC	0	20.3	17.0	6.7	SBW	N	-	RB	3
	2101	1	1	EU	1	27.7	23.5	6.6	SBW	N	LB	RB	3
	2261	18	1	EU	1	(23.4)	(20.6)	8.5	SBW	N	LB-RB	RB-MB	3
	2281	1	1	EU	1	39.5	29.5	7.6	SBW	N	LB	RB	3

Key:

Unit Type
EU = Excavation Unit
IFC = Inventory Feature Collection
SFC = Sample Feature Collection

Level
S = Surface
0 = 0-2 cm B.S.
1 = 2-10 cm B.S.

Type
SBW = Shoshone Brownware
N = Numic

Surface Colors
LB = Light Brown
MB = Medium Brown
RB = Reddish Brown
KG = Blackish Gray

Temper
1 = Fine-grained, Rounded Quartz (i.e., sand)
2 = Rounded Quartz, Sparse Angular Quartz, Undifferentiated Angular White Rock (Opalite?), and Mica
3 = Undifferentiated Rounded White and Blue-gray Rock (Opalite?), Subangular Red Rock (Rhyolite?), Rounded Quartz Grains, and Subangular Chalky (Pink) Rock

Figure 23. Examples of Shoshone Brownware (a-f), Snake Valley Gray (g), Promontory Gray (h), and Great Salt Lake Gray (i-l) ceramic sherds from testing on the peripheries of the Tosawihi Quarries.

a. 26Ek3192; specimen 1022-2, interior surface
b. 26Ek3160; specimen 1013-1-1, exterior surface
c. 26Ek3192; specimen 2281-20, exterior surface
d. 26Ek3160; specimen 1013-1-2, exterior surface
e. 26Ek3174; specimen 502-1, exterior surface
f. 26Ek3160; specimen 1013-1-3, exterior surface
g. 26Ek3198; specimen 509-3, exterior surface
h. 26Ek3092; specimen 2781-1, exterior surface
i. 26Ek3092; specimen 2042-1, exterior surface
j. 26Ek3092; specimen 2042-2, exterior surface
k. 26Ek3092; specimen 2041-14, exterior surface
l. 26Ek3092; specimen 2041-15, exterior surface



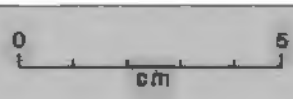
a. b. c. d.



e. f. g. h.



i. j. k. l.



Testing at Feature 1, site 26Ek3160, yielded 39 Brownware sherds. Probably representing a single vessel, temper consists largely of rounded quartz grains with some angular quartz particles, unidentified white rock, and mica. Similar to Brownware sherds collected at 26Ek3192, most surfaces (particularly interior) are striated from scraping prior to firing. One specimen possesses a biconically drilled hole (outer diameter = 9.0 mm; Figure 23f), probably drilled through the sherd in an attempt to repair a crack, but may represent an opening to facilitate hanging or carrying the vessel (cf. Heizer et al. 1968; see also Butler 1979: Figure 2). Although four rimsherds were identified in the 26Ek3160 ceramic assemblage, they are too small to infer vessel type.

A single, thick Shoshone Brownware Sherd was collected from the surface of Feature 2 at site 26Ek3174 (Figure 23e). The sherd has a very slight lateral and longitudinal curvature and may represent a basal fragment of a flat-bottomed jar. The sherd possesses a biconically drilled hole along one margin (inner diameter = 8.5 mm, outer diameter = 6.2 mm); this aperture probably also represents a hole drilled for the purpose of vessel repair.

Brownware sherds have been recovered from numerous sites in the central and eastern Great Basin (e.g., Jennings 1957; Magee 1964; Spencer et al. 1987; Thomas 1988; see especially Fowler 1968). Although the highly fragmented condition of the Tosawihi Brownware ceramic assemblage (and paucity of rimsherds) precludes inferences on vessel type, it is suspected that many specimens are fragments of large wide-mouthed, flat-bottomed jars, the most common Shoshonean vessel form (cf. Madsen 1986:211). Shoshone Brownware is poorly dated, but most likely postdates A.D. 1300 in northern Nevada (Madsen 1986:214).

Grayware

Fremont grayware was recovered from four sites in the Tosawihi Quarries vicinity. At site 26Ek3171, eight sherds (Table 26) were recovered from a discretionary surface collection unit just south of Feature 3. The sherds have exterior surface colors ranging from brownish to blackish gray, interior surfaces ranging from light to blackish gray, and a mean vessel wall thickness of 6.3 mm. The temper, consisting of rounded and subangular quartz grains, feldspar, and mica, compares most favorably to Promontory Gray (Madsen 1977:23). Promontory Gray originally was described as a Fremont grayware variety found in the Great Salt Lake variant of northwestern Utah, dating between A.D. 1000 and A.D. 1300 (Madsen 1977). Recently, however, it has been suggested that Promontory Gray vessels may also have been manufactured by later Paiute-Shoshone groups (Madsen 1986).

Table 26. Attributes and Provenience of Grayware Ceramic Sherds.

All Measurements are in Millimeters

Site No.	Reference No.	No. Sherds	Fea.	Unit Type	Level	(Mean) Length	(Mean) Width	Max. Wall Thickness	TYPE Style	TYPE Culture	SURFACE COLORS Interior	SURFACE COLORS Exterior	Temper
26Ek3092	2041	2	-	EU	1	(18.4)	(14.2)	4.1	SLC	F	LG-KG	TN	4
	2042	2	-	EU	2	(35.2)	(30.8)	3.6	SLC	F	DG	TN-BG	4
26Ek3171	2781	6	-	DSC	0	(18.2)	(12.3)	6.7	PRG	F/N	KG-MG	LG-KG	5
	2782	1	-	DSC	0	18.3	13.0	6.5	PRG	F/N	DG	LG	5
	2784	1	-	DSC	0	18.5	16.9	6.3	PRG	F/N	MG	LG	5
26Ek3198	509	3	9	IFC	S	(22.6)	(16.5)	6.7	SVG	F	LG-LB	MG	6
	1082	1	9	SFC	0	20.4	16.5	6.3	SVG	F	LG-LBG	MG-BG	6
26Ek3239	1001	1	1	SFC	0	38.8	36.4	5.8	SVG	F	LBG	BG	6
	2001	1	1	EU	1	16.6	16.4	5.9	SVG	F	LG	LBG	6

Key:

Unit Type
EU = Excavation Unit
DSC = Discretionary Unit Collection
IFC = Inventory Feature Collection
SFC = Sample Feature Collection
F/N = Fremont or Numic

Level
S = Surface
0 = 0-2 cm B.S.
1 = 2-10 cm B.S.
2 = 10-20 cm B.S.

Type
SLC = Great Salt Lake Gray, Corrugated
PRG = Promontory Gray
SVG = Snake Valley Gray
F = Fremont

Surface Colors
TN = Tan
LG = Light Gray
MG = Medium Gray
DG = Dark Gray
KG = Blackish Gray
LB = Light Brown
LBG = Light Brownish Gray
BG = Brownish Gray

Temper
4 = Rounded and Subangular Quartz Grains
5 = Rounded and Subangular Quartz Grains, Black Feldspar, Mica, and sparse white (opaque) rock
6 = Angular Quartz, Black Feldspar, and Mica

Six Snake Valley Gray sherds also were collected; four were recovered from testing at Feature 9, site 26Ek3198, and two were recovered from site 26Ek3239 during surface collections and subsurface excavations at Feature 1 (see Table 26). These sherds have interior surfaces ranging in color from light brown to light gray and exterior surfaces ranging from medium gray to brownish gray. Temper components include angular quartz, mica, and black feldspar; characteristic of Snake Valley Gray (Madsen 1977:1). This type of ceramic is the principal plainware of the Parowan Fremont variant, centered in the Parowan Valley of southwestern Utah (see Figure 4 in Madsen [1986] for a map depicting all Fremont grayware core areas). Snake Valley Gray has a temporal range of A.D. 900 - 1300 (e.g., Madsen 1977).

Finally, four corrugated Great Salt Lake Gray sherds were retrieved from subsurface excavation at site 26Ek3092 (see Table 26). Temper constituents are almost entirely rounded and subangular quartz. One specimen (2041-14; Figure 23k) is an everted neck sherd, probably representative of a cooking pot. Great Salt Lake Gray pottery has the most extensive temporal range of all Fremont ceramics; A.D. 500 to A.D. 1300 (e.g., Marwitt 1970; Madsen 1986). Elsewhere in northeast Nevada, Zeier and Zeanah (1987) report a surface collected Great Salt Lake Gray sherd from Toano Draw and Madsen (1990) reports a Great Salt Lake Gray sherd from James Creek Shelter bracketed by an overlying hearth dated to 930 B.P. and a stratigraphically earlier hearth dated to 1240 B.P., well within the range of Great Salt Lake Gray.

Although specific pottery types were not ascertained, Fremont-like grayware sherds have also been recovered from sites along the Snake River in southern Idaho (Butler 1979) and at South Fork Shelter (Heizer et al. 1968).

Part III. North Access Corridor Study Area

The results of testing at eight North Access Corridor sites are presented in Chapter 7.

Chapter 7. TESTING RESULTS

by Dave N. Schmitt

The North Access Corridor project area is a 100 foot wide, 3.5 mile linear corridor along the existing Ivanhoe Creek road. Beginning at Willow Creek on the north, the corridor traverses a series of low stream terraces before it enters Perron Canyon. The canyon, characterized by relatively steep slopes (containing occasional large rhyolitic outcrops), likely served as a natural low elevation access corridor to and from the heart of the Tosawihi Quarries. Emerging from the southern mouth of the canyon, Big Butte looms approximately four miles to the southeast; a natural landmark signifying the toolstone, water, and small mammal resources that lie ahead.

As the corridor continues south from the head of Perron Canyon, it enters the gentle, open terrain of Ivanhoe Creek Valley. This area is characterized by numerous small knolls and grassy meadows, and the alluvial slopes and stream terraces that border Ivanhoe Creek.

Vegetation in the corridor is comprised largely of big sage and low sage communities, with a sparse to dense cheatgrass understory. Big sage is most common in deeper soils, especially in alluvial sediments along stream channels, while low sage occurs more frequently in association with exposed bedrock and shallow colluvial deposits. In addition to sage, both communities include rabbitbrush, Great Basin wildrye, bluebunch wheatgrass, squirreltail, fescue, and lupine.

This chapter presents the results of archaeological testing in the northern segment of the North Access Corridor. The chapter first summarizes sites by type, then presents methods employed in field investigations. Chronological markers and intersite comparisons of artifact assemblages are discussed next, followed by descriptions specific to topographic location, site structure, and artifact constituents and frequencies. Finally, the results of testing are summarized in terms of their data potential in relation to the economics of toolstone transportation, their place in the regional economy, and cultural chronology.

Descriptive Site Summary

Fourteen archaeological sites were identified along the northern segment of the Access Road corridor (Figure 24, Table 27) of which six sites were not tested: three isolates, two diffuse, undifferentiated lithic scatters, and one historic can scatter (see Drews 1988). The remaining eight sites, five reduction loci and three reduction/ residential complexes, were examined further and are the subjects of this chapter.

Figure 24. North access corridor site location map.

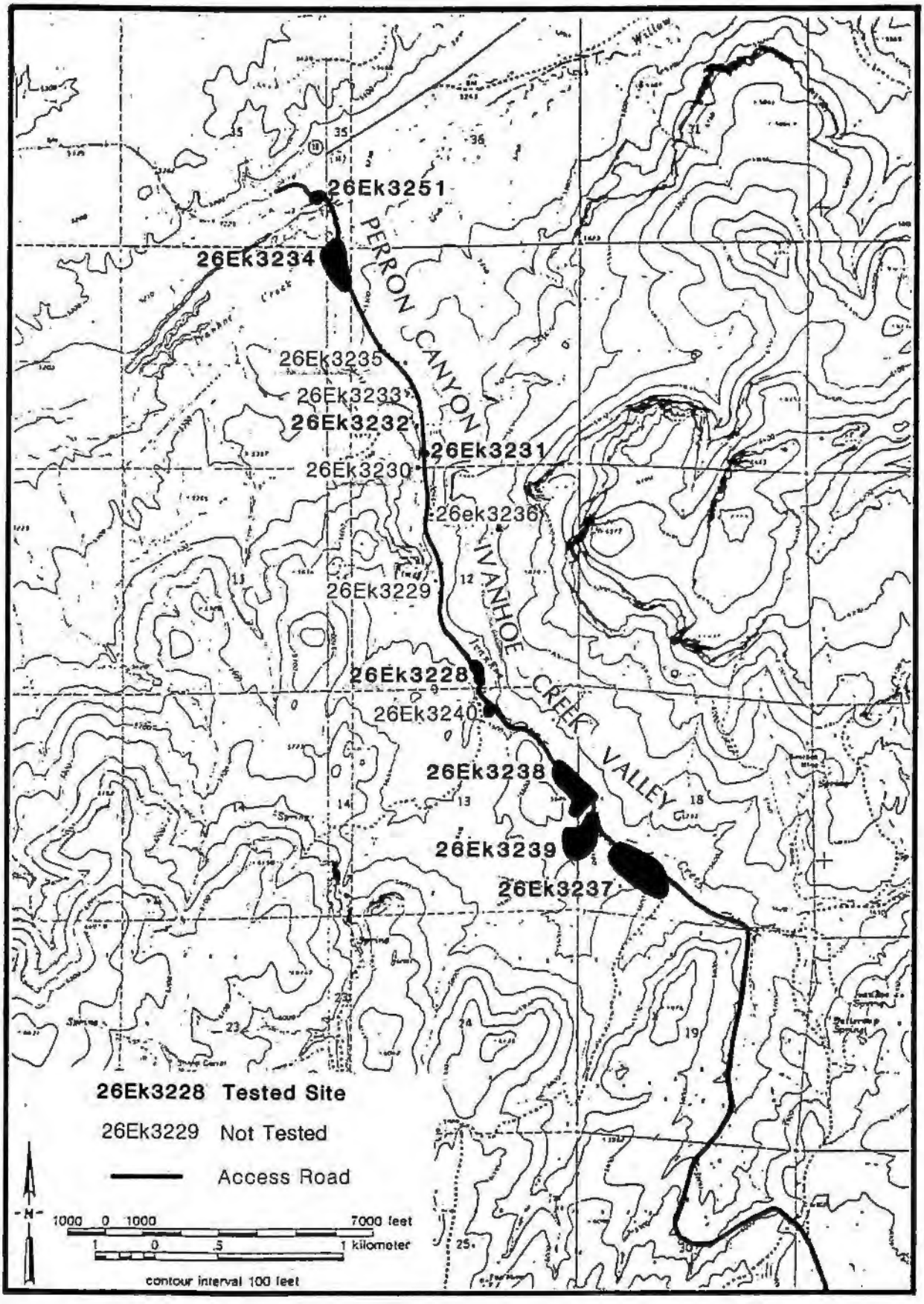

26Ek3251
26Ek3234
PERRON CANYON
26Ek3235
26Ek3233
26Ek3232
26Ek3231
26Ek3230
26ek3236
26Ek3229
IVANHOE CREEK VALLEY
26Ek3228
26Ek3240
26Ek3238
26Ek3239
26Ek3237
26Ek3228 Tested Site
26Ek3229 Not Tested
Access Road
1000 0 1000 7000 feet
1 0 .5 1 kilometer
contour interval 100 feet

Table 27. Descriptive Summary, North Access Corridor Sites.

Site Number	Type	Features (n)	Maximum Site Area (sq m)
26Ek3228	Reduction Complex	2	4,750
26Ek3229	Historic [NOT TESTED]	-	100
26Ek3230	Undifferentiated Scatter [NOT TESTED]	-	100
26Ek3231	Reduction Station	1	2,100
26Ek3232	Reduction Station	1	1,590
26Ek3233	Isolate [NOT TESTED]	-	N/A
26Ek3234	Undifferentiated (Reduction) Scatter	None	4,200
26Ek3235	Isolate [NOT TESTED]	-	N/A
26Ek3236	Isolate [NOT TESTED]	-	N/A
26Ek3237	Reduction/Residential Complex	2	42,000
26Ek3238	Reduction Complex	2	22,500
26Ek3239	Reduction/Residential Complex	1	12,800
26Ek3240	Undifferentiated Scatter [NOT TESTED]	-	15,000
26Ek3251	Reduction/Residential Complex	6	15,000

Reduction sites in the North Access Corridor study area occur in a variety of geographic settings. Two sites (26Ek3231 and 26Ek3232) are situated on stream terraces bordering the eastern bank of Ivanhoe Creek at the northern mouth of Perron Canyon. Each site contains a small lithic concentration surrounded by a sparse scatter of opalite debitage. Located approximately one mile north of Perron Canyon, site 26Ek3234 (an undifferentiated lithic scatter) occupies a terrace riser overlooking Willow Creek to the north and Ivanhoe Creek to the west. The two remaining reduction sites are situated on low stream terraces and associated knolls and inset fans along the west bank of Ivanhoe Creek. Site 26Ek3228 is characterized by two spatially discrete debitage concentrations and a light to sparse lithic scatter that roughly defines its northern boundary. Similarly, site 26Ek3238 (one kilometer upstream of 26Ek3228) contains a lithic concentration within sparse scatters of opalitic debitage.

Although debris from toolstone processing is abundant, sites 26Ek3237, 26Ek3239, and 26Ek3251 yielded large, diverse artifact assemblages suggesting short term campsites. Site 26Ek3237 exhibits three topographically distinct lithic concentrations containing a variety of chert, opalite, and obsidian debitage, and formed artifacts, such as projectile points and preforms, scrapers, hammerstones, and a host of Small and Quarry Bifaces. Test excavations revealed a near-surface fire hearth in the northern site area.

Just north of 26Ek3237, site 26Ek3239 contains a small lithic concentration located on the north trending lobe of a finger ridge. Use as a short term camp is suggested by the

recovery of pottery, scrapers, choppers, bifaces, and expedient flake tools. A small opalite cobble field (Locus A) is located adjacent an ephemeral drainage along the northern boundary of the site: although the grainy, weathered toolstone is poor quality, a few hammerstones and assayed pieces were observed in this site area.

Occupying a terrace above the north bank of Willow Creek, six discrete, functionally diverse features are located within the confines of site 26Ek3251. As suggested by the wealth of stylized tools, Small Bifaces, and ground stone, this area also appears to have served as a short term habitation locus where a variety of subsistence tasks were undertaken.

Testing Strategies

Testing in the North Access Corridor was designed to characterize surface manifestations and to explore the extent of subsurface deposits, as summarized in Table 28 below.

Table 28. Summary of Testing Procedures, North Access Corridor.

			FEATURE CONTEXT		NONFEATURE CONTEXT		RECOVERED COLLECTIONS	
	FEATURES RECORDED		Surface Skim	Subsurface Excavation	Surface Skim	Subsurface Excavation		
Site Number	Total (n)	Sampled (n)	Area (sq m)	Volume (cu m)	Area (sq m)	Volume (cu m)	Debitage (n)	Formed Artifacts (n)
26Ek3228	2	2	4.00	0.10	-	-	497	9
26Ek3231	1	1	4.00	-	-	-	313	5
26Ek3232	1	1	4.00	-	-	-	163	7
26Ek3234	-	-	-	-	2.00	-	13	3
26Ek3237	2	*1	-	0.20	9.00	1.20	1,887	97
26Ek3238	2	1	8.00	-	2.00	0.65	3,610	44
26Ek3239	1	1	4.00	0.10	-	-	1,944	47
26Ek3251	6	3	24.00	1.15	-	0.10	12,751	119

* Feature 2 was discovered in subsurface excavation.

Each site was examined by close-interval transects; identified features and extra-feature artifacts (i.e., formed artifacts found within site boundaries in non-feature contexts) flagged for subsequent mapping and collection. Unlike surface expressions in and adjacent to the Tosawihi Quarries (see, for example, Chapter 16), discrete feature concentrations are rare in the northern corridor; consequently, testing was directed towards retrieval of tools and debitage from large, undifferentiated scatters. This was achieved through systematic shovel skimming of units established along a baseline transect and/or placement and excavation of a test unit. When present, a feature (or features) was investigated by similar techniques and all surrounding artifacts were mapped and collected.

At site 26Ek3251, three of the six identified feature loci were sampled via systematic surface collections and/or excavation units. The selection of features for special scrutiny was based largely on surface debitage and tool densities and to sample the range of variability displayed by (inferred) different feature types. As was the case with a core reduction locus at 26Ek3237 and a collapsed rock cairn at 26Ek3238, features not systematically sampled at 26Ek3251 were inventoried; recordation included documentation of flake densities, functional inferences based on structure and content, and construction of a sketch map where all stylized tools were plotted and collected.

Chronology

Relative and absolute time markers were recovered from five of the eight sites investigated. At Willow Creek, sparse flecks of charcoal were observed during excavations at site 26Ek3251, but larger composite samples and/or exposure of a hearth feature are needed for radiocarbon assay. Projectile points from 26Ek3251, however, denote occupation during the Late Archaic, perhaps until protohistoric times; Rosegate, Desert Side-notched, and Cottonwood points were recovered (Table 29). Similarly, a single Rosegate point from Site 26Ek3231 also indicates Late Archaic occupation in the Perron Canyon area.

Numerous time sensitive artifacts were recovered from sites in Ivanhoe Creek Valley, suggesting occupation over thousands of years. Testing at site 26Ek3238 returned a Large Side-notched point and a Gatecliff Split Stem point indicating occupation sometime between 4,500 and 2,800 years ago. Although two point fragments from 26Ek3238 fall out of Thomas's (1981) key, both are square, edge ground basal fragments of large, stemmed lanceolate points that may be indicative of great antiquity; projectile points with similar basal morphology have been found in association with lacustrine Pre-Archaic sites in northwest Nevada (see Clewlow 1968, Figure 10o; Layton 1979, Figure 5).

At site 26Ek3239, recovery of an Elko Corner-notched point and a Rosegate point indicate occupation occurred between 850 B.C. and A.D.1300. Corresponding with the A.D. 700 - A.D. 1300 Rosegate occupation, two Snake Valley Gray pot sherds collected from Feature 1 date between A.D. 900 and A.D. 1200 (Madsen 1977).

Test excavations and surface collections at site 26Ek3237 retrieved a diverse array of projectile points and a radiocarbon date from a hearth feature. Diagnostic points there include Great Basin Stemmed (obsidian), Gatecliff Split Stem, Large Side-notched, and Rosegate Series. Radiocarbon assay of charcoal collected from Feature 1 returned a date of 150 +/- 60 B.P. (Beta-28314), indicating a very late prehistoric (perhaps protohistoric) occupation as well. While the stemmed point

fragment may signify an occupation as early as 8,000 B.P., it appears to have been reworked and may have been scavenged elsewhere and transported to the site by later inhabitants (cf. Schmitt et al. 1988). Minimally, diagnostic artifacts and the C^{14} date indicate various occupations occurred between about 4.000 B.P. and the mid-to-late 1800s.

Table 29. Projectile Point Types from North Access Corridor Sites.

Site Number	Classifiable Types STM	GGS	LSN	ECN	RSG	CTN	DSN	OOK	TOTAL
Reduction Sites									
26EK3228	-	-	-	-	-	-	-	-	0
26Ek3231	-	-	-	-	1	-	-	-	1
26Ek3232	-	-	-	-	-	-	-	-	0
26Ek3234	-	-	-	-	-	-	-	-	0
26Ek3238	2	1	1	-	-	-	-	-	4
Reduction/ Residential Sites									
26Ek3237	1	1	1	-	2	-	-	2	7
26Ek3239	-	-	-	1	1	-	-	-	2
26Ek3251	-	-	-	-	1	2	1	-	4
Total	3	2	2	1	5	2	1	4	20

Type Designations (after Thomas 1981)

STM = Great Basin Stemmed
GGS = Gatecliff Split Stem
LSN = Large Side-notched
ECN = Elko Corner-notched
RSG = Rosegate Series
CTN = Cottonwood Series
DSN = Desert Side-notched
OOK = Points Rejected by Thomas (1981) Key

Assemblage Composition

Artifacts collected from sites in the North Access Corridor include an array of reduction artifacts (e.g., cores and Quarry and Small Bifaces) as well as subsistence related artifacts and stylized tools (Table 30). Overall, bifaces dominate tool assemblages, on the average comprising 73% of the total artifacts recovered. Except at site 26Ek3251, Quarry Bifaces are most abundant (n=67) followed closely by Small Bifaces (n=59) and finally by Preforms (n=6). Reduction artifacts collected from site 26Ek3251 display a quite different pattern as Small and Preform Bifaces are most abundant (see Table 30) and Quarry Bifaces are represented by only six fragmentary specimens. This may be due in part to the residential character of the site and the economics of toolstone transportation; its distance from the Tosawihi Quarries suggests that a certain amount of latter stage lithic processing occurred before flaked stone items reached the site (cf. Elston 1988).

Table 30. Intersite Artifact Class Frequency Comparisons, North Access Corridor Sites.

ARTIFACT CLASS	ARTIFACT FREQUENCY PER SITE							
	Reduction Sites					Reduction/Residential Complexes		
Lithic Processing/	26Ek3228	26Ek3231	26Ek3232	26Ek3234	26Ek3238	26Ek3239	26Ek3237	26Ek3251
Reduction Tools								
Hammerstones	-	-	-	-	-	2	1	-
Other Percussion	-	-	-	-	1	3	-	2
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	1(2.3)	5(10.6)	1(1.0)	2(1.7)
Reduction Artifacts								
Assayed Pieces	-	-	-	-	-	-	1	-
Cores	-	-	1	-	1	-	6	-
Quarry Bifaces	5	1	4	1	14	11	31	6
Preform Bifaces	-	1	-	-	-	-	5	21
Small Bifaces	1	1	1	1	13	10	32	38
Indeterm. Bifaces	2	1	-	-	5	10	1	23
Subtotal (%)	8(88.9)	4(80.0)	6(85.7)	2(66.7)	33(75.0)	31(66.0)	76(78.4)	88(73.9)
Projectile Points								
Classifiable Types	-	1	-	-	2	2	5	4
Unclassifiable	-	-	-	-	3	-	2	3
Subtotal (%)	0(0)	1(20.0)	0(0)	0(0)	5(11.4)	2(4.3)	7(7.2)	7(5.9)
Maintenance and/or Processing Tools								
Scrapers	-	-	1	-	3	4	8	5
Knives	-	-	-	-	-	1	-	1
Gravers	-	-	-	-	-	-	1	-
Perforators	-	-	-	-	-	1	-	1
Multipurpose Flakes	-	-	-	1	1	-	1	1
Simple Flake Tools	-	-	-	-	-	1	1	3
Subtotal (%)	0(0)	0(0)	1(14.3)	1(33.3)	4(9.1)	7(14.9)	11(11.3)	11(9.2)
Plant Processing								
Metates	1	-	-	-	1	-	1	9
Manos	-	-	-	-	-	-	-	2
Subtotal (%)	1(11.1)	0(0)	0(0)	0(0)	1(2.2)	0(0)	1(1.0)	11(9.2)
Miscellaneous Artifacts								
Exotic/Decorated	-	-	-	-	-	-	1	-
Pottery	-	-	-	-	-	2	-	-
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	0(0)	2(4.3)	1(1.0)	0(0)
Site Total	9	5	7	3	44	47	97	119

Maintenance and/or processing tools were collected from six sites, and, not surprisingly, are most frequent at large residential/reduction complexes. Represented by an assortment of shapes and sizes, scrapers constitute the most abundant processing tool type; some are carefully formed flakes (modified for hafting?) with unifacially retouched and extensively utilized edges, while others display little or no stylistic modification and minimal use-wear. These latter specimens tend to be smaller and more irregular in shape than formed scrapers, probably indicative of expedient use in a single task.

With the exception of site 26Ek3251, ground stone artifacts are rare in the North Access Corridor (see Table 30). However, one of the largest assemblages of ground stone artifacts retrieved in the Tosawihi Quarries vicinity to date came from site 26Ek3251. Nine metate fragments were recovered from a variety of contexts, each representing a separate artifact as evident by differences in overall morphology and raw material types. Metates range from coarse tuff exhibiting moderate use-wear (often bifacial) to shaped, tabular rhyolite displaying extensive polish over large surface areas. In conjunction with other artifact classes, the relative wealth of ground stone at 26Ek3251 clearly suggests residential site use.

Reduction Sites

Except for site 26Ek3234, where no features were observed, reduction sites in the North Access Corridor generally are characterized by one or two distinct debitage concentrations apparently generated during the reduction of bifaces. Biface reduction features are usually small in area (on the average covering less than 8 m^2), each seemingly representative of a single reduction episode. Each of these reduction loci is situated within sparse opalite flake scatters ranging between 1,590 m^2 at site 26Ek3232 to over 22,000 m^2 at site 26Ek3238.

Site 26Ek3228

Site 26Ek3228 is located along the western terrace of Ivanhoe Creek at an elevation of 5460 ft. (1665 m). Although transected by the Ivanhoe Creek road, most of the site remains intact. The southern portion of the site consists of two discrete lithic concentrations (Locus A; features 1 and 2) situated approximately 5 meters apart. The northern site area is roughly defined by Locus B, a sparse density (2 items per m^2) lithic scatter encompassing 700 m^2. While no systematic collections were undertaken, surface reconnaissance identified two Quarry Biface fragments in this site area. Cultural materials between these loci were sparse, not exceeding one item per 3 m^2.

Features 1 and 2 were sampled systematically by surface scraping a block of four contiguous 1 by 1 m units in the center of each concentration. Feature 1 yielded 132 pieces of opalite debitage and a metate exhibiting faint use-wear polish (Tables 31 and 32). In order to further explore the contents of the feature, a 50 cm by 1 m test unit was excavated to a depth of 20 cm. Only five opalite flakes were recovered from subsurface testing, all of which were encountered in the uppermost 10 cm of excavated deposits.

Although Feature 2 returned a higher frequency of debitage and six reduction artifacts (see Tables 31 and 32), both features appear to represent brief reduction episodes where Quarry Bifaces manufactured on high quality toolstone were further reduced as suggested by the wealth of small flakes and lack of angular shatter.

Table 31. Debitage from Sample Collections at Reduction Sites in the North Access Corridor.

SURFACE COLLECTIONS

Site	Fea	Total Area	Skim Area	Mean Density	OPALITE DEBITAGE Flakes			Shatter			OTHER DEBITAGE		
Number	No.	(sq m)	(sq m)	(sq m)	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
26Ek3228	1	6	4	33	132	100.0	0.4	-	-	-	-	-	132
	2	4	4	88	360	100.0	0.9	-	-	-	-	-	360
26Ek3231	1	6	4	79	254	81.2	0.7	59	18.8	0.6	-	-	313
26Ek3232	1	5	4	41	77	47.2	2.3	85	52.1	3.1	1	0.6	163
26Ek3234	-	-	2	7	11	84.6	0.3	1	7.7	0.1	1	7.7	13
26EK3238	1	14	8	371	2832	95.6	0.8	103	3.5	1.4	26	0.9	2961
	-	-	2	32	60	93.8	0.8	1	1.6	24.5	3	4.7	64

SUBSURFACE COLLECTIONS

Site	Fea.	Unit	Depth	Volume	OPALITE DEBITAGE Flakes			Shatter			OTHER DEBITAGE		
Number	No.	No./Type	(cm BS)	(cu m)	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
26Ek3228	1	1 / E	20	0.10	5	100.0	0.1	-	-	-	-	-	5
26EK3238	-	1 / C	30	0.30	337	78.4	0.6	72	16.7	1.2	21	4.9	430
	-	2 / B	10	0.10	2	66.7	0.3	1	33.3	0.2	-	-	3
	-	3 / B	30	0.30	112	73.7	0.5	33	21.7	0.8	7	4.6	152

Key to Excavation Unit Type
B = 1 by 1 m, 1/4 in. screen
C = 1 by 1 m, 1/4 in. screen with 1/8 in. sample quad.
E = 50 cm by 1 m, 1/4 in. screen

Table 32. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Reduction Sites in the North Access Corridor.

Site No. (26Ek)	Fea. No.	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction OP	CR	QB	PB	SB	IB	Points GGS	LSN	RSG	FRG	Processing SC	MP	GS	Total
3228	1	Biface Reduction: Sample Feature	6	-	-	-	-	-	-	-	-	-	-	-	-	1	1
	2	Biface Reduction: Sample Feature	4	-	-	1	-	1	2	-	-	-	-	-	-	-	4
	-	Extra-Feature	N/A	-	-	4	-	-	-	-	-	-	-	-	-	-	4
3231	1	Biface Reduction: Sample Feature	6	-	-	-	1	1	1	-	-	-	-	-	-	-	3
	-	Extra-Feature	N/A	-	-	1	-	-	-	-	-	1	-	-	-	-	2
3232	1	Biface Reduction: Sample Feature	5	-	-	2	-	1	-	-	-	-	-	1	-	-	4
	-	Extra-Feature	N/A	-	1	2	-	-	-	-	-	-	-	-	-	-	3
3234	-	Extra-Feature	N/A	-	-	1	-	1	-	-	-	-	-	-	1	-	3
3238	1	Biface Reduction: Sample Feature	18	-	-	6	-	1	1	-	-	-	-	1	-	-	9
	-	* Extra-Feature	N/A	1	1	8	-	12	4	1	1	-	3	2	1	1	35

* Includes two artifacts (a small biface and scraper) recovered from subsurface excavation in Unit 1 and an indeterminate biface fragment from non-feature Excavation Unit 3.

Key to Artifact Classes:

Reduction Tools and Artifacts
OP = Other Percussion
CR = Cores
QB = Quarry Bifaces
PB = Preform Bifaces
SB = Small Bifaces
IB = Indeterm. Biface Fragments

Projectile Points
GGS = Gatecliff Split Stem
LSN = Large Side-notched
RSG = Rosegate Series
FRG = Unclassifiable/Fragments

Maintenance/Processing
SC = Scrapers
MP = Multipurpose Flake Tools
GS = Groundstone

Sites 26Ek3231 and 26Ek3232

Neighboring sites 26Ek3231 and 26Ek3232 occupy a gravelly stream terrace bordering the eastern bank of Ivanhoe Creek (Figure 25a and 25b, respectively) at an elevation of approximately 5300 ft (1616 m). Each site contains a single lithic concentration characterized by a small, light density scatter of opalite debitage. Too, both sites have been disturbed in recent times; site 26Ek3231 by construction of the Ivanhoe Creek road (which embedded a Rosegate Series point in the road berm) and site 26Ek3232 by a camping sheep herder.

Figure 25. Overviews of two North Access Corridor sites.

a. Site 26Ek3231 looking southwest. Arrow locates Feature 1.
b. Site 26Ek3232 looking northwest. Arrow locates Feature 1.



a.



b.

Features were sampled at these sites (each designated as Feature 1) by shovel skimming a contiguous block of four 1 by 1 m units. Feature sample collections at 26Ek3231 returned 313 small pieces of debitage and three bifaces (see Tables 31 and 32) indicative of latter stage reduction; the toolstone is all of high quality. Conversely, early stage reduction of poor quality opalite occurred at 26Ek3232; the debitage is represented by larger items (mean wt. = 2.7 g) and there is a much higher frequency of shatter (52% as compared to 18% at 26Ek3231). In fact, the ratio of shatter to flakes at 26Ek3232 is the highest of any site tested along the North Access Corridor. Reduction artifacts (particularly the Quarry Bifaces) also reflect early stage reduction of poor quality material, most of which displays weathering cracks and large vugs.

Site 26Ek3234

Site 26Ek3234 consists of a sparse lithic scatter situated near the toeslope of a northwest finger ridge overlooking Willow Creek to the north and Ivanhoe Creek to the west. Soil is a consolidated silty loam containing abundant subangular gravels and cobbles.

Because no discrete features were identified, the site was sampled by shovel skimming eight 50 by 50 cm units at 5 m intervals along a north-south transect. Based on the paucity of debitage and formed artifacts (see Tables 31 and 32) over the large surface area, it appears the site was used for multiple (yet infrequent) short term episodes of lithic reduction and maintenance. The lack of lithic concentrations or other features and the overall scarcity of cultural items precluded further surface collections or subsurface excavations.

Site 26Ek3238

Site 26Ek3238 is a large, linear lithic scatter on the west terrace of Ivanhoe Creek and associated toeslope of a north trending inset fan. The northern portion of the site is a sparse density lithic scatter with no lithic concentrations and only a few surface artifacts. Two lithic features were recorded in the southern portion of the site, one represented by a light-to-moderate density flake concentration (Feature 1) and the other a collapsed rock cairn (Feature 2). Both features are located just south of the stream terrace on the elevated northern toe of an inset fan. Extra-feature artifacts collected from this site area include a scraper, a Gatecliff Split Stem projectile point, and Quarry and Small Bifaces.

Approximately 50% of Feature 1 was collected by shovel skimming two disjunct blocks of 2 by 2 m units. Surface collections retrieved 2961 pieces of debitage, largely

represented by off-white opalite biface thinning flakes with relatively little of shatter and exotic cherts (see Table 31). Formed artifacts also reflect the reduction/manufacture of bifaces at Feature 1 as the assemblage is dominated by bifaces (89%; see Table 32), most of which are Quarry Bifaces exhibiting various manufacture failures.

Feature 2 consists of a partially collapsed rock cairn covering a 1.8 by 2.2 m area. Rocks used in its construction are all locally available large (ave. diameter ca. 35 cm), subangular rhyolitic cobbles. Based on the number of rocks present, the cairn may have been 5 to 6 courses high. Because no historic or prehistoric artifacts are directly associated, the age and function of the feature remains unknown; it may represent a prehistoric hunting feature or locational marker, or it may be a claim marker associated with historic mining activities in the Tosawihi Quarries vicinity (Zeier 1987; see also Pendleton and Thomas 1983; Schmitt 1988).

In order to examine surface and subsurface deposits on the terrace, eight 50 by 50 cm units were shovel skimmed along a baseline parallel to the terrace and three excavation units were randomly placed. Surface collections and excavations revealed the presence of cultural materials on the terrace, but found them relatively scarce (see Table 31) and largely restricted to the uppermost 20 cm of the deposits; as clays and gravels increased at ca. 15 cm below the surface, debitage frequencies dropped off considerably in excavation units 1 and 3.

Reduction/Residential Sites

Three reduction/residential site complexes were identified along the North Access Corridor; two are located in Ivanhoe Creek Valley (26Ek3237 and 26Ek3239) and one adjacent to Willow Creek (26Ek3251). Although the reduction of Quarry Bifaces and the manufacture of Small Bifaces was common at these sites, the diversity and abundance of other artifact classes suggest that these sites served as temporary residential loci where a variety of tasks was undertaken.

Site 26Ek3237

Site 26Ek3237 consists of three discrete loci situated on low stream terraces and at the toe of a north-trending finger ridge or ballena on the southwest side of Ivanhoe Creek Canyon. The ballena is one of many formed by erosion of old (probably Pleistocene) alluvial fans. Elevations in the general site area range from 5545 to 5600 ft.

Locus A occupies a low alluvial terrace of Ivanhoe Creek and is bisected by the Ivanhoe Creek and Governor Mine access

roads. Locus A is bounded on the east and north by an ephemeral drainage that flows into Ivanhoe Creek, and on the west by the gentle slope of an unnamed ridgeline (Figure 26). In addition to a light density debitage scatter, the surface of Locus A yielded a scraper, a Gatecliff Split Stem point, and seven bifaces (Table 33). As evident in Figure 26, recent construction of the Ivanhoe Creek and Governor Mine roads have disturbed rather large portions of Locus A. The single piece of groundstone (a metate fragment) recovered from the site was found just north of the locus, adjacent to the Ivanhoe Creek Road.

Shovel-skimming in Locus A returned 120 pieces of opalite debitage from eight 50 by 50 cm units (Table 34). Test excavations revealed buried cultural items in the uppermost 20 cm of deposit. In Unit 1, 210 of the 243 debitage items (86%) were retrieved from levels 1 and 2; similarly, 85% of the 172 pieces of debitage collected from Unit 4 were in the first two levels excavated. Debitage types are dominated by small opalite flakes in each excavation unit aggregate (98% and 84%, respectively).

Locus B appears on the gradually sloping toe of the ridge that extends south of the site (Figure 26). Soils consist of shallow colluvial deposits comprised of gravelly silt with some cobbles. Locus B is characterized by a scatter of opalite secondary and biface thinning flakes intermixed with some obsidian and chert debitage. Formed artifacts recovered from the surface of Locus B include a Rosegate Series point, two flake tools, and an array of Small (n=9) and Quarry (n=2) Bifaces (see Table 33). Based on the light density of lithic debitage present and the colluvial depositional environment, testing in Locus B was less intensive, involving the shovel-skimming of only five 1 by 1 m units established along a linear transect. Systematic surface collections yielded 468 pieces of debitage (98% are opalite flakes; Table 34), a core, and a Rosegate Series point.

A concentration of core/biface reduction debris (Feature 1) was located midway between Locus B and the break in slope at the base of the hill (see Figure 26). The feature contained numerous large primary and secondary flakes of opalite in association with a core and three Quarry Bifaces.

Located northwest of Locus B, Locus C is situated adjacent an area where several ephemeral drainages flow into Ivanhoe Creek. Quite likely, inset alluvial fans and terraces once were present along these drainages, but flooding and down cutting have scoured out the alluvium and only the underlying resistant alluvial and colluvial deposits remain. Locus C is situated at the toe of a ridge that has been scoured of alluvial deposits, but recent colluvial deposition may obscure buried terrace remnants.

Table 33. Description of Artifact Classes by Locus, Feature, and/or Extra-Feature Contexts, Site 26Ek3237.

Site Area/ Collection Type	ARTIFACT CLASSES: Reduction HM	CR	AS	QB	PB	SB	IB	Points STM	GGS	LSN	RSG	FRG	Processing SC	PG	MP	OF	GS	EX	Total
Locus A																			
Extra-Feature	-	2	1	3	-	4	-	-	1	-	-	-	1	-	-	-	-	-	12
Locus B																			
DSC 3	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2
Extra-Feature	-	-	-	2	-	9	-	-	-	-	1	-	-	1	1	-	-	-	14
Locus C																			
DSC 2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
EU 2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
EU 3	-	-	-	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	3
EU 5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Extra-Feature	1	1	-	12	1	5	-	-	-	-	-	1	2	-	-	-	-	-	23
Feature 1																			
Surface	-	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Non-Locus/Feature																			
Extra-Feature	-	1	-	10	3	14	-	1	-	1	-	-	3	-	-	1	1	-	35

Key: DSC = Discretionary Unit Collection
EU = Excavation Unit Collection

Reduction
HM = Hammerstones
CR = Cores
AS = Assayed Pieces
QB = Quarry Bifaces
SB = Small Bifaces
IB = Indeterminate Bifaces

Projectile Points
STM = Great Basin Stemmed
GGS = Gatecliff Split Stem
LSN = Large Side-notched
RSG = Rosegate Series
FRG = Unclassifiable/Fragments

Processing
SC = Scrapers
PG = Perforators/Gravers
MP = Multipurpose Flake Tools
OF = Other Flake Tools
GS = Ground Stone
EX = Exotic Artifacts

Table 34. Debitage from Sample Collections at Reduction/Residential Sites in the North Access Corridor.

SURFACE COLLECTIONS

Site Number	Feature (Locus)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3237	(A)	2	60	119	99.2	0.7	1	0.8	0.6	-	-	120
	(B)	5	94	461	98.5	0.8	7	1.5	5.5	-	-	468
	(C)	2	77	145	94.2	1.0	3	1.9	5.2	6	3.9	154
26Ek3239	1	4	339	1354	92.4	1.0	105	7.2	0.6	6	0.4	1465
26Ek3251	1	12	160	1922	91.0	0.4	182	8.6	1.3	8	0.4	2112
	2	12	598	7176	98.8	0.5	84	1.2	2.2	-	-	7260

SUBSURFACE COLLECTIONS

Site Number	Feature (Locus)	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3237	(A)	1 / C	30	.25	239	98.4	0.6	2	0.8	1.9	2	0.8	243
	(C)	2 / B	20	.20	166	96.0	0.7	6	3.5	16.3	1	0.6	173
	(C)	3 / C	30	.25	419	94.8	0.7	17	3.8	11.9	6	1.4	442
	(A)	4 / B	30	.30	144	83.7	0.9	27	15.7	0.8	1	0.6	172
	2	5 / C	20	.20	103	89.6	0.5	10	8.7	0.9	2	1.7	115
26Ek3239	1	1 / F	20	.10	461	96.2	0.3	16	3.3	0.5	2	0.4	479
26Ek3251	1	1 / F	30	.125	1298	94.7	0.2	66	4.8	0.9	7	0.5	1371
	-	2 / B	10	.10	13	81.3	0.3	3	18.7	0.7	-	-	16
	6	3 / C	50	.50	853	91.1	0.4	28	3.0	1.3	55	5.9	936
	2	4 / B	40	.40	1015	96.1	0.4	41	3.9	1.0	-	-	1056

Key to Excavation Unit Type
B = 1 by 1 m, 1/4 in. screen
C = 1 by 1 m, 1/4 in. screen with 50 by 50 cm 1/8 in. sample quad
F = 50 cm by 1 m, 1/4 in. screen with 50 by 50 cm 1/8 in. sample quad

A total of 799 artifacts was recovered from Locus C; 155 items from shovel-skimming eight 50 by 50 cm units, 621 from subsurface excavations, and 23 isolated (i.e., extra-feature) tools (see Tables 33 and 34). An additional six formed artifacts were surface collected during reconnaissance in the vicinity immediately surrounding the locus (Figure 27), including a reworked Great Basin Stemmed point fragment near the western locus boundary.

Figure 26. 26Ek3237, site map.

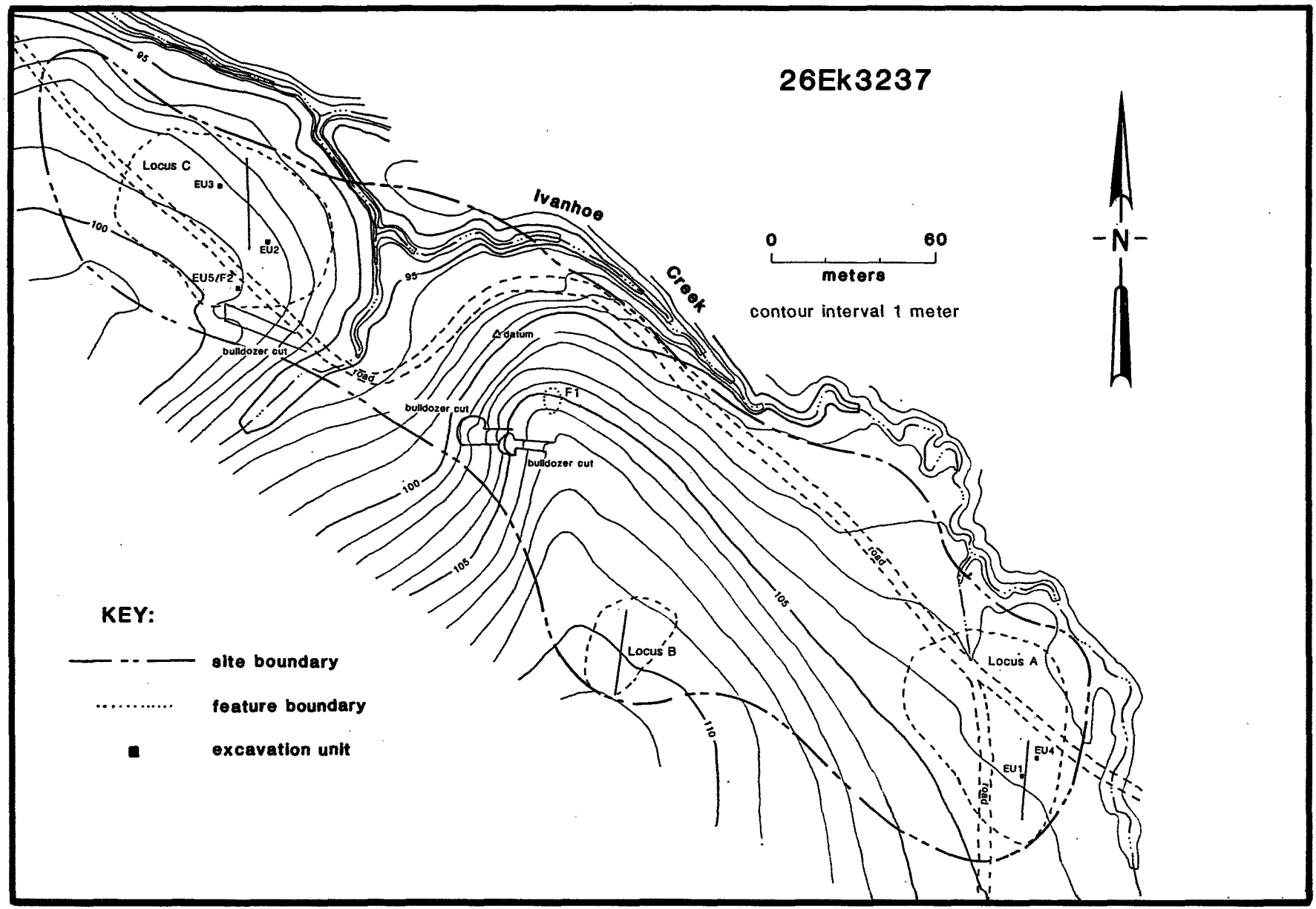

26Ek3237
Ivanhoe Creek
0
60
meters
contour interval 1 meter
N
Locus C
EU3
EU2
EU5/F2
bulldozer cut
datum
road
F1
bulldozer cut
bulldozer cut
Locus B
Locus A
EU4
EU1
road
95
100
105
110
KEY:
site boundary
feature boundary
excavation unit

Figure 27. 26Ek3237, Locus C map (top) and Feature 2 Hearth (Excavation Unit 5), west wall profile (bottom).

Artifact Key: 1 = Hammerstone
2 = Core
3 = Quarry Biface
4 = Preform Biface
5 = Small Biface
6 = Projectile Point
7 = Scraper

Profile Description:

1 Pale brown (10 YR 6/3) silty clay loam; slightly plastic, some gravels, high in organics, no charcoal, loosely consolidated.

2 Pale brown (10 YR 6/3) silty clay loam, friable,, 10% small gravels, high in organics, no charcoal, loosely consolidated.

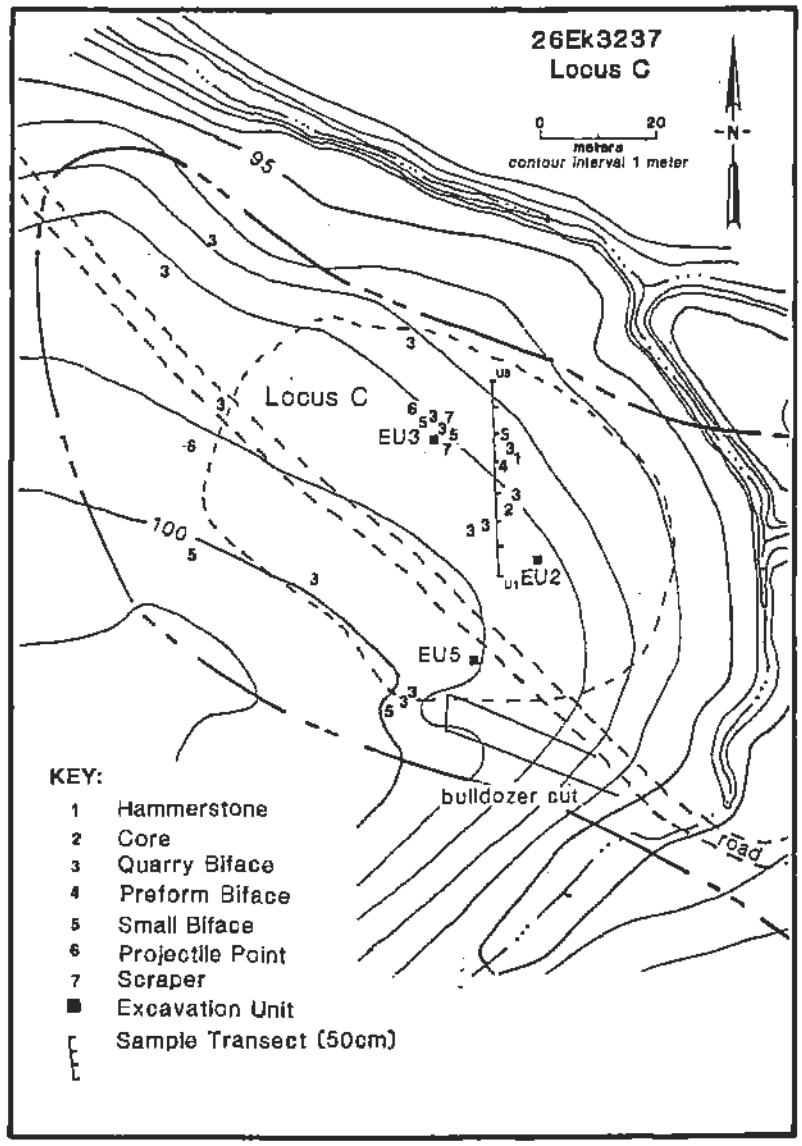
3 Brown (10 YR 5/3) silty clay loam; some small gravels, few organics, charcoal flecks, more consolidated.

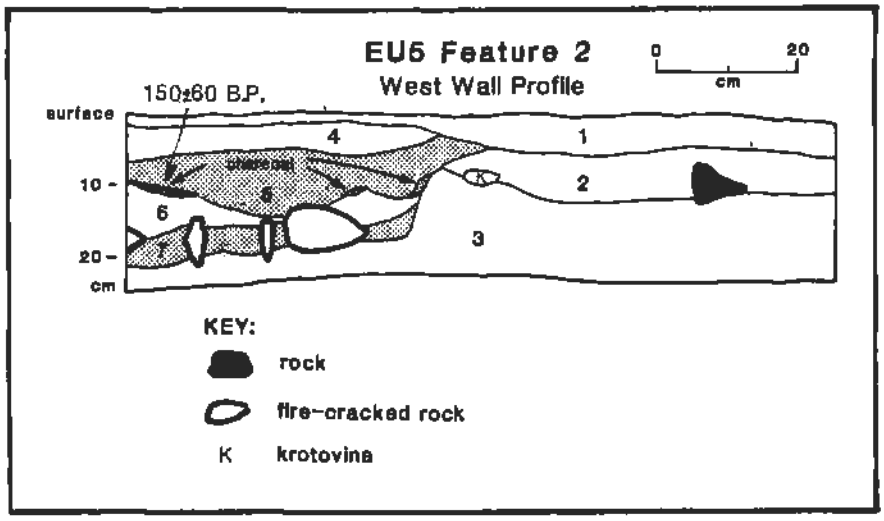
4 Light brownish gray (10 YR 6/2) silt; some small gravels, few organics, no charcoal, some ash, moderately consolidated.

5 Dark grayish brown (10 YR 4/2) silty loam; some small gravels, high in organics and charcoal, some ash, moderately consolidated.

6 Dark grayish brown (10 YR 4/2) silty loam; some small gravels, few organics, some charcoal flecks, moderately consolidated.

7 Very dark grayish brown (10 YR 3/2) silty loam; some small gravels, some organics, high in charcoal, moderately consolidated.


26Ek3237
Locus C
0
20
meters
contour interval 1 meter
N
95
100
Locus C
EU3
EU2
EU5
bulldozer cut
road
KEY:
1 Hammerstone
2 Core
3 Quarry Biface
4 Preform Biface
5 Small Biface
6 Projectile Point
7 Scraper
Excavation Unit
Sample Transect (50cm)


EU5 Feature 2
West Wall Profile
0
20
cm
150±60 B.P.
surface
10 -
20 -
cm
4
1
charcoal
2
6
3
KEY:
rock
fire-cracked rock
K krotovina

Like Locus A, most of the cultural items in Locus C are found in the uppermost 20 cm of deposits. For example, 88% of the 442 pieces of debitage recovered from Excavation Unit 3 were collected from levels 1 and 2. Unlike Locus A, however, Locus C contains a higher frequency of formed artifacts and greater toolstone material diversity (i.e., opalite, chert, obsidian, and basalt). Formed tools recovered during Locus C subsurface testing included a projectile point fragment, a scraper, and three bifaces (Table 33).

Of particular interest, excavations in Unit 5 bisected a discrete, basin-shaped fire hearth (Feature 2) containing numerous fire-cracked rocks and burned opalite debitage. Two episodes of use appear to be represented; the upper and lower ash and charcoal lenses are separated by a layer of loess-like silt that contains little charcoal (Figure 27). Radiocarbon assay of the upper ash and charcoal lens returned a date of 150 $\pm$60 years B.P. Artifacts associated with Feature 2 include an obsidian Small Biface fragment, 105 flakes, 10 pieces of shatter, and a shaped chalcedony nodule.

Although testing recovered a limited range of artifact classes, the presence of a rock-lined hearth suggests that Locus C served as a residential base or field camp at which subsistence tasks (e.g., food preparation) and tool fabrication and maintenance were undertaken.

Site 26Ek3239

Site 26Ek3239 occupies the top and northern and eastern slopes of a low north-trending ballena just south of Ivanhoe Creek at an elevation of 5560 ft (1695 m). The western and northern site boundaries are marked by an ephemeral drainage that flows into Ivanhoe Creek. Located on the northern toe slope of the ridge and extending down into the drainage, surface reconnaissance in this site area identified a ca. 1600 sq m cobble field (Locus A) containing numerous reddish-brown, subangular opalite nodules. Although the material is of poor quality (e.g., most cobbles contain weathering cracks, quartzite inclusions, and/or vugs), a few assayed pieces, primarily flakes, and angular pieces of shatter were observed. Further, two hammerstones were observed, mapped and collected from the locus. The overall scarcity of culturally modified toolstone precluded systematic collections in this site area.

A single lithic concentration (Feature 1) was discovered on a flat spot near the top of the ridge. The feature is a light to moderate density scatter of opalite debitage, bifaces, and flake tools covering approximately 48 m^2. Shovel scraping a block of four 1 by 1 m units in the feature yielded 1465 pieces of debitage (mostly flakes; n=1354, 92%; see Table 34) and 14 formed artifacts (Table 35).

Table 35. Description of Artifact Classes by Feature and Extra-Feature Contexts, Site 26Ek3239.

	ARTIFACT CLASSES											
	Reduction					Points	Processing					
	OP	HM	QB	SB	IB	RSG	SC	PG	KN	OF	CE	Total
Feature 1												
Surface	-	-	2	2	-	-	1	-	-	-	-	5
SFC	-	-	2	3	7	-	1	-	1	-	-	14
EU 1	-	-	1	-	2	-	1	-	-	-	2	6
Extra-Feature												
Surface	3	2	6	5	1	2	1	1	-	1	-	22

Key: SFC = Sample Feature Collection
EU 1 = Excavation Unit 1

Reduction	Points	Processing
OP = Other Percussion	RSG = Rosegate Series	SC = Scrapers
HM = Hammerstones		PG = Perforators/Gravers
QB = Quarry Bifaces		KN = Knives
SB = Small Bifaces		OF = Other Simple Flake Tools
IB = Indeterminate Bifaces		CE = Ceramic Fragments

Feature 1 was further explored by excavation of a 50 cm by 1 m test unit placed within the scraped area. Although excavation found the deposits relatively shallow (i.e., exfoliated bedrock was encountered at 20 cm below surface), numerous pieces of debitage (n=479), four lithic tools, and two fragments of Fremont pottery were recovered (see Table 35). The recovered tool kit in association with charcoal flecks and fire-cracked rock encountered in excavation suggest Feature 1 served as a short term campsite where subsistence related activities occurred in conjunction with lithic fabrication and maintenance.

Site 26Ek3251

Site 26Ek3251 is situated in the bottom of Willow Creek Valley (elevation 5220 ft [1592 m]), occupying the second low terrace of Willow Creek. Although partially disturbed by the Ivanhoe Creek road and cattle treadage, most of the site remains intact. Surface soils are a fine, slightly consolidated wind blown silt that changes to a hard, gravelly silt at depth.

While generally flat, the site area is divided by two gullies which separate three different occupation areas. Reconnaissance of 26Ek3251 identified 6 discrete cultural features (Figure 28) and 24 extra-feature artifacts, most of which were concentrated in the flat site areas. Features 1 and 6 appear to have served multiple functions since a diverse array

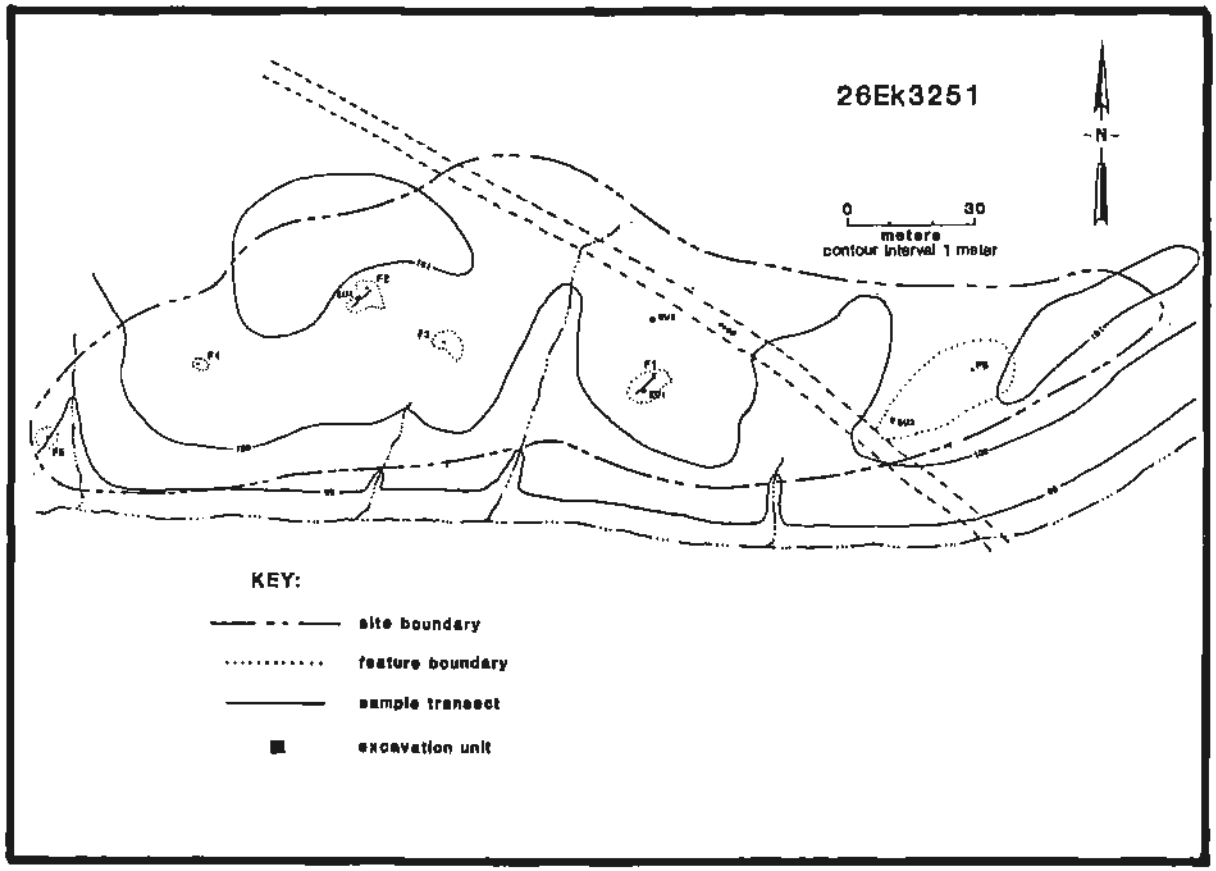
Figure 28. 26Ek3251, site map (top) and Excavation Unit 3, south wall profile (bottom).

Profile Description:

1 Grayish brown (10 YR 5/2) silty loam; some small gravels (< 1%), small roots, no charcoal, loosely consolidated.

2 Brown (10 YR 5/3) silty loam; sparse gravels, many small roots, sparse charcoal, more consolidated.

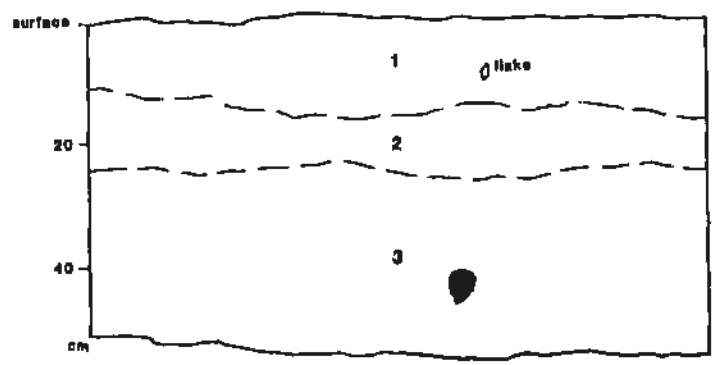
3 Pale Brown (10 YR 6/3) silty loam; increase in gravels, few roots, no charcoal, highly consolidated with cobble layer at base.



26Ek3251

South Wall Profile EU3

	Debitage n	Tools n
0-10	724	3
10-20	112	-
20-30	53	-
30-40	38	-
40-50	8	-



of artifact types (e.g., bifaces, flake tools, and ground stone) was present. Feature 3 contains a moderately dense scatter of small opalite secondary and biface thinning flakes, but may have been a multipurpose locus; the only implements observed were expedient flake tools and a Preform Biface. The remaining three features (2, 4, and 5) consist of moderate to dense lithic scatters of opalite secondary and biface thinning flakes generated during the reduction of latter stage bifaces.

Feature 1 is a dense scatter (11 by 7.5 m) of off-white opalite debitage that contained several flake tools and ground stone fragments; most of the opalite debitage has been heat treated. A 2 by 6 m grid was established near the feature center, spanning its long axis. The area was shovel-skimmed in 1 by 1 m units. An abundance of debitage (n=2112, primarily small opalite flakes [mean weight per item = 0.4 g]) and formed artifacts (Table 36) was recovered, thus prompting the decision to explore subsurface deposits by excavating a 50 cm by 1 m unit (Excavation Unit 1). The unit was excavated to a depth of 30 cm and soils were passed through 1/4 in. mesh; the north 50 by 50 cm portion of the unit was passed through 1/8 in. mesh as a control to determine the amount of small items present. Excavation revealed cultural deposits containing charcoal flecks and fire-cracked rock intermixed with opalite and obsidian debitage (n=1371; see Table 34), bifaces, and modified flakes. Although lithic debris was encountered throughout excavation, debitage was most frequent in level 2 (n=751; 55% of the total collection). These data indicate that Feature 1 served as a campsite where a diverse range of tasks was performed, including tool fabrication and food processing.

Feature 2 was an ovate debitage scatter approximately 11 by 7 m in size encompassing four debitage concentrations; no stone tools were observed in associations. The westernmost concentration was selected for examination and a 2 by 6 m surface scrape was conducted. Shovel-skimming returned numerous bifaces and biface fragments and a Rosegate projectile point (see Table 36) in association with 7260 pieces of opalite debitage (tool-debitage ratio = 1:242).

The subsurface character of Feature 2 was explored by excavation of a 1 by 1 m unit to a depth of 40 cm below surface. Excavation yielded 1056 pieces of opalite debitage (see Table 34), most of which (89%) were recovered from the uppermost 20 cm of excavated deposits. The wealth of bifaces and debitage generated from their manufacture suggests tasks performed at Feature 2 were largely, but not exclusively, related to the reduction/manufacture of bifaces.

Table 36. Description of Artifact Classes from Feature and Extra-Feature Contexts, Site 26Ek3251.

Fea No.	Type	Area (sq m)	ARTIFACT CLASSES: Reduction OP	QB	PB	SB	IB	Points RSG	CTN	DSN	FRG	Processing SC	KN	PG	MP	OF	GS	Total
1	Complex Locus: Sample Feature	68	1	1	11	16	12	-	1	-	1	3	1	-	1	-	3	51
2	Complex Locus: Sample Feature	48	-	-	4	10	11	1	-	-	1	1	-	-	-	2	-	30
3	Complex Locus	35	-	-	1	-	-	-	-	-	-	1	-	-	-	1	-	3
4	Biface Reduction	18	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
5	Biface Reduction	42	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	2
6	Complex Locus: Sample Feature	1050	-	1	1	3	-	-	-	-	-	-	-	1	-	-	2	8
-	Extra-Feature	N/A	1	4	3	7	-	-	1	1	1	-	-	-	-	-	6	24

Key:

Reduction
OP = Other Percussion
QB = Quarry Bifaces
PB = Preform Bifaces
SB = Small Bifaces
IB = Indeterm. Bifaces

Projectile Points
RSG = Rosegate Series
CTN = Cottonwood Series
DSN = Desert Side-notched
FRG = Unclassifiable/Fragment

Processing
SC = Scrapers
KN = Knives
PG = Perforators/Gravers
MP = Multipurpose Flake Tools
OF = Other Flake Tools
GS = Ground Stone

Feature 6, the largest feature noted, consists of a debitage scatter some 30 m long by 15 m wide located near the eastern site boundary (see Figure 27). In general, debitage density appeared light, but was highest in deflated and eroded areas suggesting that subsurface deposits were present. A 1 by 1 m test unit was placed centrally to a debitage concentration and was excavated to a depth of 50 cm. Excavation returned 936 pieces of debitage (including 4 obsidian flakes from a 1/8 in. screen sample quad), 3 flake tools (a perforator and 2 Small Bifaces), 3 artiodactyl molar fragments, and a marmot (Marmota flaviventris) cranial fragment. A majority of the items were encountered in the uppermost 20 cm of deposits, but debitage was present in all four levels (see Figure 28). Surface inventory of Feature 6 also resulted in the recovery of a Quarry Biface, a Preform Biface, a Small Biface, and two metate fragments, one of which displays rather extensive bifacial use. When considered collectively, items from the surface and subsurface of Feature 6 are representative of a multifunctional activity locus.

Finally, in order to sample site deposits outside the context of a surface feature, a 1 by 1 m excavation unit was dug north of Feature 1 in an area where surface items were scarce (only one opalite flake was visible). This unit was excavated to a depth of 10 cm and produced only 13 opalite flakes and 3 pieces of shatter.

Summary

Archaeological test excavations in the North Access Corridor found artifact assemblages largely dominated by biface reduction debris, but also discovered intersite variation in site function and assemblage compositions. While data collected from reduction sites 26Ek3228, 26Ek3231, 26Ek3232, 26Ek3234, and 26Ek3238 is limited in many respects, the distinct character and clarity of most of the feature concentrations offer a high degree of resolution for inquiry into the structure and content of isolated lithic reduction events. In particular, comparative analysis of tool kits and debitage from feature concentrations reveal differences in toolstone quantity and quality, stage reduction, and, in some instances, chronology as well.

Site 26Ek3237 exhibits a range of artifact classes suggesting its use as a short term residential site. A rock-lined hearth, perhaps serving for cooking and/or food preparation, attests further to domestic use of the site. Fuller exposure of the area surrounding the hearth will contribute to understanding the subsistence pursuits incidental to quarrying activities.

The site also offers data regarding toolstone transportation and reduction. Toolstone is dense and heavy; the amount that can be transported by human power alone has a fundamental limit. This fact probably accounts for much of the extensive initial processing and the presence of (biface) caches at or near the Tosawihi Quarries, as well as the fall-off in relative amount of Tosawihi opalite in assemblages, degree of reduction, and size of tools and debitage as a function of distance from the source (Elston 1988).

Although 26Ek3237 is some distance from the Quarries, it has relatively high proportions of cores and Quarry Bifaces, suggesting that either the site is too close to the Quarries for fall-off to be manifest or there may be another (undiscovered) lithic source within the foraging radius of the site. Clearly, data from additional survey in the site area and extensive comparative and actualistic studies on the economics of toolstone transportation would shed light on these issues.

Site 26Ek3237 lies on slopes and alluvial terraces of Ivanhoe Creek, just downstream from alluvial deposits containing Mazama ash. Since the site produced at least one artifact that pre-dates the Mazama eruption (i.e., a Great Basin Stemmed point fragment), the possibility exists that old deposits are present. Artifacts, organic deposits, and/or tephra in these deposits may contribute toward the development of a regional alluvial chronology.

Like 26Ek3237, data from site 26Ek3251 can address the place of the Tosawihi Quarries in the regional economy through

comparisons among assemblages. Site 26Ek3251 is a non-quarrying site located some distance from the Quarries, in a riparian situation offering a much different set of resources than is available in the Quarries. The assemblage contains a wider variety of tool classes than does 26Ek3237. Cores are absent and Quarry Bifaces comprise a very small proportion of the reduction artifact assemblage.

Data collected from testing indicate that 26Ek3251 functioned as a campsite, but whether occupied for only short periods or perhaps serving as a winter camp, is not known. There is no ethnographic evidence of winter occupation along Willow Creek, but informal survey along the drainage indicates that 26Ek3251 is merely a local manifestation of a much larger streamside complex.

In many respects, the site is similar to 26Ek3095, located on the western periphery of the Tosawihi Quarries (see Chapter 12). Both sites contain a diversity of tool types, a similar range of features (short term residential and secondary lithic reduction clusters), and significant numbers and kinds of seed grinding tools. However, at site 26Ek3251, average flake tool and debitage size is small and most items appear to be heat-treated. Considered together with its unique depositional setting, 26Ek3251 provides a significant data point for comparing intersite assemblage variability and examining the economics of toolstone procurement and transport across the region.

Part IV. USX-West Study Area

Preceded by a physical description of the USX-West Study Area in Chapter 8, results of testing there are organized geographically: Rodent Valley Sites are described in Chapter 9, Red Hill Quarries in Chapter 10, Basalt Canyon Sites in Chapter 11, and Bitterroot Ridge Sites in Chapter 12.

Chapter 8. INTRODUCTION TO USX-WEST

by Elizabeth E. Budy

The USX-West project area encompasses an irregular parcel of about 600 acres situated adjacent the Tosawihi Quarries (site 26Ek3032) on the southwest. The present and following chapters are concerned with the investigation of 30 of the 36 prehistoric sites (Budy 1988) located in this study area.

The project area is located along moderately steep, dissected terrain that drains to Little Antelope Creek. Four archaeological subareas, Rodent Valley, Red Hill Quarries, Basalt Canyon, and Bitterroot Ridge are segregated for purposes of discussion (Figure 8-1). These divisions group sites according to their relative proximity to the Tosawihi Quarries, and consider similarities in topographic setting, depositional environment, and assemblage constituents.

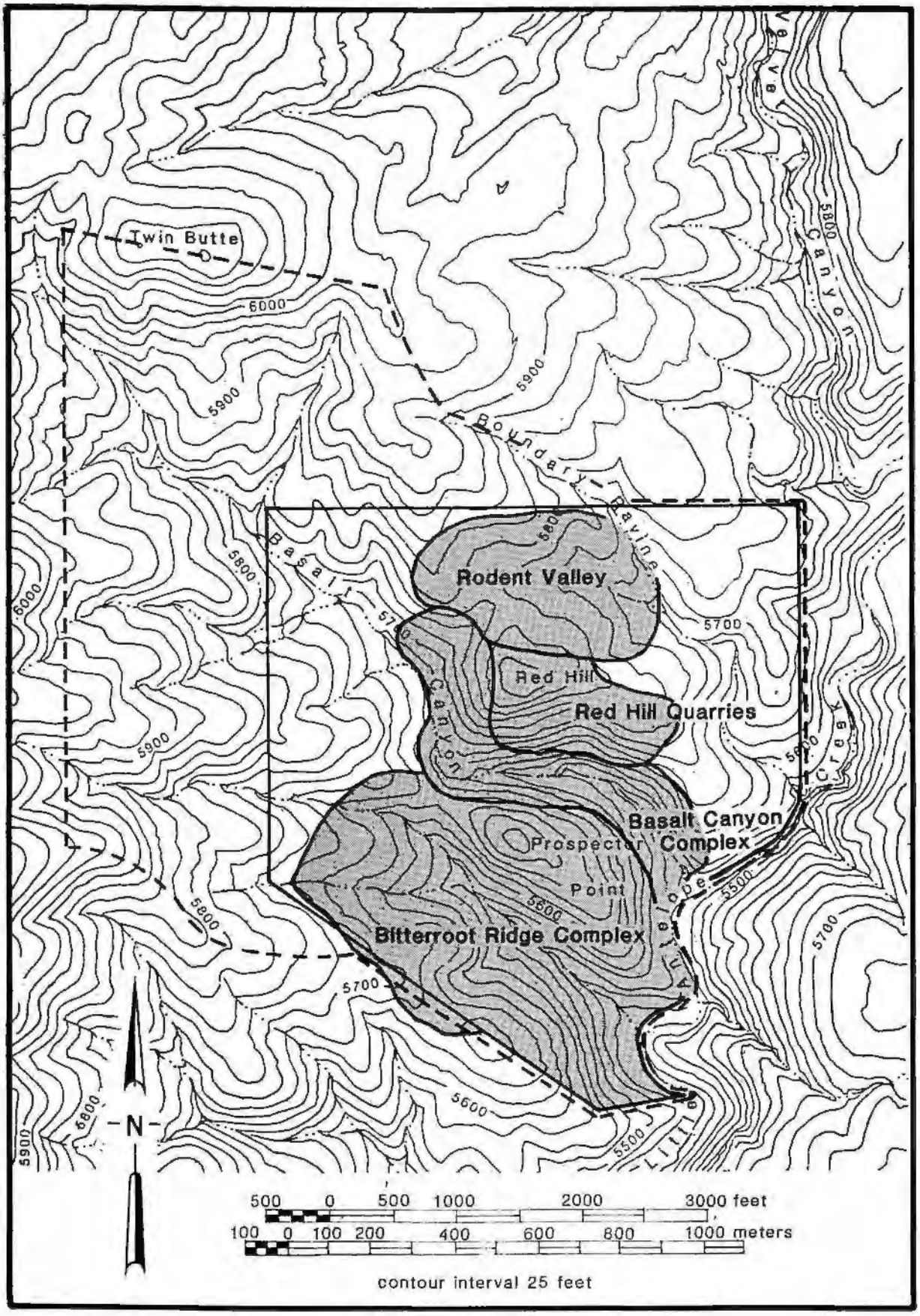
Rodent Valley is a small elevated basin just south of the drainage which marks the south edge of the Tosawihi Quarries. Its name derives from the large ground squirrel population located therein and the conspicuous effects of their turbation to archaeological deposits. Eight archaeological sites are located in the valley; seven were tested. Most sites are large, diffuse reduction scatters; one is a small outcrop quarry.

Red Hill is a prominant knoll containing gold bearing deposits that have interested miners since the early 1980s. Small opalite outcrops on the steep south slopes of the formation served as loci for prehistoric toolstone extraction. Seven quarry sites are located on Red Hill, of which six were tested.

Steep-sided Basalt Canyon divides areas of opalite bedrock north of it from unsilicified basaltic formations to the south. Both erosional transformations and alluvial deposition are evident in the canyon. Eleven sites are located on the lower canyon slopes; of nine tested, one is a stratified buried site that appears to represent a series of short term campsites, and eight are eroded sites reflecting toolstone reduction.

Bitterroot Ridge, named for the edible bitterroot plants in flower during testing, encompasses a series of ballenas or finger ridges, dissected by narrow ephemeral drainages that feed Little Antelope Creek. Eight of the ten sites located here were tested. They include several large, complex biface staging centers that saw numerous occupations and were used as short term residential sites.

Figure 29. USX-West project area and archaeological subareas.


Twin Butte
6000
5900
5800
Boundary Ravine
Basalt Canyon
Rodent Valley
Red Hill
Red Hill Quarries
Basalt Canyon Complex
Prospector Point
Bitterroot Ridge Complex
5700
5600
5500
Little Creek
N
500 0 500 1000 2000 3000 feet
100 0 100 200 400 600 800 1000 meters
contour interval 25 feet

Organization of Discussion

The site descriptions which appear in the next four chapters are organized according to archaeological subarea. Nevertheless, data for each site are presented so as to allow for ready comparison among sites and subareas. Each chapter summarizes sites by type, and presents tabular compilations of testing strategies, chronological indicators, and intersite comparisons of artifact assemblages. Site specific descriptions of depositional contexts and structural arrangements of features are given.

Chapter 9. RODENT VALLEY SITES

by Elizabeth E. Budy

Rodent Valley, a small basin perched about 150 feet above and west of Basalt Canyon (Figure 30), lies between the primary Tosawihi Quarries toolstone source areas on the north and several small localized sources found on the south slopes of Red Hill. Silicified opalite in this small basin is restricted to a small outcrop at site 26Ek3104 on the extreme northeast edge of the study area.

Nonsiliceous bedrock outcrops likewise are restricted to the western perimeter of the valley where, at site 26Ek3096, they provided vantage points where several small reduction features are located. Elsewhere in the valley, sandy silts and silty loams mantle the ridge slopes and form a surface layer 80 cm thick overlying an ancient paleosol in the center of the valley. These sediments encourage fairly dense stands of big sagebrush and form good habitat for tunneling rodents.

The most obvious prehistoric activity in Rodent Valley was the reduction of opalite toolstone procured from nearby quarries. Other factors that may have conditioned prehistoric use of the valley include the abundance of small mammals, especially ground squirrels, and the absence of permanent water.

Descriptive Site Summary

Seven of the eight sites recorded in Rodent Valley were tested. They include six reduction complexes and one small outcrop quarry as listed in Table 37 below.

Table 37. Descriptive Summary, Rodent Valley Sites.

Site Number	Type	Features (n)	Maximum Site Area (sq m)
26Ek3096	Reduction Complex	7	14,250
26Ek3100	Reduction Complex	2	5,850
26Ek3101	Reduction Complex	-	11,250
26Ek3102	Reduction Complex	5	2,400
26Ek3104	Outcrop Quarry	-	600
26Ek3105	Undifferentiated Scatter [NOT TESTED]	-	3,000
26Ek3106	Reduction Complex	6	5,175
26Ek3107	Reduction Complex	5	6,750

Figure 30. Topographic setting, Rodent Valley sites.

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Reduction complexes are characterized by debitage scatters whose spatial organization or extent reflect several episodes of opalite toolstone reduction. Artifact diversity (ratio of artifact types to numbers of artifacts) is low, residential features are absent or restricted to short-term hearths, and subsistence-related artifacts are limited in kind and quantity. In short, such sites are thought to represent palimpsests of specific tasks of brief duration.

Testing Strategies

Testing followed the procedures described in Chapter 1. Close interval survey recovered only a small collection of formed artifacts from the surface of each site. Most were dominated by reduction biface forms. Attention focused on recovering data from spatially discrete features, so that 14% to 50% at each site were sampled by complete surface collection (Table 38).

Table 38. Summary of Testing Procedures, Rodent Valley Sites.

			FEATURE CONTEXT		NONFEATURE CONTEXT			RECOVERED COLLECTIONS	
Site Number	FEATURES Total (n)	RECORDED Sampled (n)	Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	Trench Cross Section (n)	Debi-tage (n)	Formed Artifacts (n)
26Ek3096	7	1	4	-	-	-	-	814	18
26Ek3100	2	1	2	-	-	-	-	962	2
26Ek3101	-	-	-	-	2	0.70	1	2,663	27
26Ek3102	5	1	8	-	-	-	-	1,782	17
26Ek3104	-	-	-	-	-	0.03	-	2,266	18
26Ek3106	6	2	42	0.30	-	-	-	14,530	61
26Ek3107	5	1	4	-	0.13	0.13	1	1,918	6

Controlled subsurface excavation sampled two clearly organized features at site 26Ek3106, one of which was a buried hearth. Backhoe trenches were opened for stratigraphic exposure at sites 26Ek3101 and 26Ek3107, where surface patterns had been obscured by erosion and turbation but where diagnostic artifacts suggested the possibility of pre-Archaic use. Both surface skimming and subsurface excavation recovered samples from nonfeature contexts at sites 26Ek3101 and 26Ek3107. Interval samples were collected along the slope of the opalite outcrop at quarry site 26Ek3104, for comparison with toolstone from other sources.

Chronology

A summary of the time sensitive projectile points recovered from the Rodent Valley sites is presented in Table 39. The collection is notable for its small size and for the absence of Middle Archaic time markers. An early use (ca. 7000 -8000 B.C.) of Rodent Valley is signaled by a basalt Great Basin Stemmed point base recovered from site 26Ek3107. Late Archaic points (A.D. 500 to A.D. 1850) were recovered from spatially discrete features at sites 26Ek3102 and at site 26Ek3106. Charcoal preserved in a hearth (Feature 4/5) at site 26Ek3106 dates to 300 ± 70 B.P. (Beta-26827).

Table 39. Projectile Point Types from Rodent Valley Sites.

Site Number	Early Archaic	Late Archaic			
	STM	RSG	CTN	PPT	TOTAL
26Ek3096	-	-	-	-	0
26Ek3100	-	-	-	-	0
26Ek3101	-	-	-	-	0
26Ek3102	-	1	-	-	1
26Ek3104	-	-	-	-	0
26Ek3106	-	-	1	1	2
26Ek3107	1	-	-	-	1

Key:
STM = Great Basin Stemmed
RSG = Rosegate Series
CTN = Cottonwood Series
PPT = Point Rejected by Thomas (1981) Key

Assemblage Composition

Formed artifacts from the Rodent Valley sites are predominantly reduction stage forms (cores and early stage Quarry Bifaces) (Table 40). Although few specialized tools or subsistence related artifacts were recovered, projectile points signal some use of the area for hunting; a metate fragment associated with a hearth (Feature 4/5 at site 26Ek3106 suggests seed grinding coincident with camping. However, these tools were found in lithic concentrations composed largely of opalite reduction debitage, suggesting short term maintenance activities were incidental to toolstone production.

Cores and large Quarry Bifaces compose, on an average, more than 80% of lithic reduction artifacts at Rodent Valley sites. Small Bifaces, common at residential sites elsewhere in the project area (e.g., on Bitterroot Ridge) are scarce in Rodent Valley, indicating a narrow focus on toolstone reduction, and little campsite use, at these sites. As we expected, Rodent Valley sites, which are located close to the Tosawihi Quarries opalite sources, are characterized by more preliminary reduction

materials than are sites more distant from toolstone sources, such as those on Bitterroot Ridge. For example, compare the relative proportion of Stage II to Stage III Quarry Bifaces from Rodent Valley (39.1% and 26.9%, respectively) to those from Bitterroot Ridge (29.% and 49.2%, respectively).

Table 40. Intersite Artifact Class Frequencies, Rodent Valley Sites.

ARTIFACT CLASS	ARTIFACT FREQUENCY PER SITE						
	Quarry	Reduction Sites					
Lithic Processing/ Reduction Tools	26Ek3104	26Ek3096	26Ek3100	26Ek3101	26Ek3102	26Ek3106	26Ek3107
Hammerstones	1	2	-	-	-	1	-
Scratched Stones	-	-	-	-	-	1	-
Other Percussion	1	1	-	1	-	-	1
Subtotal (%)	2(11.1)	3(16.7)	0(0)	1(3.7)	0(0)	2(3.3)	1(16.6)
Reduction Artifacts							
Assayed Pieces	1	-	-	-	-	-	-
Cores	9	1	2	1	4	8	-
Quarry Bifaces	6	11	-	10	9	38	3
Preform Bifaces	-	-	-	2	-	-	-
Small Bifaces	-	1	-	3	1	1	1
Indeter. Bifaces	-	1	-	4	1	4	-
Subtotal (%)	16(88.9)	14(77.8)	2(100)	20(74.1)	15(88.2)	51(83.6)	4(66.7)
Projectile Points							
Classifiable Types	-	-	-	-	1	1	1
Unclassifiable	-	-	-	-	-	1	-
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	1(5.9)	2(3.3)	1(16.6)
Maintenance and/or Processing Tools							
Scrapers	-	-	-	3	1	4	-
Perforators	-	-	-	2	-	-	-
Gravers	-	-	-	1	-	-	-
Multipurpose Flakes	-	-	-	-	-	1	-
Simple Flake Tools	-	-	-	-	-	-	-
Subtotal (%)	0(0)	0(0)	0(0)	6(22.2)	1(5.9)	5(8.2)	0(0)
Plant Processing							
Manos	-	1	-	-	-	-	-
Metates	-	-	-	-	-	1	-
Subtotal (%)	0(0)	1(5.6)	0(0)	0(0)	0(0)	1(1.6)	0(0)
Site Total	18	18	2	27	17	61	6

Reduction Sites

Except for sites 26Ek3096 and 26Ek3106, reduction complexes in Rodent Valley retain little evidence of discrete use episodes, as such are inferred from surface artifact patterns. Sites average about 6,600 m^2, with few apparent features, generally small, in each (Table 41).

Site 26Ek3096

Site 26Ek3096 consists of a light density (<100 items per m^2) lithic scatter covering a ridgetop on the west side of Rodent Valley (Figure 31). Weathered, nonsilicified bedrock outcrops as boulders on the ridgetop where six spatially discrete reduction features (numbers 1-4, and 6-7) were recorded. The boulders may have provided shade or windbreak for prehistoric knappers, and these loci afford broad views of the surrounding countryside. Feature 5, located lower on the east-facing ridge slope, was disturbed by recent bulldozer scrape.

Feature 1 was completely collected by surface skimming. Debitage is dominated by opalite flakes in a range of sizes, but most appear to derive from a particular off-white material; the low density of materials (204 items per m^2) and the occurrence of three Quarry Bifaces and one Small Biface suggests the feature represents a single brief episode of biface reduction (Table 42). A mano in the feature may have been scavenged from a nearby site (or feature); no other ground stone was associated. Because bedrock outcrops at or near surface, no subsurface exploration was conducted at this site.

Site 26Ek3100

Site 26Ek3100 is composed of a sparse scatter of lithics covering a small round knoll; two small reduction features were recorded (see Figure 30). Feature 1 consists of fairly dense (481 items per m^2) core reduction debitage centered on the top of the knoll; the concentration was collected completely with two 1 by 1 m surface units (see Table 42). Preliminary reduction is indicated by two cores and by the quantity of large flakes (average weight = 3.2 g) mixed with smaller shatter fragments (average weight = 2.7 g).

Feature 2 is composed of 25 biface thinning flakes located in a small area (1 m^2) on the edge of the drainage channel on the east side of the site; this may be a remnant of a larger activity area that has eroded away. No collections were taken from Feature 2.

Table 41. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Sites in Rodent Valley.

Site Number	Fea. No.	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction HM	OP	SS	CR	QB	PB	SB	IB	Points PT	FG	Processing SC	PG	MP	GS	Total
26Ek3096	+1	Biface Reduction	4	-	-	-	-	3	-	1	-	-	-	-	-	-	1	5
	2	Core & Biface	10	-	1	-	1	2	-	-	-	-	-	-	-	-	-	4
	3	Biface Reduction	10	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	4	Biface Reduction	12	1	-	-	-	1	-	-	-	-	-	-	-	-	-	2
	5	Disturbed Locus	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	6	Biface Reduction	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	7	Core & Biface	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	-	Extra-Feature	N/A	1	-	-	-	4	-	-	1	-	-	-	-	-	-	6
26Ek3100	+1	Core Reduction	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2
	2	Biface Reduction	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
26Ek3101	-	Extra-Feature	N/A	-	1	-	1	10	2	3	4	-	-	3	3	-	-	27
26Ek3102	+1	Core & Biface	8	-	-	-	3	1	-	-	1	-	-	-	-	-	-	5
	2	Biface Reduction	7	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	3	Biface Reduction	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	4	Core & Biface	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	5	Biface Reduction	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	-	Extra-Feature	N/A	-	-	-	1	7	-	1	-	1	-	1	-	-	-	11
26Ek3104	-	Extra-Feature	N/A	1	1	-	10	6	-	-	-	-	-	-	-	-	-	18
26Ek3106	+1	Core & Biface	6	-	-	-	-	18	-	-	-	1	1	1	-	-	-	21
	2	Core Reduction	3	-	-	-	1	1	-	-	-	-	-	-	-	-	-	2
	3	Core & Biface	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	4/5	Complex Locus: Sample Feature	36	1	-	1	7	15	-	1	4	-	-	3	-	1	1	34
	6	Core Reduction	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	7	Biface Reduction	25	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
	-	Extra-Feature	N/A	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
26Ek3107	+1	Core & Biface	4	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2
	2	Biface Reduction	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	3	Core & Biface	5	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2
	4	Biface Reduction	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	5	Disturbed Locus	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	-	Extra-Feature	N/A	-	-	-	-	1	-	-	-	1	-	-	-	-	-	2

* (All features are lithic reduction features)
\+ 100% surface collection

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
OP = Other Percussion
SS = Scratched Stone
CR = Cores and Assayed
QB = Quarry Trajectory Bifaces
PB = Preform Bifaces
SB = Small Trajectory Bifaces
IB = Indeter. Biface Fragments

Maintenance/Processing
SC = Scrapers
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
GS = Ground Stone

Projectile Points
PT = Classifiable Points
FG = Unclassifiable/Fragments

Figure 31. Site map, 26Ek3096.

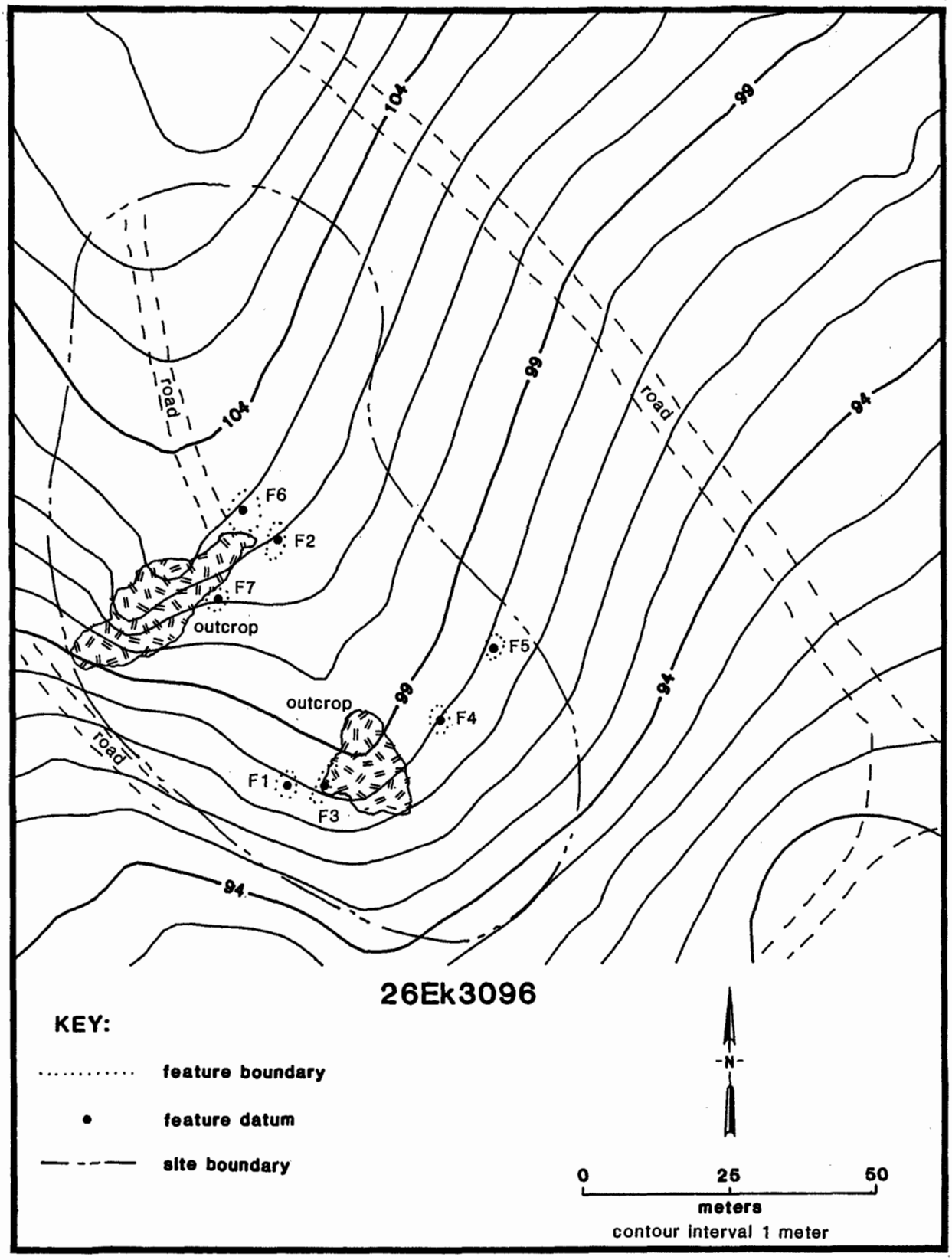

104
99
94
road
F6
F2
F7
outcrop
F5
F4
F1
F3
26Ek3096
KEY:
feature boundary
feature datum
site boundary
N
0
25
50
meters
contour interval 1 meter

Table 42. Debitage from Rodent Valley Sites.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3096	1	4	4	204	790	97.0	1.3	24	2.9	0.9	-	-	814
26Ek3100	1	2	2	481	844	87.7	2.9	118	12.3	5.0	-	-	962
26Ek3101	-	-	2	133	221	83.4	0.9	44	16.6	1.1	-	-	265
26Ek3102	1	8	8	223	1,362	76.4	4.2	412	23.1	2.8	8	0.4	1,782
26Ek3106	1	6	6	546	2,878	87.9	2.8	397	12.1	2.4	1	<0.1	3,276
	4/5	36	36	213	6,267	81.6	1.7	1,383	18.0	1.7	31	0.4	7,681
26Ek3107	1	4	4	401	1,393	86.9	3.3	200	12.5	5.6	10	0.6	1,603

SUBSURFACE COLLECTIONS

Site Number	Fea No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3101	-	1 / A	70	0.70	1,847	77.0	0.9	499	20.8	1.7	52	2.2	2,398
26Ek3104	-	1 / J	10	0.006	249	63.7	2.3	142	36.3	32.4	-	-	391
	-	2 / J	10	0.006	477	61.9	4.5	294	38.1	5.5	-	-	771
	-	3 / J	10	0.006	315	55.7	0.9	250	44.2	9.2	-	-	565
	-	4 / J	10	0.006	287	53.2	2.9	252	46.8	11.2	-	-	539
26Ek3106	1	1 / D	30	0.15	2,869	91.3	2.1	271	8.6	3.2	1	<0.1	3,141
	4/5	2 / A	10	0.10	242	82.0	3.2	51	17.3	8.1	2	0.6	295
	4/5	3 / G	10	0.025	124	90.5	0.9	12	8.8	2.5	1	0.7	137
26Ek3107	-	1 / J	10	0.006	97	49.7	0.7	34	17.4	0.8	64	32.8	195
	-	2 / J	10	0.006	30	25.0	0.9	32	26.7	0.5	58	48.3	120

Key to Excavation Unit Types
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen
G = 50 by 50 cm, 1/8 in. screen
J = 25 by 25 cm, 1/8 in. screen

Site 26Ek3101

Site 26Ek3101 is a rather large, but quite diffuse lithic scatter on a saddle on the west side of the valley (see Figure 30). The western half of the site once served as some sort of containment pond which subsequently was filled and seeded with grasses (Mark Bartlett, personal communication, 1988); today, this zone and the softer sediments at site center provide habitat for a very active ground squirrel population.

Artifacts were distributed uniformly over the center of the saddle to the extent that no concentrations were discerned. Two 1 by 1 m surface units recovered sparse debitage (133 items per m^2) comprised of small flakes (78.3%) and shatter (21.7%); however, the shatter appears to include numbers of broken flakes (hence unclassifiable as such) indicating post-depositional disturbance. This may be the result, in part, of historic mining activity presently obscured by revegetation. On the other hand, the general absence of spacial organization in conjunction with a rather homogeneous surface artifact density may be the result of a long period of exposure coincident with recurrent rodent turbation.

A distinct early component at 26Ek3101 could not be distinguished, however. A backhoe trench exposed about 80 cm of silty loam overlying an ancient paleosol; controlled subsurface excavation indicated cultural materials similar in composition to surface debitage (see Table 42); and rodent turbation had homogenized the sediments so that discrete cultural layers could not be distinguished.

Site 26Ek3102

Site 26Ek3102 consists of a very light density scatter (1-10 items per m^2) on the gentle southeast facing slopes at the toe of a ridge. Numerous small rills and shallow erosion channels cross the site. A central zone of slightly higher flake density (5-10 items per m^2), where deeper soils form habitat for big sagebrush and ground squirrel, surrounds five small reduction features. Artifacts collected from the surface are dominated by large Quarry Bifaces (see Table 40), although few were recovered from feature contexts (see Table 41). A Rosegate Series projectile point signals occupation during the Late Archaic; any earlier components have been obscured by erosion and rodent turbation.

Systematic surface collections from Feature 1 sampled the most visibly discrete debitage concentration at the site. Three cores, one Quarry Biface, and an indeterminate biface fragment were recovered mixed in with large flakes (average weight = 4.4 g) and abundant shatter (17.8%). Debitage composition is similar that noted elsewhere in the valley where

cores were reduced to large Quarry Bifaces (see tables 31 and 32) and provides a good example of early stage reduction close to Tosawihi Quarry source areas.

Site 26Ek3106

Site 26Ek3106, located along the east slopes of a small ridge (Figure 32), is notable among Rodent Valley sites for good preservation of spatially discrete debitage concentrations. Six debitage features were scattered on the east side of a ridge slope overlooking Boundary Ravine; few cultural materials occur on the slope intervals between features.

Two features (numbers 1 and 4/5) were sampled by complete surface collection and limited subsurface excavation. Both contain the residue of Quarry Biface production, but they differ in the range of staging activities reflected in the debitage.

Feature 1 is composed of dense debitage (546 items per m^2) confined to a small bench above, but nearly contiguous with, another concentration recorded as Feature 2. Most (61.1%) of the 18 Quarry Bifaces recovered are Stage II types. Although no cores were present, large flakes and shatter fragments (average weight = 2.8 g) indicate production of Stage II Quarry bifaces from core-like pieces (see Table 42). Two small projectile points were recovered in the subsurface excavation unit. One is a Cottonwood type, the other is unclassifiable but looks like a Desert Series variant.

Feature 4/5 is a large debitage scatter (36 m^2) located on another bench higher up the slope. Collection recovered a comprehensive assemblage of reduction tools and artifacts, including 7 cores, 15 Quarry Bifaces, 1 Small Biface, 4 indeterminate biface fragments, 1 hammerstone, and 1 scratched stone likely used to prepare platforms. Unlike Feature 1, which lacks cores and is dominated by Stage II Quarry Bifaces, Feature 4/5 contains numerous cores and is dominated by Stage III (n=7) and Stage IV (n=4) Quarry Bifaces. Surface skimming exposed a small hearth central to the concentration, but the only associated food processing tools were a burned groundstone fragment included among the hearth rocks, three scrapers and a multipurpose flake tool (Figure 33). Charcoal from the near surface hearth feature was radiocarbon dated to 300 $\pm$ 70 B.P. (Beta-26827), indicating use in the latter part of the Late Archaic period (ca. A.D. 1650).

The spatial integrity of features sampled at site 26Ek3106 is in strong contrast to undifferentiated scatters at most other sites in Rodent Valley. The site appears to contain several discrete activity areas whose spatial integrity is related to their limited time of exposure at the surface. Late Archaic use is attested by chronological indicators from both features

Figure 32. Site map, 26Ek3106

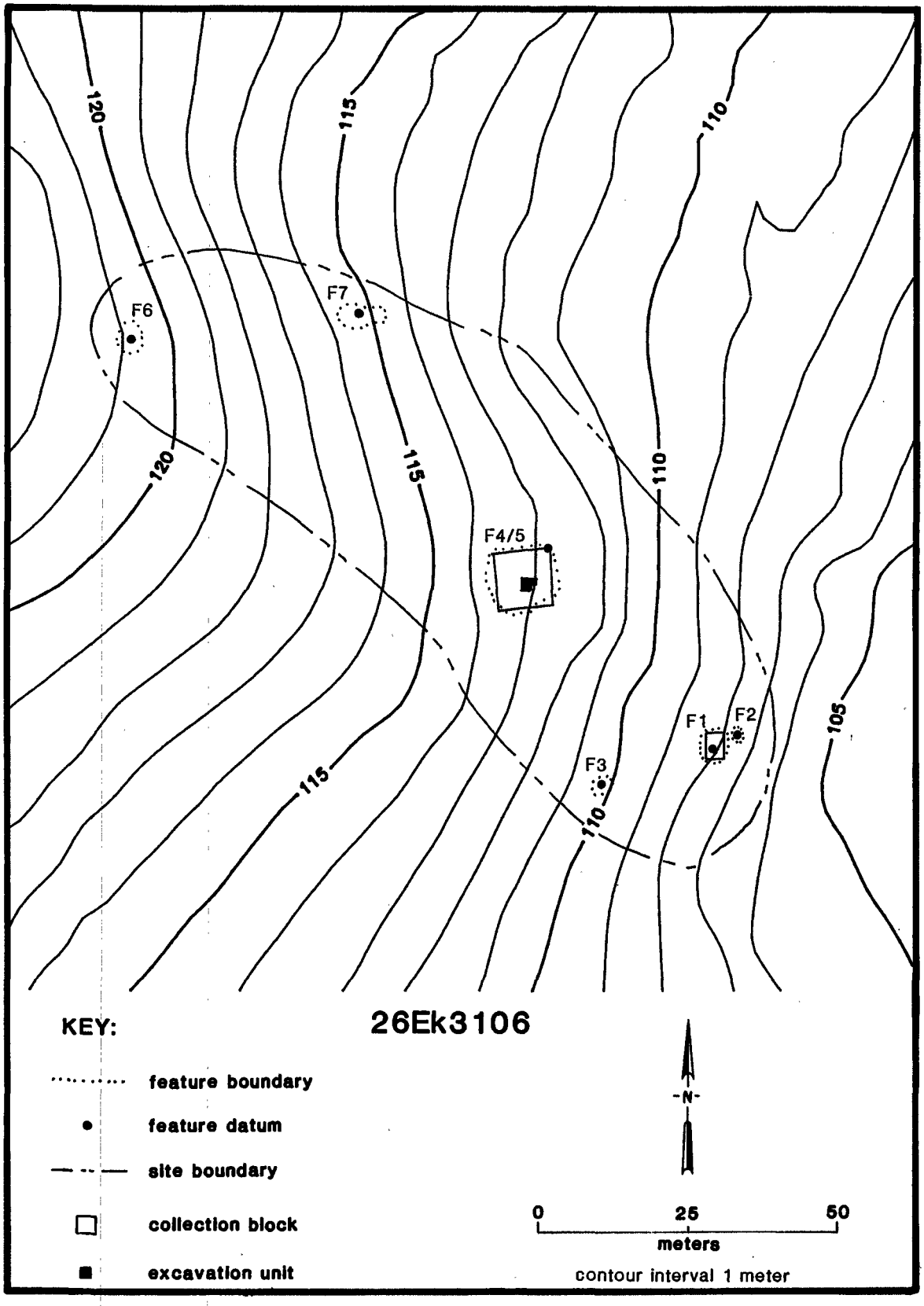
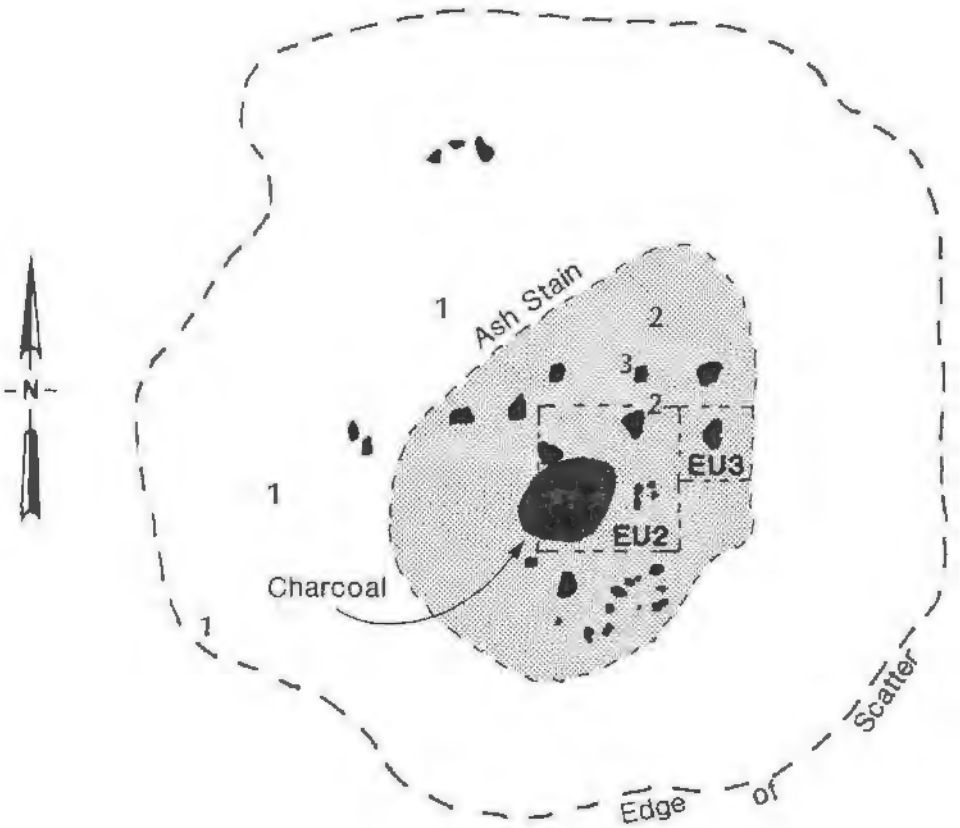

120
115
110
F6
F7
120
115
110
F4/5
F1
F2
105
F3
115
110
KEY:
26Ek3106
feature boundary
feature datum
site boundary
collection block
excavation unit
-N-
0
25
50
meters
contour interval 1 meter

Figure 33. Plan of Feature 4/5, site 26Ek3106.

26Ek3106

Feature 4/5



KEY:

1	Scraper
2	Quarry Biface
3	Groundstone
EU	Excavation Unit
●	Rock

1 meter

sampled; the high visibility and small area of the remaining features suggest a similar short period of surface exposure. Especially significant in light of future investigations is the small hearth found in the lithic reduction concentration at Feature 4/5. Such arrangements were expected to be common in the landscape surrounding the Tosawihi Quarries (Elston 1988), but we are finding that rapid deflation and erosion are affecting near surface hearths elsewhere in the project area.

Site 26Ek3107

Site 26Ek3107 consists of a scatter of debitage and naturally shattered, multi-colored opalite extending along the west slopes of the ridge hosting site 26Ek3106 (see Figure 30). Five surface debitage concentrations were recorded; three (features 2, 3, and 4) are visible as a consequence of erosion and form small "flake rills" parallel to the slope. Feature 5, a small flaking station located near the top of the ridge, had been disturbed by a bulldozer scrape; it is of interest because the base of a finely crafted Great Basin Stemmed point was exposed as a consequence of accelerated erosion caused by the bulldozer activity.

Only Feature 1, a small biface reduction station located on a soil mound formed at the toe of the slope, retained a degree of spatial integrity suggestive of its original deposition; this feature was sampled by complete surface collection. A backhoe trench was located through the soil mound in the center of the feature, but no buried cultural layers were noted and no controlled subsurface collections were made.

Surface debitage collections from Feature 1 reflect the reduction of cores to large Quarry Bifaces (see tables 41 and 42). Opalite from this feature, as from all surface feature concentrations at this site, is an off-white material likely procured from a nearby locality in the Tosawihi Quarries. The colorful opalite shatter natural to the site is of unknown origin, perhaps deriving from redeposit of a weathered source area higher on the ridge north of the site; however, as evident in nonfeature sample excavation units, some of this material was used for toolstone.

Quarry Site 26Ek3104

Site 26Ek3104 is a small outcrop quarry on the south edge of Boundary Ravine directly opposite several high quality, intensively quarried localities in the Tosawihi Quarries site on the north side of the ravine. A small, near surface opalite exposure at site 26Ek3104 served as the locus for toolstone assay and limited biface and core production; sample collections along the east slope of the exposure are dominated by large shatter (see Table 42). The absence of extraction features apparently reflects the poor quality of the source.

Summary

Sites in Rodent Valley reflect short term episodes of toolstone reduction over several thousand years. A sparse background scatter is characteristic of most sites in the valley, and most evidence past and recent rodent turbation. Though chronological indicators are few, site 26Ek3107 contained a Great Basin Stemmed point indicating use of this area as early as 8000 B.C. Furthermore, the absence of discrete features and the dispersed nature of the surface scatters at nearby site 26Ek3101 suggest the effects of geological processes and bioturbation over a relatively long period of time. Late Archaic diagnostics were recovered from sites 26Ek3102 and 26Ek3106 where several spatially contained features likewise support recency of deposit. The exposure of a hearth central to reduction feature 4/5 at 26Ek3106 provides one example of short term campsite use (apparently quite ephemeral) incidental to toolstone procurement and reduction. This will provide useful comparative data when a larger sample of hearths, and their associated activities, are available from sites in the Tosawihi vicinity.

Chapter 10. RED HILL QUARRIES

by Elizabeth E. Budy

Red Hill forms the irregular, east-trending knoll defining the south edge of Rodent Valley. The focus of minerals exploration since 1980, the hill is terraced by drilling access roads. Red Hill is so named for the distinctive red-orange color of its fill, a result, in part, of hydrothermal alteration of tuff and undifferentiated tuffaceous sediments. The top of the formation consists of a series of stepped flats gradually decreasing in elevation from the high point at 5865 ft to about 5650 ft at the lowest flat on the east. The south side of Red Hill is a steep slope (25-45%) which descends about 250 ft to the channel of Basalt Canyon (at about 5525 ft in elevation). Small opalite exposures occur in several areas along the upper portion of the slope and these outcrops were loci of prehistoric toolstone quarrying (Figure 34).

Vegetation on the severe south aspect of the knoll consists of a thin cover of grass (mainly cheatgrass with some wheatgrass and Great Basin wild rye) interspersed with shrubs such as rabbitbrush and horsebrush. Tumble mustard and fiddleneck are conspicuous along roads and in other disturbed places. Deeper soils on the top and north side of the knoll harbor a big sagebrush-grass community.

Red Hill forms a prominent local landform marking the southern margin of the silicified opalite zone. In contrast to toolstone source localities recorded in the Tosawihi Quarries to the north, Red Hill sites are fewer, more localized, and smaller. Rock formation types, and their degree of silicification, are quite variable on Red Hill.

Descriptive Site Summary

Seven small quarries were recorded originally on the south slopes of Red Hill (Table 43); six were tested. Sites 26Ek3208 and 26Ek3085, recorded at different times (Elston et al. 1987; Budy 1988) and thought to be distinct and separate sites, were found during testing to be contiguous complexes exploiting the same geologic formation. The separate site numbers are retained, but the two are treated as components of the same quarrying phenomena in this report.

Three sites (25Ek3082, 26Ek3083, and 26Ek3207) are small outcrop quarries evidencing minimal exploitation. Sites 26Ek3084 and 26Ek3208/3085, on the other hand, contain evidence of focused toolstone extraction in the form of pit features and thick accumulations of quarry debris. The level of effort expended at each site, as evidenced by the kinds of extraction features, or lack of them, appears commensurate with the quality and abundance of silicified materials expressed at or near site surface.

Figure 34. Topographic setting, Red Hill quarries.

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Table 43. Descriptive Site Summary, Red Hill Quarries.

Site Number	Type	Features (n)	Maximum Site Area (sq m)
26Ek3082	Outcrop Quarry	3	300
26Ek3083	Outcrop Quarry	-	2,000
26Ek3084	Quarry Pit	2	4,250
26Ek3207	Outcrop Quarry	-	1,200
*26Ek3208/			
*26Ek3085	Quarry Pit Complex	**8	13,200
26Ek3270	Disturbed Quarry [NOT TESTED]	-	8,500

* adjacent sites treated as one
** 10 additional historic mining features were recorded here by Zeier (1987)

Testing Strategies

Quarry loci generally are expressed by thick accumulations of toolstone extraction and reduction debris which overwhelm standard surface collection and excavation techniques. Methods developed for quarry assessments in the Tosawihi vicinity were designed to collect data sufficient to distinguish among various prehistoric toolstone extraction techniques and reduction strategies while minimizing recovery of redundant collections. Testing procedures and yields are summarized in Table 44, below.

Table 44. Summary of Testing Procedures, Red Hill Quarry.

	FEATURES		FEATURE CONTEXT				NON-FEATURE CONTEXT	RECOVERED COLLECTIONS	
Site Number	Total (n)	RECORDED Sampled (n)	Surface Skim Area (sq m)	Trench Cross Section (n)	Strati-graphic Profile (n)	Column Sample (n)	Surface Skim Area (sq m)	Debitage (n)	Formed Artifacts (n)
26Ek3082	3	1	0.06	-	-	-	-	15	0
26EK3083	-	-	-	-	-	-	-	1	0
26EK3084	2	2	0.50	1	1	28	-	645	7
26EK3207	-	-	-	-	-	-	0.06	20	1
26EK3208/									
26EK3085	8	1	-	1	1	17	-	0	4

Initially, each site was subjected to intensive surface survey to identify discrete extraction features and to locate specialized tools and time-sensitive artifacts. Geologic parameters, physical characteristics, and areal extent of the

toolstone source exposure, were observed; size, density, and composition of cultural debris scatters, as well as extraction feature loci, were recorded and mapped. Specialized tools and exotic artifacts were collected; toolstone samples were taken for quality assay and future chemical sourcing studies.

Subsequent to this, a preliminary evaluation addressed the kinds and intensity of prehistoric quarrying at the site. Sites with little surface variability and limited potential for subsurface accumulations, such as 26Ek3082, 26Ek3083, and 26Ek3207, were not assessed further.

Sites with quarry pit features and thick accumulations of debris were sounded by subsurface probes. At 26Ek3084 and 26Ek3208/3085, a pit feature was selected for vertical cross-section by trenching. After exposure, the stratigraphy of cultural and natural deposits was recorded in profile drawings. Where present, charcoal was collected for C^{14} assay; bulk debitage samples (1 to 5 liters) were taken, as feasible, from each discrete layer for mass debitage studies.

Chronology

The Red Hill quarries, unlike sites used as biface staging centers and campsites that contain time-sensitive projectile points, diagnostic pottery, and dateable obsidian items, yielded few stylized artifacts and only one that provides tentative chronological information. A small basalt biface found on the surface at site 26Ek3208/3085 appears to be preform to a Great Basin Stemmed point. If it is, early use (ca. 7000 - 8000 B.C.) of this source area is suggested.

Tests at Red Hill demonstrate that some quarries, notably 26Ek3084 and 26Ek3208/3085, contain deeply stratified deposits of quarry waste and colluvium that document periods of quarry pit use and abandonment. Charcoal often is present in these buried extraction features and, where sufficiently abundant, provides material suitable for radiocarbon assay. At site 26Ek3208/3085, charcoal was concentrated in the basal strata of a quarry pit, particularly along the face of the massive bedrock outcrop. From this we assume that fire was used to break up the formation to facilitate extraction of toolstone. The charcoal provided two radiocarbon dates, 650 $\pm$ 60 B.P. (Beta-26755) and 800 $\pm$ 60 B.P. (Beta-26754).

Assemblage Composition

The Red Hill quarries provide little evidence of on-site activities other than toolstone extraction. In addition to quantities of debitage and shatter, most quarries contain numerous assay pieces, cores, and hammerstones. Good quality

sources that were exploited intensively also contain biface blanks and other early stage Quarry Biface fragments. The handful of formed artifacts collected from the Red Hill quarries sample units (see Table 44) are discussed with the sites from which they were recovered.

Outcrop Quarries: Context and Structure

Three outcrop quarries (26Ek3082, 26Ek3083, and 26Ek3207) are characterized by rather amorphous zones of quarry debitage surrounding small, localized opalite exposures. As good toolstone material is either distributed sparsely in surface cobbles or embedded in extensively weathered near-surface formations which require considerable extractive energy investment, use of these quarries appears to have been largely exploratory and/or expedient; no extraction pit features were present.

Sample surface debitage collections (25 by 25 cm units) were used to characterize the scatters composing sites 26Ek3082 and 26Ek3207. As illustrated in Table 45, these sites contain high (> 65%) proportions of shatter relative to controlled reduction flakes and so reflect primarily material assay and preliminary core reduction.

Table 45. Debitage Sample Collections from Site 26Ek3082 and 26Ek3207.

Site	Flakes			Shatter			
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	Cores
26Ek3082	4	(26.7)	4.5	11	(73.3)	137.6	-
26Ek3207	7	(35.0)	26.4	13	(65.0)	67.8	1

Site 26Ek3082

Site 26Ek3082 consists of a small, light density (< 100 items per m^2 each) scatter of material assay and core reduction debitage surrounding a nonsiliceous tuff boulder outcrop (Figure 35a). Three small (< 2 m^2) core reduction accumulations (<200 items total) along the outcrop were recorded as features 1 through 3; given the steep (35%) slope of the site, these accumulations may be the result of natural slope movement. Feature 3 consists of about 50 large primary flakes and coarse chunks of shatter accumulated below a shallow (1 m deep), adit-like excavation in the outcrop (Figure 35b). This suggests that a large siliceous nodule was extracted from the tuff matrix.

Figure 35a. Nonsiliceous outcrop at site 26Ek3082, view southwest.

Figure 35b. Adit-like Feature 3 at site 26Ek3082, view northeast.



a.



b.

Small nodules (<50 by 50 cm) of siliceous opalite are embedded in the tuff matrix of the boulder outcrop, indicating the probable source of the material assayed and reduced at the site. As pockets of siliceous opalite weathered out of the matrix, nodules of potentially useful toolstone became available on the surface or were loosely incorporated in the colluvium on the steep slope surrounding the outcrop. As can be seen in the roadcut on the south side of the site, naturally shattered and culturally modified opalite clasts have accumulated on the downslope side of the outcrop and are mixed in the colluvium to a depth of about 50 cm below present ground surface.

Site 26Ek3083

Site 26Ek3083 also is characterized by a light density scatter (< 50 items per m^2) of quarry debitage containing several assayed pieces and cores, and a few large biface fragments. The source area is similar to that at site 26Ek3082 in that opalite nodules appear to have weathered out from small pockets contained within a nonsiliceous tuff matrix. The exposure differs, however, in that the tuff formation at site 26Ek3083 has weathered to the extent that only small (1 by 1 m) boulders remain scattered along the slope. Silicified nodules, most of which evidence assay and/or reduction, occur intermittently along the slope of the scatter where they have become incorporated in the surface colluvium. A red-colored tuff outcrop forms a bench on the lower, south edge of the site, but the nonsiliceous characteristics of this formation render it unsuitable for toolstone. All evidence of purposeful toolstone processing reflects the reduction of white-grey colored materials similar to the nodules which occur naturally higher on the slope. The red tuff is of interest because of its surficial similarity to a colorful source located about 250 meters to the east at site 26Ek3084; these may be isolated expressions of an underlying geologic formation.

Site 26Ek3207

Site 26Ek3207 is distinguished from the other outcrop quarries on Red Hill by the better quality and somewhat greater availability of its toolstone. Opalite is exposed along a series of stepped bedrock benches, the tops of which protrude for no more than 20 cm above ground surface. The underlying bedrock apparently forms tabular sheets which break up where exposed along the slope, hence the terrace-like steps. Site 26Ek3207 contains no extraction features or substantial accumulations of quarry refuse. This may reflect the limited utility of the source (which appears generally fractured where exposed at the surface) or perhaps the road (which cut the upper edge of the site) removed an exposure of higher quality toolstone.

Summary

The low density scatter, absence of extraction features, and small amounts of core reduction debitage at 26Ek3082 suggest little energy investment in toolstone procurement at this site. Contributing factors are probably the scarcity of suitable nodules and/or high energy required to extract and reduce the stone. In spite of this, most of the readily available toolstone was used up and only assay residue and unsuitable interior core-like pieces remain. At site 26Ek3083, a similar situation obtains but the slightly more abundant evidence of successful core reduction, and some residue of early stage biface manufacture, indicate that rather better and/or more easily obtained toolstone was present, likely as large cobble to small boulder sized pieces embedded in surface colluvium. At site 26Ek3207, a greater abundance of controlled reduction flakes attest to a source of higher quality toolstone, but again, the scatter forms only a thin veneer on a bedrock-controlled surface.

Quarry Pit Sites: Context and Structure

Two quarries, site 26Ek3084 and the 26Ek3208/3085 complex, represent intensively exploited toolstone sources. Both contain prehistoric extraction pits, cross sections of which provide clues to past toolstone extraction strategies and techniques.

Site 26Ek3084

Site 26Ek3084 is a small (1,350 m^2) quarry, visible on the surface as a fan-shaped scatter of cores and debitage on the steep, south-facing slope between two road cuts (Figure 36). Prehistoric toolstone procurement apparently was directed at a small exposure of very colorful, high quality stone. Most of the lithic raw material is jasper-like, including shades of brown, yellow, orange, red, maroon, and purple, but a substantial proportion of the debitage is the greenish-white opalite common elsewhere in the project area.

Two features, a quarry pit (Feature 1) and a debris pile (Feature 2), were identified on the surface. Feature 1 appeared initially as a small shallow depression at the juncture between the base of the upper road fill and the slope at the upper edge of the site. A trench excavated through the feature revealed it to be a quarry pit, now largely buried under road fill. Feature 2, located midway on the slope near the center of the site, consisted of a thick lobe of quarry rubble with no outcrop or extraction features apparent. Both features were sampled by taking small (25 by 25 cm) surface collections at intervals along the slope (Table 46).

Figure 36. 26Ek3084, site map.

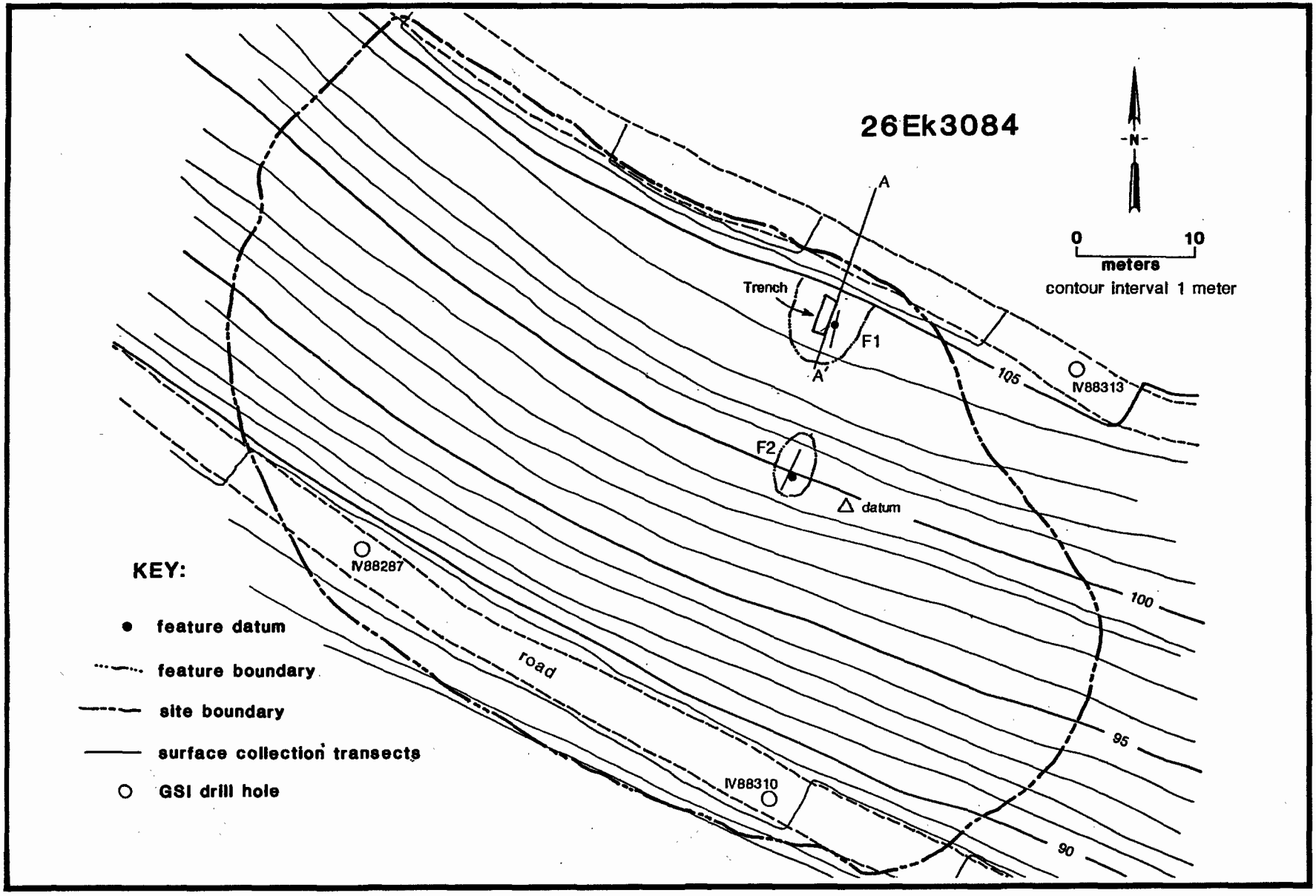

26Ek3084
N
0
10
meters
contour interval 1 meter
A
A'
Trench
F1
F2
datum
IV88313
IV88287
IV88310
105
100
95
90
road
KEY:
feature datum
feature boundary
site boundary
surface collection transects
GSI drill hole

Table 46. Comparison of Debitage from Sample Feature Collections, Site 26Ek3084.

Unit No.	DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	Total
Feature 1							
1	6	54.5	1.8	5	45.5	4.2	11
2	55	35.5	4.4	100	64.5	5.1	155
3	51	43.2	9.0	67	56.8	7.1	118
4	40	51.3	2.0	38	48.7	2.0	78
Feature 2							
1	3	30.0	117.9	7	70.0	167.6	10
2	21	52.5	31.2	19	47.5	31.1	40
3	65	60.2	4.4	43	39.8	5.1	108
4	58	46.4	10.6	67	53.6	16.2	125

Debitage from both quarry features is dominated by shatter produced during initial toolstone reduction, but heavier items are concentrated in the Feature 2 debris pile where four percussion tools were collected. Feature 2 may represent a colluvial deposit of heavier items formerly edging or thrown from the quarry pit higher on the slope. On the other hand, it is possible that Feature 2 represents a separate, extraction related feature centered on a low outcrop buried by the rubble pile. Similar rubble piles consisting of large pieces of shatter, cores, and crude bifaces often occur at the bases of outcrops where they form open work talus cones. Smaller items tend to sift downward in these deposits and surface collections from this type of talus feature are dominated by large pieces of debitage.

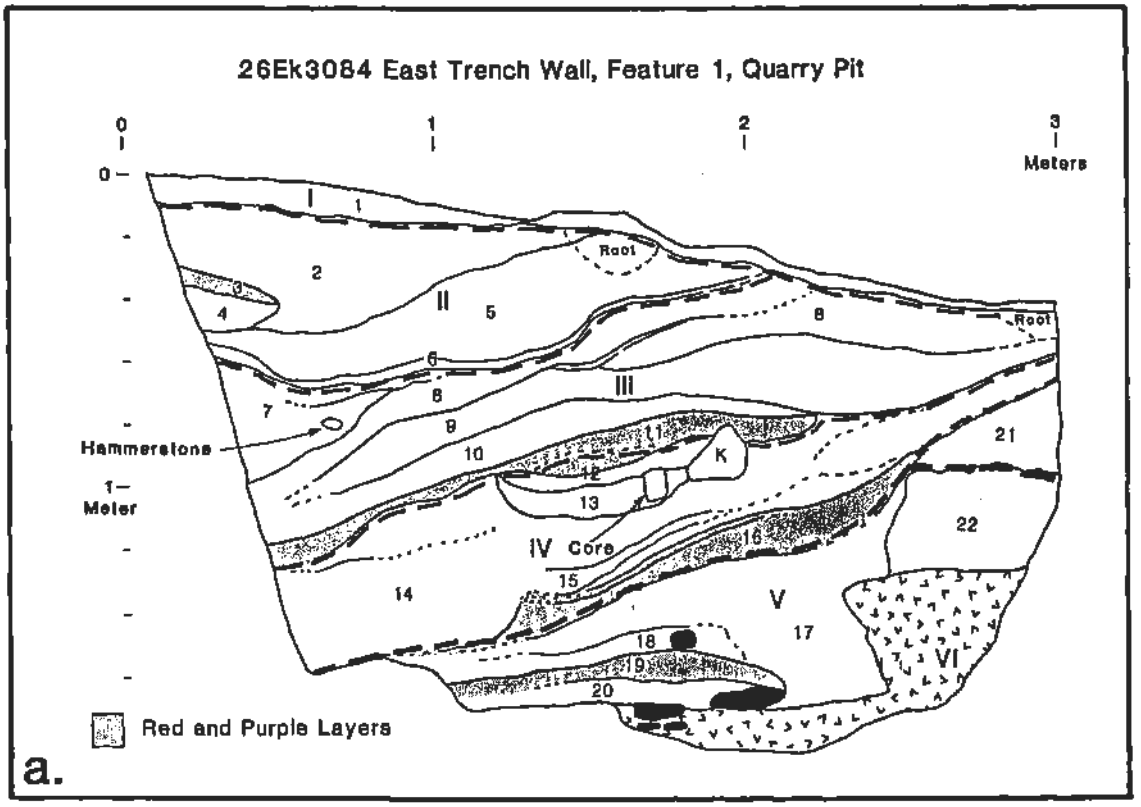
Quarry Pit Stratigraphy

The trench cross section through the Feature 1 quarry pit cut through several north-sloping strata not conforming with the present south-sloping surface (Figure 37a). However, the trench intersected only the downhill margin, or berm, of the quarry pit and the central extraction pit and toolstone source area are located under the road fill (Figure 37b).

The following description of the stratigraphy of the east wall trench profile provides definition of the strata as grouped tentatively by major horizons (Table 47). Particle size, artifact content, and sediment color often change within a few centimeters, but it is possible to organize groups of strata into tentative horizons, each a broad time-stratigraphic unit including one or more related events marked by surfaces and conformable strata. The reader should note that this unit-horizon connection is used whenever possible in subsequent stratigraphic descriptions.

Figure 37a. 26Ek3084, Feature 1, east wall trench profile.

Figure 37b. 26Ek3084, Feature 1, road fill cross section.


26Ek3084 East Trench Wall, Feature 1, Quarry Pit
0
1
2
3
Meters
Root
Root
Hammerstone
1 Meter
IV Core
K
Red and Purple Layers
a.

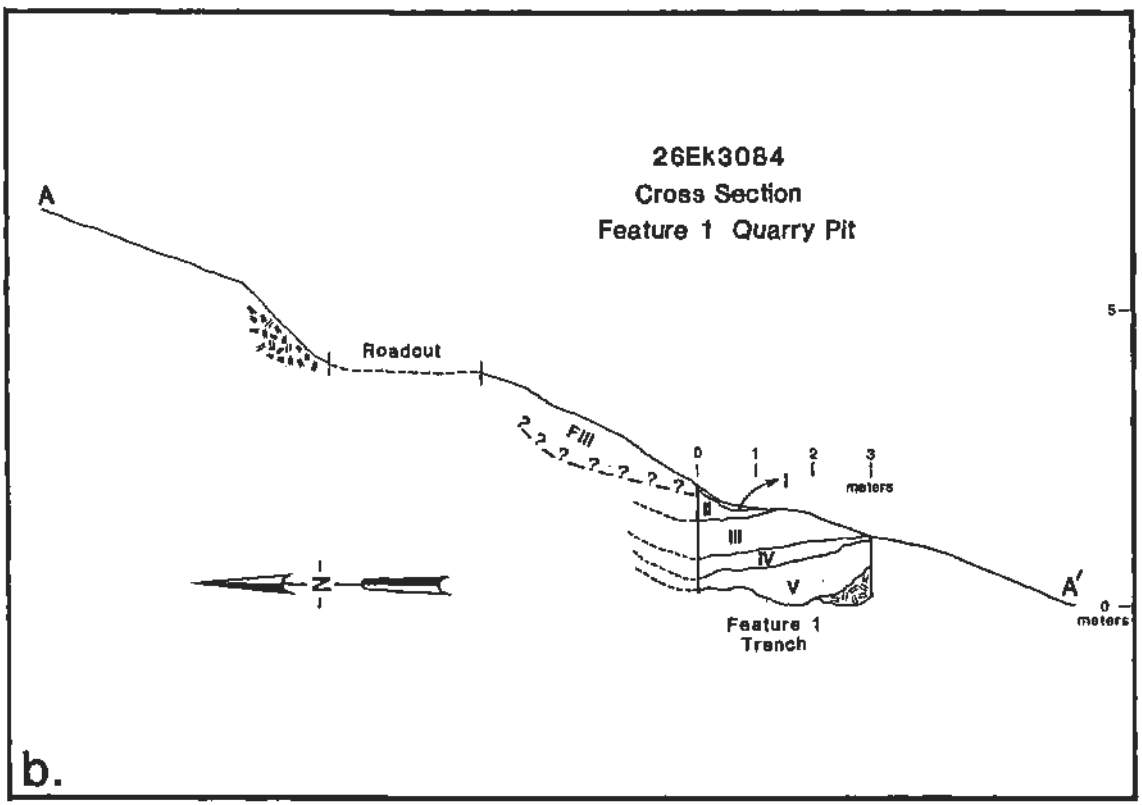

26Ek3084
Cross Section
Feature 1 Quarry Pit
A
Roadcut
Fill
meters
A'
Feature 1
Trench
b.

Table 47. Description of Stratigraphic Units by Horizon, East Wall of Trench through Feature 1, 26Ek3084.

Horizon	Stratum	Description
I	1	Very dark grayish brown (10YR 3/2) cobbly gravelly sand; contains abundant jasper-like flakes, chunks and cores.
II	2	Dark brown (7.5YR 3/2) loamy sand with abundant flakes and cores.
	3	Very dusky red (10R 2.5/2) sandy loam; abundant charcoal in upper 0.5 cm.
	4	Brown (10YR 4/3) sandy loam with small flakes and angular white opalite waste.
	5	Dark brown (7.5YR 3/3) clay loam; large clasts and flakes sparse.
	6	Light brown (7.5YR 6/4) sandy loam; abundant flakes.
III	7	Openwork large flakes and cores with little or no matrix at top; basalt hammerstone, smaller flakes and cores with angular shatter and brown (10YR 4/3) sandy loam matrix in lower portion.
	8	Dark brown (7.5YR 4/2) sandy loam with sparse angular opalite waste and few flakes, although a flake line parallel to Unit 6 is within Unit 8.
	9	Yellowish brown (10YR 5/4) angular tuff rubble with few flakes.
	10	Light brown (7.5 YR 6/4) gravelly sandy loam gravelly tuff with small flakes; effervescent to strongly effervescent.
	11	Weak red (10R 5/3) sandy loam; weakly effervescent to non-effervescent; sparse flakes.
IV	12	Brown (7.5YR 5/4) (lower) to reddish brown (5YR 5/3) (upper) sandy loam matrix with large angular opalite chunks and flakes.
	13	Brown (10YR 5/3) sandy loam with few or no flakes.
	14	Pale brown (10YR 6/3) sandy loam with angular, unmodified opalite chunks; little, if any cultural material on north; becoming coarser toward north with openwork very large flakes and chunks at south end of trench; strongly effervescent.
	15	Brown (7.5YR 5/4) sandy loam with small flakes.
	16	Weak red (10R 4/3) sandy loam with few flakes.
V	17	Light brown (7.5YR 6/4) sandy loam with few flakes.
	18	Brown (7.5YR 5/4) sandy loam with small flakes.
	19	Weak red (10R 5/3) sandy loam with few or no flakes.
	20	Brown (10YR 4/3) sandy loam with few or no flakes.
	21	Light brown (7.5YR 6/4) sandy loam with flakes; non-effervescent.
VI	22	Light brown (10YR 4/3) sandy loam with no flakes; capped with fist-sized chert and tuff cobbles; effervescent to strongly effervescent at bottom.
	Bedrock	Pink (7.5YR 7/4) to reddish yellow (7.5YR 6/6) weathered and/or altered tuff with tabular (flaggy) pieces of jasper-like toolstone at upper contact which probably were the target resource.

The duration of stratigraphic events probably varies considerably. For instance, surfaces were created through excavation (pit floors) and by deposition (surfaces of depositional units). Cultural surfaces and strata (pit floors and slopes, strata deposited through waste disposal) were

created instantaneously in archaeological terms, while strata created through natural processes (colluviation, slope wash, eolian deposition) no doubt took longer to accumulate.

Six horizons are identified, as described above. The lowest and uppermost horizons segregate the unmodified sediments and basal bedrock (Horizon VI) and the surface layer of colluvium (Horizon I). Horizons II through IV define one or more temporally related events, here visible as four large pit excavations and their constituent layers of fill. Strata and horizons are numbered consecutively from the surface, but the description proceeds from bottom up to facilitate understanding the sequential order of events.

Horizon VI comprises the oldest deposits which are visible as the bedrock and soil stratum (Unit 22) in the southern end of the trench that have been truncated by quarry pit excavation. Bedrock exposed in the trench bottom is soft, altered tuff in shades of pink, orange, and yellow. Tabular cobbles of jasper-like toolstone occur at the contact. Unit 22 overlies the bedrock and appears to be colluvial soil mantling the slope prior to use of the site as a quarry; it apparently contains no flakes. Unit 22 is capped with a layer of opalite and tuff cobbles.

Horizon V has five units (21 through 17) which compose the fill of the deepest pit visible. The pit was excavated through Unit 22 and along the north face of the bedrock, producing an overhanging pit wall on the south. Unit 21 may represent soil and waste material from this pit. Units 20, 19, 18, and 17 fill this lowermost pit, and are parallel to the underlying tuff bedrock. Red colored Unit 19 is probably backdirt from excavation into the altered tuff bedrock. The brown units (20, 18 and 17) are most likely derived from slope wash.

Horizon IV is comprised of units 16 through 12 which fill a pit that truncated Unit 21 on the south and Unit 17 on the north. Unit 16 is the lowest in a stack of strata that slope to the north at a steeper angle than those of Horizon VI, and appear to fill a larger pit, the bottom of which is located further north (under the road fill). Red unit 16 probably marks altered tuff bedrock waste at the bottom of the horizon; sparse flakes in brown Unit 15 suggest it may have accumulated through slopewash, while the abundant large flakes and cores in Unit 14 suggest quarry waste and processing debris.

Filling a small pit inset into Unit 14 are units 12 and 13. When observed in the field, the shape of this small pit suggested the possibility of a hearth, but neither Unit 12 nor Unit 13 contained charcoal. Unit 12 is comprised of two lenses, of two different colors. A large core was embedded in Unit 13.

Horizon III contains units 11 through 7; the pit they fill has a configuration similar to the one containing Horizon IV strata, but its bottom is located further north. This is visible in the orientation of strata 8 through 10 which have a "berm-like" conformation extending under and outward from the thick openwork of stratum 7. Unit 11 is red sandy loam from the excavation of altered tuff bedrock at the bottom of the pit, and units 10, 9 and 8 are sandy loams probably derived from slope wash. Unit 7 is a wedge of openwork large flakes, cores and angular cobbles, probably debris created by processing quarried toolstone.

Horizon II is comprised of units 6 through 2, filling a relatively shallow pit. The outline of this pit is given by Unit 6, a thin flake layer; the pit bottom is visible in the profile near the northern end of the trench. Unit 5 is a sandy deposit with few flakes, probably derived from slope wash; Unit 2, containing abundant flakes and chert cobbles, is probably quarry waste. Only the edge of units 4 and 3 can be seen at the northern edge of the trench. The red colored Unit 3 has abundant charcoal in its upper portion; whether it is red because it contains altered tuff or because of oxidation from a hearth fire cannot be said at this point.

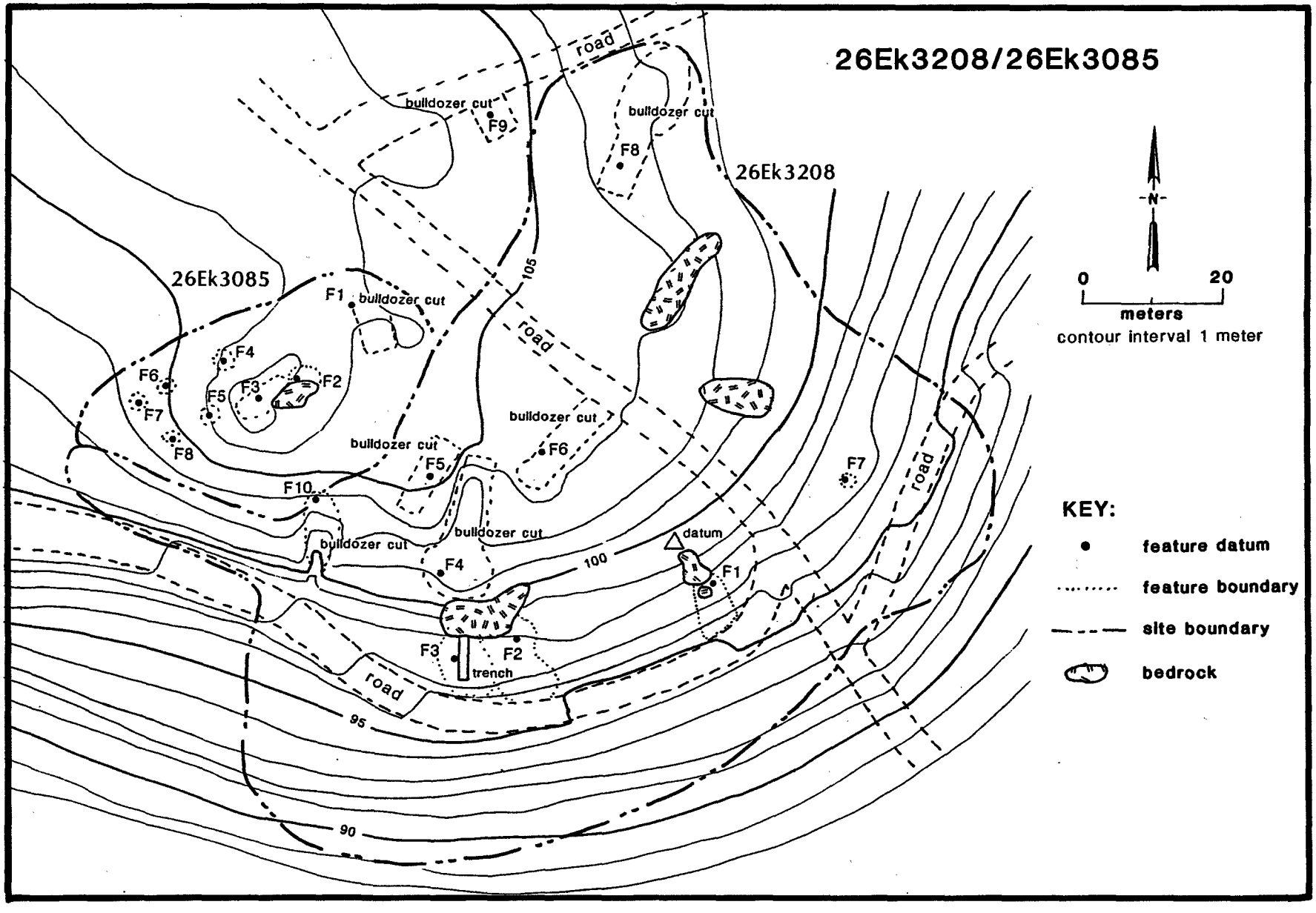
Horizon I is comprised of a single stratum, the surficial layer, Unit 1. Unit 1 slopes south and unconformably overlies and/or truncates several lower units. This suggests that the unconformity is largely the result of erosion.

Presently, the larger portion of the quarry pit is buried under road fill so that neither its horizontal extent nor its maximum depth are known. For the same reason, we have no direct evidence of whether the pit was excavated to exploit a vertical bedrock outcrop or a more or less horizontal layer of bedrock covered with colluvium, or both. The size and shape of some of the quarry shatter, and the tabular structure of the bedrock in Horizon VI, suggests that, whatever the nature of the formation, opalite occurs in tabular pieces. If true, this may account for the relative absence of charcoal in the deposits because the use of fire would not be necessary to extract it. However, the apparently oxidized red soil in stratum 3 must be explored further before the use of fire can be discounted. These questions illustrate certain significant data gaps which are fundamental to addressing defined research issues. A fuller exposure of the quarry pit, subsequent to removal of the road fill, will be necessary to understand the nature of the formation and the extractive strategies employed.

Site 26Ek3208/26Ek3085

Sites 26Ek3208 and 26Ek3085 are adjacent quarry pit complexes (Figure 38). The bedrock is exposed discontinuously at the surface so that the pit complexes appeared to be spatially discrete when they were recorded. In actuality, the outcrops are

Figure 38. 26Ek3208/3085, site map.


26Ek3208/26Ek3085
26Ek3208
26Ek3085
road
bulldozer cut
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
105
100
95
90
trench
datum
N
0
20
meters
contour interval 1 meter
KEY:
feature datum
feature boundary
site boundary
bedrock

slightly different, but contiguous manifestations of the same geologic formation and the pit complexes are elements of the same archaeological phenomenon.

The 26Ek3208 quarry pit complex is centered on a prominent opalite ledge outcrop exposed along the southeast edge of the ridgeline. Two large pits (features 2 and 3) are visible on the surface at the base of the steep outcrop face; another smaller pit (Feature 1) is situated nearby. The top of the exposure, on the ridgeline, has been the focus of more recent mining exploration; five historic mining features (pits, bulldozer scrapes, trenches) were recorded (features 4 through 10); all five were excavated in areas of thick prehistoric quarry deposits, one of which (Feature 5) exposed a basalt biface which appears to be a Great Basin Stemmed Point preform.

Site 26Ek3085 is a small pit cluster composed of five shallow prehistoric quarry pits (features 3, and 5 through 8), two large historic pits (features 1 and 4), and one pit of uncertain origin (Feature 2). The quarry pits are associated with a low extrusion of opalite bedrock centered on the top of the saddle and west of the prominent outcrop at 26Ek3208.

Surficial distinctions in the size of the quarry pits and the quality of the exposed opalite suggest differences in the degree of energy expended at 26Ek3085 as opposed to 26Ek3208; quarry pits at 26Ek3085 are smaller (2 to 4 m maximum dimension), shallower (ca. 30 cm deep), and associated with restricted debris scatters. Few formed artifacts were located in these pits; one Quarry Biface was collected from Feature 5 and one basalt percussion tool was collected from Feature 8. Flakes and other quarry products are visible in pit berms and debris cones, but a thick layer of matted grass covers the features and obscures all but their general surface conformation.

Unlike the large pits (features 2 and 3) at adjacent 26Ek3208 which exploit a massive ledge, the prehistoric pits at 26Ek3085 were excavated into narrow colluvial pockets which have formed between low bedrock ledges. These pockets likely contained fractured opalite bedrock, some of which would have been suitable for toolstone reduction. The small size of the pits, and the restricted area of associated extraction debris, suggest a lesser quality toolstone available for extraction than at 26Ek3208.

At 26Ek3208, a dense layer of reduction debris covers the top of the outcrop and extends down the south slope, below its steep face, to form a thick debris cone. This talus is largely cultural in origin and includes great numbers of rejected bifaces, large pieces of shatter, and crude cores as well as many basalt and rhyolite hammerstones in a range of sizes. One of the two surface depressions, Feature 3, at the base of the outcrop was sectioned by backhoe trench; its complex stratigraphy is described below.

Quarry Pit Stratigraphy

The cross section of Feature 3 reveals deposits composed of numerous intercalating layers extending more than two meters below surface (Figure 39). Horizons and strata are numbered consecutively from the surface. In the following discussion, horizons and strata are presented in reverse order, from bedrock to the surface. Munsell colors (wet) are given for most strata, but soil descriptions are not, since the highly mineral deposits are all gravelly sands with few or no fines (Table 48).

Horizon V is a thick deposit comprised mostly of conformable strata appearing to represent sequent episodes of filling a large pit excavated at the face of the outcrop. We did not observe the bottom of this pit and do not know if it bottoms out on bedrock.

Excavation of pits in Horizon III and Horizon IV truncated several units (15 through 13) in Horizon V; consequently, the original surface is gone and the extent of pit berms cannot be determined. Units 13 through 17 may not be part of Horizon V, but may be more closely related to Horizon III or Horizon IV. Still, these units seem to be more conformable to Horizon V than to any other. It appears there has been some retreat of the face of the opalite outcrop as it was mined, and this helps account for the order and morphology of strata in Horizon V. Indeed, an adit may extend into the face of the outcrop just east of the profile, since the bedrock outcrop can be seen to bend around to the north on the east side of the trench.

Charcoal is common in Horizon V, increasing in abundance with depth, suggesting that fire setting against the face of the outcrop was used to weaken the tuff and dislodge chunks of toolstone. This is supported by the presence near the bottom of the profile of two lenses of charcoal-rich sediment containing fragments of burned tuff and opalite. A Bison sp. scapula fragment, found on the contact between units 23 and 24, probably was used as a shovel to help remove quarry waste from the pit. Radiocarbon dates from strata 25 and 28 bracket the basal deposits in Horizon V between ca. A.D. 1150 and 1300 (Table 49). The order of the dates is reversed; however, since they are within two standard deviations of each other, they may be considered the same date.

The strata in Horizon V tend to alternate in coarseness between layers of sandy decomposed tuff and layers of tuff and opalite rubble. The latter usually are more extensive, while the finer grained deposits often pinch out on the interior slope of the pit they partially fill. Perhaps the rubble layers represent episodes of quarry activity when rock was removed from the face of the outcrop and waste discarded in the pit and on the berm. The finer sediments may be material accumulated in the pit bottoms through natural processes such as slope wash between quarrying episodes. The fact that coarse layers overlie both charcoal lenses supports this hypothesis if the lenses are relics of the firesetting technique and not natural accumulations of charcoal from wildfires.

Figure 39. 26Ek3208, Feature 3 quarry pit cross section, east wall trench profile.

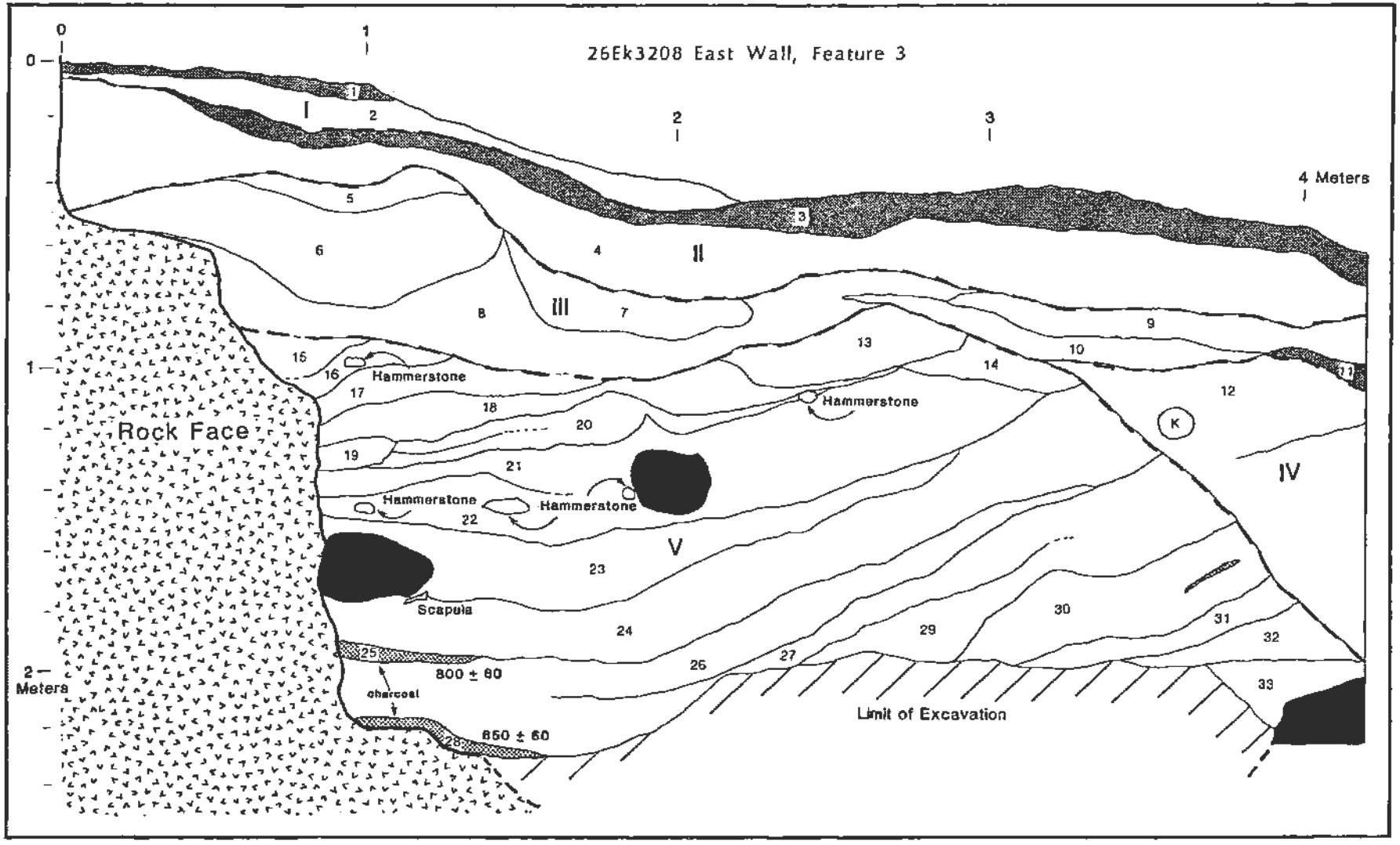

26Ek3208 East Wall, Feature 3
0
1
2
3
4 Meters
0
1
2 Meters
I
II
III
IV
V
K
Rock Face
Hammerstone
Hammerstone
Hammerstone
Hammerstone
Scapula
charcoal
800 ± 60
850 ± 60
Limit of Excavation
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

Table 48. Description of Stratigraphic Units by Horizon, East Wall of Trench through Feature 3, 26Ek3208.

Horizon	Stratum	Description
I	1	0-5 cm but extends only to one meter beyond the base of the outcrop; very dark brown (10YR 2/2); essentially an A1 horizon or humic accumulation containing a little silt in the upper portion of Unit 2. Flakes and cores are present but sparse.
	2	5-10 cm; lobe of mostly open-work talus of greenish white (5GY 9/1) opalite with very dark grayish brown (10YR 3/2), very sparse sandy matrix. Particle size is 1-3 cm within one meter of the outcrop, increasing to fist-size at toe of lobe. Flakes and cores are present but sparse.
II	3	10-30 cm; buried by units one and two to 2.2 meters from the face of the outcrop, thereafter at surface; black (10YR 2/1); possibly an A1 horizon developed in the upper portion of Unit 4. An accumulation of organic material containing abundant tiny flakes between 3.0 and 3.3 meters from the outcrop is probably an old harvester ant midden. Flakes are abundant throughout.
	4	Very dark brown (10YR 2/2), fist-size or larger angular chunks of opalite in a sandy matrix; flakes less abundant than in Unit 3 above. Perhaps most of the dark color is derived from infiltration of humic material from Unit 3. The upper surface of Unit 4 is roughly parallel to the present surface; the lower boundary suggests that Unit 4 is unconformable over berms and in pits forming the surface of underlying units of Horizon II. The large size of opalite clasts in Unit 4 suggests its origin as waste from unobserved quarry pits located further to the east.
III	5	Brown (10YR 5/3) sandy deposit comprised mostly of decomposed tuff with few flakes.
	6	Light colored openwork tuff and poor quality opalite rubble; clasts 10-15cm diameter; sparse dark grayish brown sandy matrix.
	7	Angular openwork rubble with matrix similar to Unit 5.
	8	Dark grayish brown (10YR 4/2) decomposed tuff near the base of the outcrop, coarsening and becoming lighter in color with distance to south; contains large flakes.
	9	Grayish openwork tuff rubble with relatively few flakes.
	10	Decomposed tuff with angular chunks of rubble; darker color than Unit 9; possibly a facies of Unit 11.
	11	Black (10YR 2/1) organic layer with no free charcoal.
IV	12	Dark grayish brown (10YR 4/2) sandy matrix with small particles of tuff; flakes are relatively scarce. No internal stratification is obvious.
V	13	Greyish brown sandy matrix with few obvious flakes.
	14	Greyish brown sandy matrix with big pieces of tuff and poor quality toolstone shatter.
	15	Light colored, fine grained sediment filling small pit against the outcrop; truncated by Unit 8.
	16	Darker gray sandy sediment with large flakes; truncated by Unit 8.
	17	White (10YR 8/2) decomposed tuff containing large chunks of good quality opalite and medium to large opalite flakes.
	18	Openwork layer of high quality greenish white (5GY 9/1) opalite flakes of all sizes from very large to small. Appears to be core reduction debris.

Table 48, continued.

Horizon	Stratum	Description
(V, cont.)	19	Light colored, angular, gravel-sized decomposed tuff.
	20	Dark grayish brown (10YR 4/2) silty sand matrix with abundant flakes; flakes are larger in upper portion, smaller below but form open work at bottom of unit.
	21	Dark gray (10YR 4/1) silty sand with abundant small charcoal flecks; merges with Unit 22.
	22	Dark grayish brown (10YR 4/2) openwork opalite flakes and cobbles with sandy matrix and abundant charcoal; contains large (20 x 25 cm) rhyolite boulder and hammerstones. Boundary between units 21 and 22 becomes indistinct about 80 cm. south of the outcrop, as Unit 22 becomes a stack of intercalated lenses of coarser material alternating with light and dark colored decomposed tuff.
	23	Grayish brown (10YR 5/2) to pale brown (10YR 6/3) decomposed tuff and angular rubble containing abundant charcoal. Unit is coarser on bottom and nearest outcrop fining toward the south; unit is darker in color nearest outcrop, becoming lighter toward south; unit contains a large (20 x 35 cm) rhyolite boulder; a bison scapula was found in Unit 23 at contact with Unit 24.
	24	Dark grayish brown (10YR 4/2) sandy matrix with abundant charcoal, but mostly large, loose chunks of angular, cobbly opalite and tuff rubble becoming more sandy to the south.
	25	Very dark gray (10YR 3/1) opalite sand with very abundant charcoal; contains small chunks of burned opalite and tuff.
	26	Pale brown (10YR 6/3) sparse sandy matrix in coarse cobbly deposit near outcrop becoming very dark grayish brown (10YR 3/2) decomposed tuff sand with flakes toward south.
	27	Light brownish gray (10YR 6/2) decomposed tuff with angular opalite chunks and flakes; differentiated from Unit 26 about 65 cm south of outcrop; most cobbly nearest outcrop, fining southward.
	28	Very dark gray (10YR 3/1) opalite silty sand with very abundant charcoal in contact with opalite bedrock; contains small chunks of burned opalite and tuff.
	29	Dark gray (10YR 4/1) large, angular rubble; distinction between Unit 27 and Unit 29 lost about 2.2 meters south of outcrop.
	30	Dark grayish brown (10YR 4/2) decomposed tuff with small angular chunks; contains a narrow band or lens of charcoal.
	31	Large rubble.
	32	Dark gray (10YR 4/1) silty sand with charcoal.
	33	Light gray (10YR 7/2) decomposed tuff with few flakes but some charcoal.
	Bedrock	At the outcrop, bedrock is banded opalite and tuff; large tuff boulder at south end of profile may also be bedrock.

Table 49. Provenience of Radiocarbon Samples from 26Ek3208.

Reference Number	Laboratory Number	Date (Years B.P)	Provenience
2500-2/4	Beta-26754	800 +/- 60	Stratum 25; 1.80-1.85m BS
2500-4/5	Beta-26755	650 +/- 60	Stratum 28; 2.05-2.10m BS

Horizon IV is comprised of the fill of a single large pit, Unit 12, at least 90 cm deep. The pit may have been excavated to exploit previously quarried opalite material in older pit fills and berms of Horizon V, but it may have penetrated to bedrock as well. It is overlain by units 10 and 11 of Horizon III. Only the northernmost portion of Unit 12 was observed.

Horizon III contains strata that seem to relate to the last episodes of quarry pitting visible in the profile. The quarry activity appears to have been oriented as much toward reworking older quarry waste in berms and pit fill as with working the outcrop. Consequently, pits, berms and fills intercut each another and vary in distance from the outcrop. Actually, all the pits in Horizon III and the single large pit in Horizon IV (filled with Unit 12) may be related to the same horizon.

Unit 8 fills a larger pit, extending to 2.5 m south of the outcrop; units 9 and 10 probably are layers of waste from this large pit. Unit 11, possibly an extension of Unit 10, is probably a buried humic horizon similar to Unit 3. Unit 7 fills a small pit between 1.5 and 2.5 m south of the outcrop; units 5 and 6 fill a pit between the face of the outcrop and 1.5 m south. Both these units have been truncated on the south by the pit filled with Unit 4.

Horizon II is comprised of two units that run the length of the trench, forming, in part, the present ground surface. Large flakes and cores are more abundant in these units than in those of Horizon I.

Horizon I is comprised of two strata that are parallel to the present ground surface, but limited in horizontal extent. Flakes and cores, though relatively scarce, are thought to be included through such natural processes as slope wash from above. Horizon I therefore includes material deposited through natural processes since the last major episode of toolstone extraction at the site.

In summary, five major kinds of deposits have accumulated in the quarry pit deposits. Fine grained, tuff sand and silty tuff sand strata (cf. units 33, 30, 27, 23; possibly Unit 12) are probably non-cultural accumulations of material deposited through slope wash and aeolian processes during intervals when the quarry site was not in active use. These are mostly light-colored sediments. Unit 12, filling a large pit, is darker in color and somewhat more coarse in texture; it may be humic soil excavated from another pit and not have accumulated through slope wash. Charcoal and fire-altered rock form lenses that may have been deposited during episodes of fire setting to weaken bedrock. Coarse rubble, comprised of angular tuff and/or opalite, often containing abundant flakes and cores, is probably quarry waste generated by working the bedrock. Flake layers are deposits of pure opalite debitage with little or no sand or rubble. These sediments suggest toolstone processing and/or initial reduction. Colluvium is coarse material accumulating

through natural processes of mass wasting of the outcrop face. In addition, humic horizons can develop on any of these strata if they are exposed long enough at the surface.

The stratigraphic record revealed in trench profile suggests that there are two types of subsurface quarry features. One type is the large pit excavated against the bedrock face in order to quarry toolstone from the face, and represents the technique used during the earliest episode of quarrying visible in the trench. Quarrying tools associated with this feature type are large (< 25 cm diameter) andesitic basalt boulders, hammerstones, and bison scapula shovels. Fire setting apparently was used to weaken rock in the outcrop, but whether fire was more effective on well silicified opalite, or on the tuff, is not known.

The second type of feature is the pit sunk into deposits of waste rock generated by exploitation of the outcrop; these pits vary in size and no quarrying tools were observed in them. The reworking of earlier quarry debris is a technique employed during the last episodes of quarry use at this site.

Summary

The three small outcrop quarries (sites 26Ek3082, 26Ek3083, and 26Ek3207) suggest brief exploration (material assay) and limited core reduction perhaps incidental to toolstone procurement elsewhere in the vicinity or for expedient toolstone manufacture while hunting or foraging in the area. These sites lack time-sensitive artifacts or other chronological indicators which might segregate episodes of use. Likewise, the lack of spatially discrete extraction features provides few clues to the organization of production at these small quarry sites.

Site 26Ek3084 is a unique opalite source locality; it is areally restricted, distinctive in color, high in quality, and was exploited intensively. It is expected that the high quality of the toolstone is related to its desirability and that this may be measured by the energy used to extract it. Furthermore, material removed from the quarry to nearby reduction sites may be traced due to its distinctive color and unusual jasper-like composition.

The 26Ek3208/26Ek3085 quarry pit complex provides a wealth of data for comparing prehistoric quarry strategies and for calculating energy investments relative to variations in material quality and abundance along the same geologic formation. The presence of dateable charcoal in stratified deposits is especially significant. Quarry features may be dated as discrete stratigraphic events, energy investments may be calculated by strata, and a cultural-chronological dimension can be added to our understanding of extractive strategies and energy investments.

Chapter 11. BASALT CANYON SITES

by Elizabeth E. Budy

Where it passes through the USX-West project area, Basalt Canyon is a narrow, steep-sided division between Red Hill and a series of southeast trending ridgelines comprising the Bitterroot Ridge Complex (Figure 40). The ephemeral stream follows a sinuous course bending around the base of Red Hill to flow into Little Antelope Canyon on the east.

Constrained by underlying bedrock, the grade of the channel varies. Along most of its extent, the relatively steep grade of the stream combined with seasonal high energy flows has not favored alluvial deposition. Sediments tend to accumulate in reaches with more shallow gradient where small terraces form; here, water is forced to the surface by underlying bedrock and is retained by the accumulated alluvial sediments. The stream channel contains seeps and pools of standing water that may persist for several weeks after the steeper reaches have dried up. For example, resistant underlying bedrock on the eastern (downstream) edge of the bend near site 26Ek3092 serves to control stream downcutting, favoring the accumulation of alluvial deposits at the bend interior. As a result, a series of small terraces, likely formed during the Late Holocene, served as loci for prehistoric occupation from about 3000 B.C. to A.D. 1850.

Intermittent water and small persistent pools provide seasonal habitat for both large and small mammals. Faunal data from alluvial terrace deposits at site 26Ek3092 suggest that bighorn sheep, possibly bison, and other deer-sized mammals were hunted in the vicinity. Basalt Canyon also provides small amounts of edible grass and sedge seeds as well as drinking water in early summer which may have conditioned, in part, site locations along the lower reaches of the canyon. Assemblage constituents at several sites likewise suggest on-site subsistence related activities as well as some limited residential use; however, as elsewhere in the project area, cultural activity centered on toolstone reduction.

Descriptive Site Summary

Eleven sites were recorded along the lower reach of Basalt Canyon (Table 50), nine of which were tested.

Tested sites, as grouped by operational field types, include five reduction stations (small scatters), one reduction/cobble assay site (scattered workshop and on-site cobble assay residue), one reduction complex (with three spatially discrete workshop features), and two reduction/

Figure 40. Topographic setting, Basalt Canyon sites.

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

residential complexes (where short term occupation is inferred from the variety of subsistence-related artifacts recovered). In actuality, these types provide only broad parameters for grouping sites in Basalt Canyon. As a result of streamside and/or steep slope location, artifact patterns have been rendered obscure by slopewash and/or alluvial processes. Indeed, test assessments were oriented initially towards better site definition relative to local depositional characteristics.

Table 50. Descriptive Summary, Basalt Canyon Sites.

Site Number	Type	Features (n)	Maximum Site Area (sq m)
26Ek3086	Reduction/ Cobble Assay	-	1,100
26Ek3087	Reduction Station	-	300
26Ek3088	Reduction Station	-	650
26Ek3089	Reduction Station [NOT TESTED]	-	36
26Ek3090	Rockshelter/Reduction Station	-	150
26Ek3091	Reduction Station	-	400
26Ek3092	Reduction/Residential Complex	5	4,800
26Ek3097	Reduction Station	-	500
26Ek3098	Isolated Artifact [NOT TESTED]	-	N/A
26Ek3099	Reduction Complex	4	750
26Ek3149	Reduction/Residential Complex	3	2,500

Testing Strategies

Each Basalt Canyon site was subjected initially to systematic close interval surface survey to locate all formed artifacts and obsidian suitable for sourcing, characterize surface debitage patterns, establish boundaries, and prepare detailed site maps. Discrete artifact concentrations were recorded as features at three sites (26Ek3092, 26Ek3099, and 26Ek3149) and all associated artifacts were plotted on plan maps and collected (Table 51). At site 26Ek3149, surface features are constrained in vertical extent by bedrock, but artifact patterns appeared to be affected minimally by slopewash. Consequently, a representative sample feature was collected completely for debitage classification and distributional studies. Such is not the case at sites 26Ek3092 and 26Ek3099 where features are located on steep slopes, and materials, though clustered, can be seen to have been redistributed by erosion. Eroded features were judged to contain little data suitable for reconstructing cultural patterns; no systematic debitage collections were taken from surface features at these sites.

Table 51. Summary of Testing Procedures, Basalt Canyon Sites.

Site Number	FEATURES Total (n)	FEATURES RECORDED Sampled (n)	FEATURE Surface Skim Area (sq m)	NONFEATURE CONTEXT Subsurface Excavation Volume (cu m)	Trench Cross Section (n)	Stratigraphic Profile (n)	RECOVERED COLLECTIONS Debitage (n)	Formed Artifacts (n)
26Ek3086	-	-	-	-	-	-	3	6
26Ek3087	-	-	-	-	-	-	1	4
26Ek3088	-	-	-	-	-	-	0	4
26Ek3090	-	-	-	0.45	-	-	173	6
26Ek3091	-	-	-	-	-	-	0	8
26Ek3092	5	-	-	2.30	4	3	29,135	117
26Ek3097	-	-	-	-	-	-	0	0
26Ek3099	4	-	-	-	-	-	0	13
26Ek3149	3	1	4.0	0.25	-	-	527	25

Depth of deposit at most sites in Basalt Canyon is constrained by near surface bedrock or steep colluvial slopes that provide little opportunity for subsurface cultural accumulations. However, subsurface tests were conducted outside feature contexts at three sites (26Ek3090, 26Ek3149, and 26Ek3092) where deeper sediments were observed. At rockshelter/reduction site 26Ek3090, a 1 by 1 m test unit sampled deposits accumulated at the base of a low rock overhang. At reduction/residential site 26Ek3149, a 0.50 by 1 m unit sampled recent alluvium edging Basalt Canyon at the lower edge of the site. At site 26Ek3092, alluvial terrace deposits were cross sectioned by backhoe trenches and sampled by controlled excavation.

Site 26Ek3092 is otherwise unique among sites located in Basalt Canyon for its buried alluvial deposits and stream terraces. Tests focused on identifying any buried cultural components of the terrace sediments and on working out the relative chronology of occupation. To do this, four backhoe trenches opened cross sections for stratigraphic study. Subsequent to drawing trench profiles, three 1 by 1m test units were located so as to intersect discrete stratigraphic layers visible in three trench wall profiles.

Chronology

The chronology of prehistoric occupation in Basalt Canyon presently relies on time-sensitive artifacts recovered from only one site, 26Ek3092. The earliest evidence is a reworked obsidian projectile point, found in the basal terrace deposits (80-90 cm below surface), which is classified as a Gatecliff

Split Stem (dated between 3000 and 1300 B.C.) but which may be, in fact, a reworked Elko Series point (dated between 1300 B.C. and A.D. 700). Fremont pottery, indicating a maximum range of A.D. 400 and 1350, and Desert Side-notched projectile points (dated between A.D. 1300 and 1850) also were recovered from discrete subsurface layers in the terrace deposits. Charcoal suitable for radiocarbon assay is expected to be recovered in future investigations at this buried site.

Assemblage Composition

The small reduction sites in Basalt Canyon recovered few formed artifacts; these largely consist of Quarry Bifaces (Table 52). Greater functional diversity in artifact classes is apparent at sites 26Ek3092 and 26Ek3149 which are thought to have served as campsite locations at various times. The collection from site 26Ek3149 is not large, but it does include seed grinding stones as well as more general food getting or processing tools. Although larger, the collection from site 26Ek3092 represents only a small sample (2.30 m^3) of the culture bearing alluvium in the terrace sediments. At present, the low density of tools and high density of debitage reflects only short term uses coincident with toolstone reduction, but future investigations are expected to expose a greater range of activities in the context of buried residential features.

The section which follows describes sedimentary contexts, artifact distributions, and feature arrangements at each of the Basalt Canyon sites. The discussion groups the small eroded reduction sites for initial description followed by the two reduction/residential complexes.

Table 52. Intersite Artifact Class Frequency Comparisons, Basalt Canyon Sites.

ARTIFACT CLASS	ARTIFACT FREQUENCY PER SITE							
	Small Reduction Sites						Reduction/Residential	
Lithic Processing/ Reduction Tools	26Ek3086	26Ek3087	26Ek3088	26Ek3090	26Ek3091	26Ek3099	26Ek3092	26Ek3149
Hammerstones	-	-	-	-	-	1	1	-
Other Percussion	-	-	-	-	-	1	-	1
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	0(0)	2(15.4)	1(0.9)	1(4.0)
Reduction Artifacts								
Cores	-	-	1	-	2	3	10	1
Quarry Bifaces	4	4	2	4	5	6	38	9
Preform Bifaces	-	-	-	1	-	1	1	-
Small Bifaces	-	-	-	-	1	-	11	3
Indeter Bifaces	-	-	-	-	-	1	12	-
Subtotal (%)	4(66.7)	4(100.0)	3(75.0)	5(83.3)	8(100.0)	11(84.6)	72(61.5)	13(52.0)
Projectile Points								
Classifiable Types	-	-	-	-	-	-	4	-
Unclassifiable	-	-	-	-	-	-	4	3
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	8(6.8)	3(12.0)
Maintenance and/or Processing Tools								
Scrapers	2	-	1	1	-	-	25	3
Knives	-	-	-	-	-	-	-	1
Perforators	-	-	-	-	-	-	1	1
Spokeshaves	-	-	-	-	-	-	-	1
Multipurpose Flakes	-	-	-	-	-	-	4	-
Simple Flake Tools	-	-	-	-	-	-	1	-
Abraders	-	-	-	-	-	-	1	-
Subtotal (%)	2(33.3)	0(0)	1(25.0)	1(16.7)	0(0)	0(0)	32(27.4)	6(24.0)
Plant Processing								
Metates	-	-	-	-	-	-	-	1
Manos	-	-	-	-	-	-	-	1
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(8.0)
Miscellaneous Artifacts								
Pottery	-	-	-	-	-	-	4	-
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	4(3.4)	0(0)
Site Total	6	4	4	6	8	13	117	25

Small Reduction Sites: Context and Structure

The seven small reduction sites assessed in Basalt Canyon were found to offer limited research opportunities. Located on steep slopes and/or edging the contemporary floodplain of Basalt Canyon, the sites are characterized by low density reduction scatters and demonstrate little internal spatial organization. Sites 26Ek3086, 26Ek3087, and 26Ek3088 are probably low enough to suffer periodic inundation.

Site 26Ek3086

Site 26Ek3086, a diffuse scatter reflecting cobble assay and biface reduction, is located on a gravel bar exposed at the toe of a ridge at the confluence of Basalt Canyon and Little Antelope Creek (see Figure 40). Cobble-sized pieces of opalite and sparse assay flakes are included in the gravels. Controlled reduction flakes are few, but four Quarry Bifaces were recovered along with a carefully modified end scraper and an expedient scraping tool. None of the formed artifacts appears (by color and other physical characteristics) to have been made from opalite available on the site. No features were recorded and the distribution of artifacts is unpatterned.

Site 26Ek3087

Reduction site 26Ek3087 is situated on a small terrace, about 35 m long and 15 m wide, two meters above, and on the south side of the stream bed (see Figure 40). Terrace sediments consist of a 40 cm thick layer of rocky, sandy silt derived in part from slopewash which overlies large boulders. Examination of the streamcut profile and rodent tailings revealed no evidence of buried cultural materials and none are suggested by surface artifact distributions.

Debitage is scattered thinly (1-5 items per m^2) across the terrace; no feature concentrations were identified. The small collection of formed artifacts consists of four Quarry Bifaces. Debitage material is a purple-to-brown, jasper-like opalite similar to the Red Hill quarry source at site 26Ek3084; cobble-sized pieces of this material also are available in the streambed.

Site 26Ek3088

Site 26Ek3088 is located on a small terrace (22 m wide by 25 m long) on the south side of the canyon (see Figure 40); the terrace is comprised mainly of large boulders with a thin mantle of soil. There are no discrete features on the site, and cultural material is not deeply buried. Surface debitage is

relatively sparse (1 item per m^2), with a slightly higher density (5 items per m^2) along the terrace margin where it is exposed and concentrated by erosion. Collections include one core, two Quarry Bifaces, and one scraper. The site appears to be an eroded core and biface reduction locus, perhaps representing several ephemeral uses.

Site 26Ek3090

Site 26Ek3090 consists of a light density lithic scatter extending from a bedrock/boulder overhang, over a narrow bench, and downslope approximately 20 m to the streambed (Figure 41a). The north-facing overhang is two meters deep, four meters long, and less than one meter high; as such, it would provide a convenient shaded work space or a place to crouch out of the wind. An active packrat nest is located in the east end of the shelter, consisting of an elongated mound of sticks, pebbles, bones, and fresh vegetable matter. Formed artifacts on the surface totalled three Quarry Biface fragments and an end scraper; one of the bifaces was found under the lip of the overhang where a subsurface excavation unit was located.

A 1 by 1 m excavation unit (EU1) was excavated to 40 cm below surface and sediments were passed through 1/8 in. screen; the last level (40 to 50 cm below surface) was reduced to 50 cm by 1 m because wet sticky sediments made excavation and screening difficult. Only a small amount of debitage was recovered from the subsurface test; rather high average flake weight suggests most were produced during preliminary trimming of large Quarry Bifaces or as a consequence of core reduction (Table 53). Other artifacts recovered include one Preform Biface and one Quarry Biface.

Table 53. Artifact Collections from EU1, Site 26Ek3090.

	DEBITAGE				
Depth	Flakes		Shatter		
(cm BS)	(n)	(Av Wt)	(n)	(Av Wt)	OTHER ARTIFACTS
0-10	32	2.6	23	14.4	Preform Biface
10-20	36	6.5	6	51.9	none
20-30	10	6.0	4	6.6	none
30-40	29	7.8	20	9.8	Quarry Biface
*40-50	10	2.7	16	2.2	none

* converted (times two) to reflect comparable volume

The south wall profile of the excavation unit shows three major stratigraphic units (Figure 41b). Unit 1, comprising the upper 15-25 cm of deposit (thickens to the west), is a dark brown silt loam in which charcoal flecks and chunks are common.

Figure 41a. Overview southeast, site 26Ek3090.

Figure 41b. South wall profile EU1, site 26Ek3090.

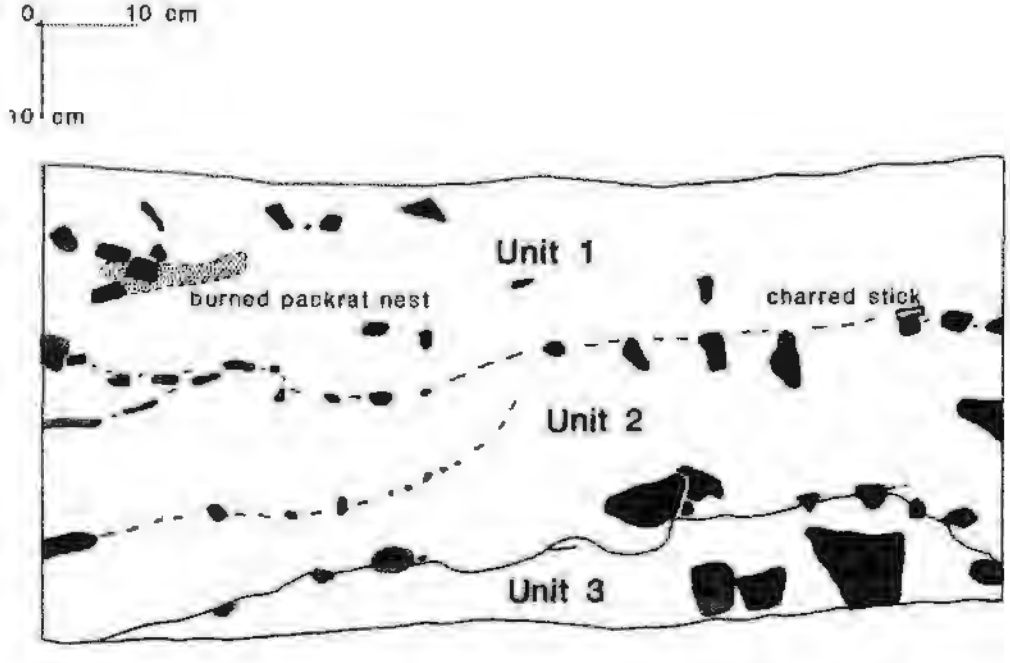
Key

Unit 1: dark brown silt loam (7.5YR 3/2); slightly plastic; fine roots common; charcoal present.

Unit 2: very dark brown silt loam; slightly plastic; roots and charcoal common.

Unit 3: dark reddish brown (5YR 3/4) silty clay loam; subangular blocky; plastic.




0
10 cm
10 cm
Unit 1
burned packrat nest
charred stick
Unit 2
Unit 3

A charcoal lens about 10 cm below the surface in this unit is thought to represent a burned packrat midden of the type presently on the surface; the charcoal lens has the same shape and directly underlies the surface midden. Unit 2 is a dark brown silt loam containing cobbles of opalite; charcoal is also abundant. Unit 2 is approximately 20 cm thick. Unit 3 is dark reddish brown silty clay loam containing abundant opalite cobbles and boulders and no charcoal. Unit 3 probably represents the buried paleosol that forms the virtual bedrock in the vicinity of Red Hill. The boundary between Unit 1 and underlying Unit 2 is marked by a conspicuous pebble line contact extending across the profile.

Comparison of debitage frequencies and average weight per item by level listed in Table 53 with the stratigraphic profile suggests that the pebble line contact is probably a buried surface. Note that debitage numbers decrease with increased depth to about 30 cm then increase again just below the contact. Some size grading also is apparent in the upper layers, with heavier items tending to accumulate above the pebble line at about 20cm below surface.

The alcove apparently provided temporary shelter to those reducing local toolstone. Incidental hunting is suggested during its latest use (upper surface) by a broken projectile point preform.

Site 26Ek3091

Site 26Ek3091 is among a group of boxcar-sized boulders on a steep rocky colluvial slope north of the stream channel (see Figure 40). Two large boulders form shallow overhangs, but no cultural material was observed on the surface there. A flake scatter east of the boulders has been obscured by drilling mud from recent exploration holes in the road above the site. A flake scatter located on the west side of the large boulder seems to have been concentrated by slope wash. Due to the eroded and disturbed site context, no features were identified.

Formed artifacts collected from the site totalled eight items, including two cores, five Quarry Bifaces, and one Small Biface. The boulders served as a locus for reducing cores and fabricating several large bifaces, but this use appears to have been quite ephemeral.

Site 26Ek3097

Sites 26Ek3097 is located on a moderately steep (24%) colluvial slope at the western edge of the Basalt Canyon sites. The site consists of a thin flake scatter extending downslope from a probable reduction locus cut by a road. Though some

zones of higher density were observed, these appear to result from differential erosion on the slope; no features were recorded. As a consequence of the probable disturbance from road construction, and observable effects of slope movement, no collections were made from the site.

Site 26Ek3099

Site 26Ek3099 is located on the upper portion of the slope above site 26Ek3097. It retains evidence of four reduction features, but these have been moved about in recent times by heavy equipment turnabouts. The features contain evidence of both core and large biface reduction, and prior to their recent disturbance, appeared to have been only moderately affected by movement on the rather steep (> 20%) slope. As such, the features likely reflect recent prehistoric reduction episodes. Artifacts collected from the site include three cores, eight reduction bifaces, a hammerstone, and a chopper-like tool. No systematic debitage collections were made because of the disturbed contexts of the cultural deposits.

Reduction/Residential Sites: Context and Structure

Two sites in Basalt Canyon, 26Ek3092 and 26Ek3149, are inferred to be short term residential sites because tools and other materials (i.e., fauna from 26Ek3092) recovered from them reflect food processing, equipment maintenance, and other activities conducted at campsite locations. As the following descriptions indicate, however, these sites are quite distinct in their depositional characteristics.

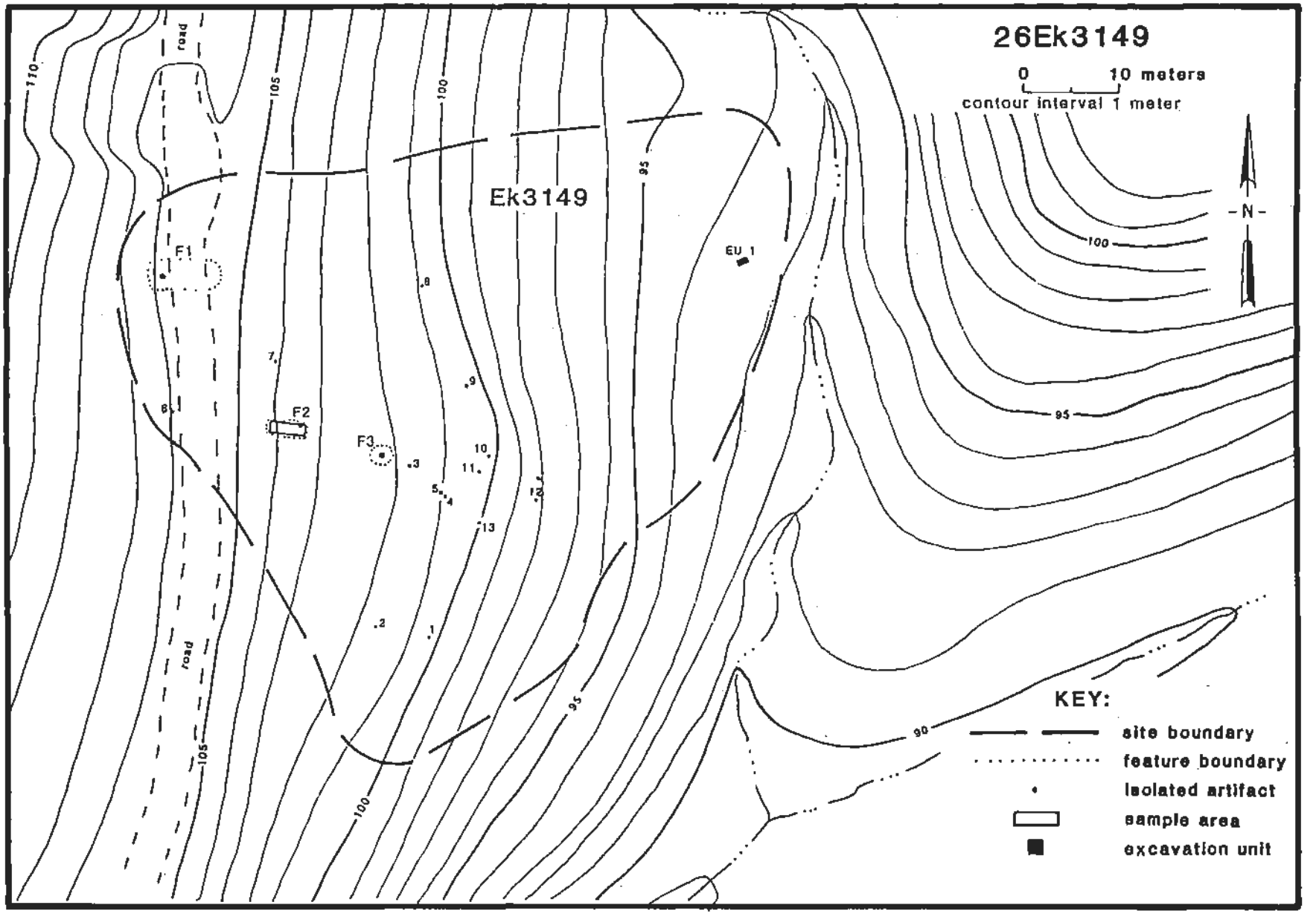
Site 26Ek3149

Site 26Ek3149 is located on a rocky east-facing slope above the confluence of Basalt Canyon and Little Antelope Creek (Figure 42). The focus of site use appears to have centered on the upper, western edge of the site, where two debitage features have been intersected by a road, and along a series of narrow bedrock benches near the center of the site, where several formed artifacts were scattered. Artifacts located on the bedrock benches (and plotted on Figure 43) include five rejected and/or broken Quarry Bifaces, three Small Bifaces that may be specialized tool preforms, an unclassifiable projectile point fragment, a spokeshave, and a scraper. Apparently, these benches served as convenient places to sit while maintaining equipment or conducting miscellaneous subsistence tasks.

Figure 42. 26Ek3149, site map.

Key to Artifact Plots

1. Quarry Biface
2. Small Biface
3. Point Fragment
4. Small Biface
5. Quarry Biface
6. Metate
7. Mano
8. Quarry Biface
9. Scraper
10. Spokeshave
11. Chopper
12. Quarry Biface
13. Quarry Biface


26Ek3149
0 10 meters
contour interval 1 meter
Ek3149
road
road
F1
F2
F3
EU 1
110
105
100
95
90
-N-
KEY:
site boundary
feature boundary
isolated artifact
sample area
excavation unit

The original contexts of three features recorded on the western edge of the site are obscured to some extent by road construction and slope movement. Feature 1 consists of a linear scatter (5 m by 11 m) of about 300 large to medium sized biface reduction flakes; one Stage I Quarry Biface fragment was recovered. Feature 3 is a small (4 m^2) concentration (< 50 items per m^2) composed exclusively of biface thinning flakes. Feature 2 consists of a narrow, linear debitage scatter (1 by 4 m) extending downslope below the roadcut. Small pieces of fire-cracked rock were observed in the scatter and the feature was selected for systematic sampling. Debitage totaled 313 opalite items composed of 88.8% small flakes (average weight = 0.9 g) and 11.2% shatter (average weight = 4.7 g). In addition to two Quarry Bifaces, several hunting and general maintenance tools were recovered: one Small Biface, three scrapers, and two small projectile point fragments. A mano located nearby, and a metate found on the upper edge of the roadcut, suggest a campsite locus upslope of our collection units has been cut by the road (see Figure 43).

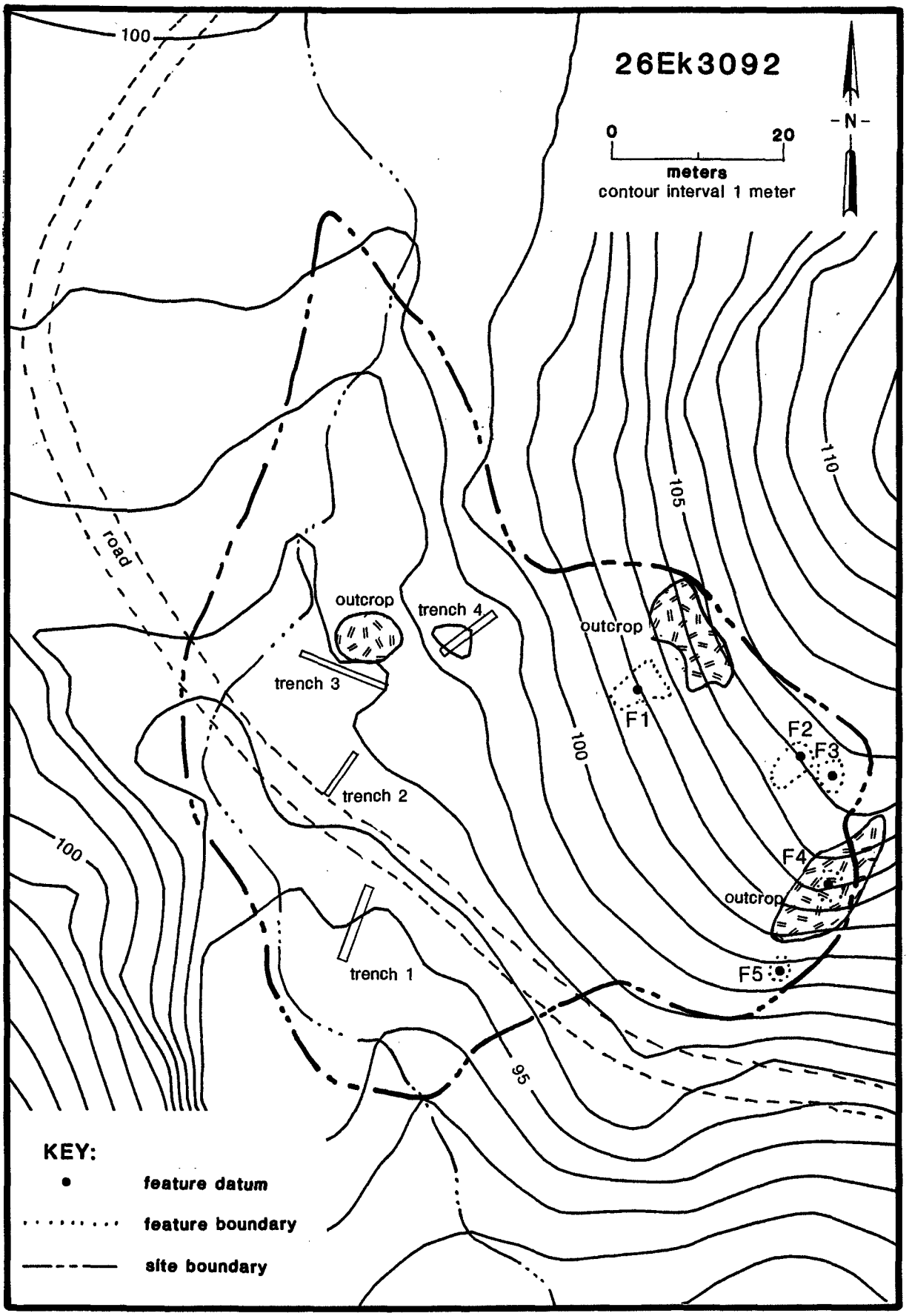
Near-surface bedrock (and road disturbance) offered little promise for subsurface explorations over the main portion of the site, but tests were conducted along a narrow streamside terrace to verify its recent formation. A 50 cm by 1 m excavation unit (EU1) probed deposits to a depth of 50 cm below surface; materials were screened though 1/8 in. mesh. A biface fragment and perforating tool were found in the upper 10 cm where debitage was most abundant (Table 54). Flakes are consistently small in size throughout all levels and decrease in frequency with depth, suggesting that cultural materials have been worked downward into the profile by bioturbation.

Table 54. Artifact Collections from EU1, Site 26Ek3149.

	OPALITE DEBITAGE				
Depth	Flakes		Shatter		
(cm BS)	(n)	(Av Wt)	(n)	(Av Wt)	OTHER ARTIFACTS
0-10	72	0.7	9	15.0	Perforator, Biface
10-20	51	0.8	2	19.8	none
20-30	43	0.8	3	4.7	none
30-40	17	0.7	1	0.4	none
40-50	8	2.7	4	1.1	none

Severe rodent turbation was evident as numerous mottles throughout the deposit, and badger burrows pocket the extent of the terrace. The terrace serves as the modern floodplain during high energy flows and offers little opportunity to preserve a clear record of its prehistoric uses.

Figure 43. 26Ek3092, site map.


26Ek3092
0
20
meters
contour interval 1 meter
N
100
105
110
100
95
road
outcrop
trench 4
trench 3
trench 2
trench 1
outcrop
F1
F2
F3
F4
outcrop
F5
KEY:
feature datum
feature boundary
site boundary

In summary, the diversity of artifact types, but small numbers of each, suggest a range of rather ephemeral subsistence-related activities were conducted at site 26Ek3149. The distribution of groundstone around Feature 2 where fire-cracked rocks were found suggests this was a small campsite locus prior to its disturbance by the road. The light density of surface materials outside of the feature loci suggest a long period of exposure and several episodes of brief use at various times.

26Ek3092

Site 26Ek3092 is located on a series of low stream terraces at a sharp bend in Basalt Canyon (see Figure 43). The terraces rise about 4 m above the channel on its north side and extend for a maximum distance of 30 m to the steep slopes of Red Hill.

When the site was recorded in November 1987, a small scatter of reduction flakes was noted next to a large flat boulder and the site was classified as a small reduction station. Testing located five additional reduction scatters on the slopes above the terrace and several previously unnoticed formed tools. Rodents were active throughout the spring test investigations and flakes seen in their burrow tailings suggested of buried cultural material.

Testing opened long backhoe trench exposures across the terraces and controlled hand excavation recovered systematic samples of cultural materials. Trench 1 was located in the lowest terrace, close to the present streambed, while Trench 2 was placed in the center of the widest and flattest terrace. Trench 3 was situated along the edge of a large flat boulder and Trench 4 extended into the base of the colluvial slope edging the site. Three 1 by 1 m excavation units were used to recover a sample of the cultural materials in trenches 1 through 3. These were located so as to intersect possible cultural surfaces marked by flake and pebble lines observed in wall profiles.

Terrace Stratigraphy

Test excavations indicate that cultural materials are present in stratified alluvial deposits to about 90 cm below the surfaces of the terraces. Analysis of the trench profiles suggests that there have been at least four major episodes of terrace-building deposition at the site. Strata relating to each terrace are grouped into four time-stratigraphic horizons that are correlated tentatively across trenches 1 through 3. However, the trenches were not connected physically and correlations between depositional horizons across the site are based on soil color, texture, structure, relative position, and artifact content. In addition, a pedogenic unit, the A soil horizon, is present on all surfaces across the site.

Trench 4, located at the base of the steep slopes of Red Hill, exposed deposits of colluvial origin and without stratigraphic definition. The colluvium consists of at least 1.8 m of reddish brown, gravelly silt loam that slightly increases in chroma with depth. Some pebble lines can be traced for a few meters, but there is no difference in the sediments above or below such lines. Toward the west end of the trench, at the toe of the slope, we observed a recent depositional sequence that probably represents a common mode of deposition. A gray humic horizon about 5 cm thick containing charcoal and burned roots is buried by a layer of reddish silt that thickens downslope. These are overlain by the present brown A horizon similar to that found elsewhere on the site. This suggests that a recent wildfire denuded the slopes above, allowing reddish silty sediment to be washed down and bury the old A horizon and roots of the burned vegetation it once supported.

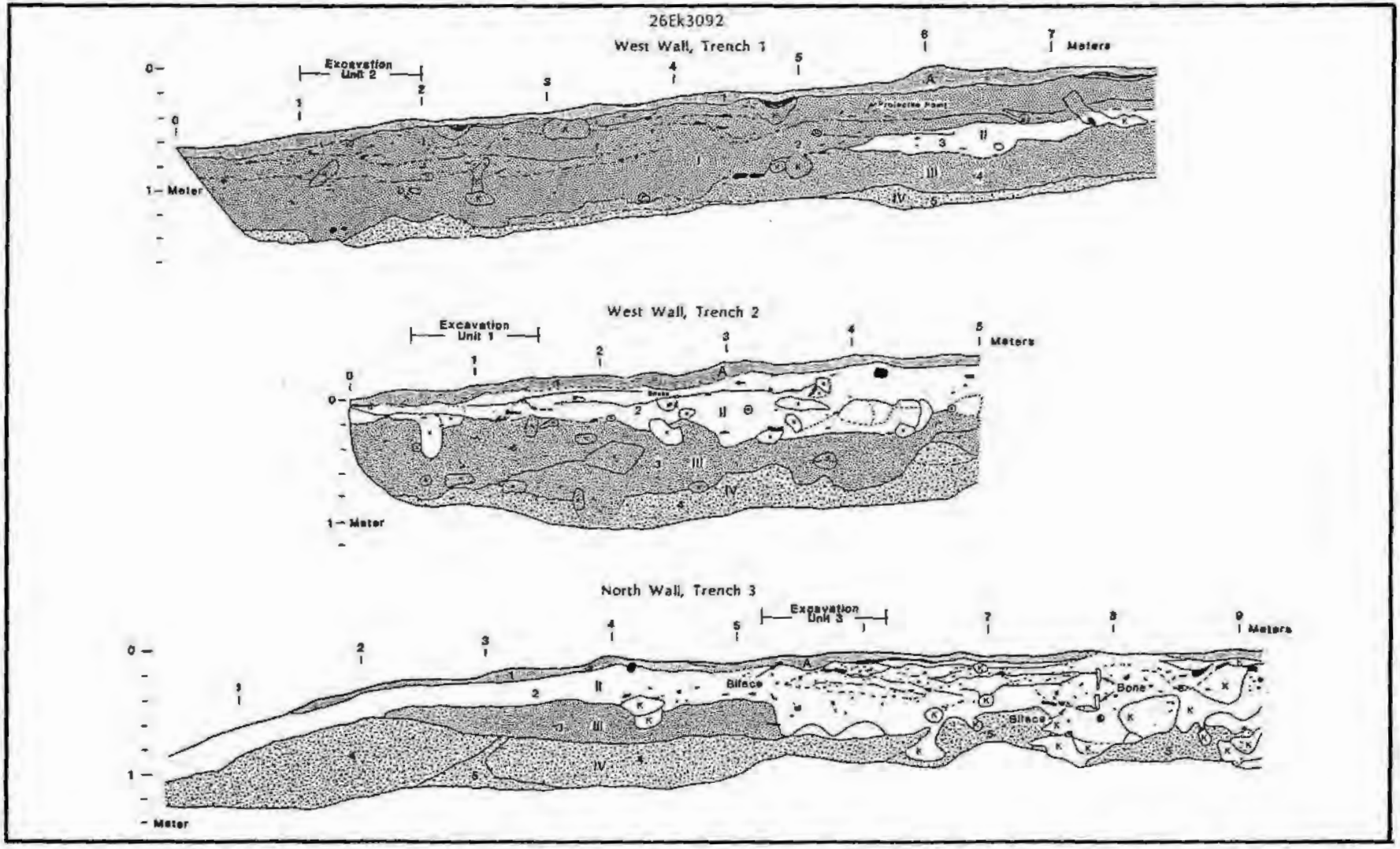
The stratigraphic units observed in each terrace trench were numbered consecutively from the top to the bottom of the profile (Figure 44). Since the number of stratigraphic units varies from trench to trench, this means that unit numbers may or may not refer to the same stratum from trench to trench. However, tentative correlations are made on the basis of time-stratigraphic horizons (also numbered from the surface down), referring as much as possible to the deposits of a particular stream terrace. The relationships between terrace stratigraphic units and horizons are summarized in Table 55.

Table 55. Stratigraphic Units and Horizons by Trench.

	Stratigraphic Units		
	Trench 1	Trench 2	Trench 3
Horizon			
(A)	A	A	A
I	1	1	1
II	2	-	-
III	3	2	2
IV	4	3	3

Horizon IV, the lowest strata revealed in all three terrace backhoe trenches, is dark reddish brown (5YR 3/2-3/4) clay with varying amounts of sand, gravel and cobbles. Because of their low position in the stratigraphic column, sediments of this horizon are poorly observed and not well understood. Some of this sediment is probably colluvial, similar to the reddish, altered soil observed in road cuts to mantle Red Hill and some adjacent ridges, while other deposits are alluvial stream gravels. For instance, the lowest strata in Trenches 1 and 2 are stream deposits. However, at Trench 3, gravels of a filled

Figure 44. 26Ek3092, Trenches 1, 2, and 3.


26Ek3092
West Wall, Trench 1
Excavation Unit 2
Meters
1 Meter
West Wall, Trench 2
Excavation Unit 1
Meters
1 Meter
North Wall, Trench 3
Excavation Unit 3
Meters
Biface
Bone
Biface
1 Meter

stream channel are inset into loam or silt loam. Both the stream gravels and loam are tentatively assigned to Horizon IV. Artifacts were not observed in sediments of Horizon IV, except in krotovinas where they could have been introduced through bioturbation. The age of Horizon IV is, therefore, unknown.

In trenches 1 and 3, Horizon III is comprised of a single stratigraphic unit, dark reddish brown (5YR 3/2-3/3) loam to sandy loam. At the north end of Trench I, this sediment is 40 cm thick over the cobbly clay of Horizon IV. In Trench 2, up to 80 cm of these sediments are inset into the cobbly clay of Horizon IV and partially overlie it toward the north. In Trench 3, a lens of dark brown cobbly loam overlies dark reddish brown stream gravels. Since the gravels appear to be Horizon IV, we tentatively assign the cobbly loam to Horizon III.

Both the loam in Trench 2 and the cobbly loam in Trench 3 have subangular structure; abundant mottles and krotovina in Trench 2 show these deposits to be highly bioturbated. Excavation Unit 1 at Trench 2 recovered cultural bone and abundant artifacts from Horizon III. A later mid-Holocene age for the Horizon is suggested by an obsidian projectile point recovered from near the bottom of the loam in Trench 2 (80 to 90 cm BS), either a Gatecliff Split-stem (3000 - 1300 B.C.) or a reworked Elko Series (1300 B.C. - A.D. 500).

Sediments of Horizon II are dark reddish brown (5YR 3-2.5/2) loam to sandy loam. These deposits overlie Horizon III loam in the north end of Trench 1, and throughout Trench 2 where they are up to 50 cm thick. At Trench 3, they overlie and are partially inset into the cobbly loam of Horizon III. Horizon II deposits contain abundant artifacts, including cultural bone and Fremont pottery. The latter suggests an age range for Horizon II between A.D. 500 and 1450. Surfaces defined by flake lines are commonly observed; some of these, particularly at Trench 3, may define cultural features.

Sediments of Horizon I are very dark brown (10YR 2/2) sandy loam. Observed only in Trench I, deposits of Horizon I form the lowest and most recent stream terrace, inset into and truncating all of the older sediments described above. Artifacts are abundant in Horizon I, including Desert Side-Notched projectile points, in use between about A.D. 1000 to 1850. As in Horizon II deposits, flake and pebble lines defining surfaces are common.

The present A horizon on all the terraces is very dark brown (10YR 2/2) sandy loam. Within the A horizon, and at the contact between it and Horizon I, are basin-shaped lenses of charcoal. These appear to be rootballs of Great Basin rye grass burned during a recent wildfire.

Subsurface Artifact Distributions

Tests recovered 29,135 debitage items and 117 formed artifacts, most of which were found in the three subsurface test units (Table 56). This constitutes a rather large collection considering the small volume of sediment excavated (2.3 m^3). The assemblage reflects primarily toolstone reduction, but also includes small numbers of expedient flake tools, perforators, and several projectile points.

Classifiable projectile points (after Thomas 1981) include three Desert Side-notched and one reworked Gatecliff Split Stem suggesting a possible range of occupation from 3000 B.C. to historic times.

Unique among sites tested in the USX-West project area was the recovery of four Fremont Great Salt Lake Gray pottery sherds (Madsen 1977:19) from the upper 20 cm in Trench 3. The sherds are very thin (mean thickness of 3.8 mm) and have corrugated exterior surfaces created by unobliterated horizontal coils. One sherd (specimen 2041-14) is a neck portion from a wide-mouthed jar with an outcurved, flared mouth; such jars generally are considered to be cooking pots (Madsen 1977). Great Salt Lake Gray is the principal pottery type for the Fremont Great Salt Lake variant, centered around the Great Salt Lake, western Utah; the type dates between A.D. 400 and 1350 (Madsen 1977:19). The four sherds are interesting finds as corrugation as a decorative technique is not mentioned as a variety of Great Salt Lake (Madsen 1977). Corrugated wares apparently are common only in the Parowan Fremont variant of southwestern Utah; here, they date to between A.D. 1100 and 1200 (Madsen 1977:9).

Faunal materials recovered during excavation include a wide range of small rodents that likely are intrusive, some rabbit-sized specimens that may be prehistoric food residue, and fragments of large artiodactyls that likely were consumed by prehistoric residents at the site (Table 57). Bighorn sheep are represented by both adult and milk teeth and indicate at least two different individuals. A large, thick bone specimen that may be bison was found in the level containing Fremont pottery in EU3. Given bioturbation, this could be cow rather than bison; however, the numbers of rabbit-sized specimens and the occurrence of large mammals such as bighorn sheep in the same unit, suggest that the faunal collection is, in part, the residue of prehistoric cooking.

The large flat boulder adjacent to Trench 3 likely provided a convenient locus for reducing toolstone, preparing and cooking food, and sleeping. Faunal remains and Fremont pottery from a cultural surface located at about 30 cm BS in Trench 3 suggest that such an activity area is located here. Though none were exposed in tests, residential features such as structures, hearths, and refuse disposal areas are thought to be present in this portion of the site.

Table 56. Vertical Artifact Distributions, Site 26Ek3092.

Trench/ Unit No.	Depth (cm BS)	ARTIFACT CLASSES: Reduction HM	CR	QB	SB	IB	Points PT	FG	Processing SC	PG	MP	OT	CE	Total	DEBITAGE: Opalite Flakes	Shatter	Other Debitage	Total
1/EU2	0-10	-	-	2	-	-	-	-	-	-	-	-	-	2	677	19	5	701
	10-20	-	-	1	1	-	-	-	1	-	1	-	-	4	502	15	1	518
	20-30	-	-	-	-	-	-	-	-	-	-	-	-	0	359	14	3	376
	30-40	-	-	-	-	-	1	1	1	-	-	-	-	3	341	6	2	349
	40-50	-	-	1	1	-	-	-	-	-	-	-	-	2	183	7	-	190
	50-60	-	-	-	1	1	-	-	-	-	-	-	-	2	147	3	1	151
	60-70	-	-	-	-	-	-	-	-	-	-	-	-	0	50	1	-	51
	Subtotal	0	0	4	3	1	1	1	2	-	1	0	0	13	2,259	65	12	2,336
2/EU1	0-10	-	-	3	-	2	-	-	3	-	1	-	-	9	2,672	2	17	2,691
	10-20	-	-	1	-	-	-	1	-	-	-	1	-	3	3,473	25	11	3,509
	20-30	-	1	1	1	-	-	-	-	-	-	-	-	3	1,160	8	3	1,171
	30-40	-	-	1	1	-	-	-	-	-	-	-	-	2	779	6	1	786
	40-50	-	1	-	1	-	-	-	1	-	-	-	-	3	410	-	2	412
	50-60	-	-	1	-	-	-	-	-	1	-	-	-	2	351	7	6	364
	60-70	-	-	1	-	1	-	-	-	-	-	-	-	2	346	5	6	357
	70-80	-	1	1	-	2	-	-	1	-	-	-	-	5	462	3	6	471
	80-90	-	-	-	1	-	1	-	-	-	-	-	-	2	225	4	-	229
	Subtotal	0	3	9	4	5	1	1	5	1	1	1	0	31	9,878	60	52	9,990
3/EU3	0-10	1	4	2	-	-	-	-	8	-	-	-	-	15	3,660	94	703	4,457
	10-20	-	-	4	-	-	1	1	1	-	-	-	2	9	7,111	216	1,316	8,643
	20-30	-	-	-	-	-	-	-	-	-	-	-	2	2	1,814	75	91	1,980
	30-40	-	-	-	-	1	-	-	-	-	-	-	-	1	347	28	20	395
	40-50	-	-	-	-	2	-	-	1	-	1	-	-	4	509	44	33	586
	50-60	-	-	1	-	-	-	-	1	-	-	1	-	3	444	27	40	511
	60-70	-	-	-	-	-	-	-	-	-	-	-	-	0	209	4	24	237
	Subtotal	1	4	7	0	3	1	1	11	0	1	1	4	34	14,094	488	2,227	16,809

Key:

Reduction Tools and Artifacts
HM = Hammerstones
CR = Cores
QB = Quarry Bifaces
SB = Small Bifaces
IB = Indeter Biface Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Other Simple Flake Tools
CE = Ceramic Fragments

Projectile Points
PT = Classifiable Points
FG = Unclassifiable/Fragments

Table 57. Faunal Materials from 26Ek3092 Excavation Units.

EU2 (Trench 1) Level	*Sylvilagus* sp.	*Sylvilagus idahoensis*	*Lepus* sp.	*Marmota flaviventris*	*Spermophilus* sp.	*Thomomys talpoides*	*Perognathus* sp.	*Peromyscus* sp.	*Neotoma* sp.	*Microtus* sp.	*Taxidea taxus*	cf. *Ovis Canadensis*	*Ovis Canadensis*	*Bos* or *Bison*	Artiodactyl	I - II	III	IV	V	V - VI	Unidentified	Total
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	4
3	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	7	-	-	1	-	-	10
4	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	7	-	-	1	-	-	9
5	-	-	-	-	6	1	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	23
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Subtotal	-	-	-	-	6	1	-	-	-	1	-	-	2	-	-	36	1	-	2	-	-	49
EU1 (Trench 2) Level																						
1	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	6
2	-	-	-	2	16	-	1	-	-	-	-	-	-	-	1	52	2	-	1	-	-	75
3	-	-	-	-	16	-	3	-	1	-	1	-	-	-	4	88	22	9	4	-	-	148
4	3	-	-	-	2	-	1	-	-	-	-	-	1	-	2	23	3	-	1	-	-	36
5	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	2	3	2	2	-	-	11
6	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	10	2	-	-	1	-	16
7	1	-	-	-	2	1	-	-	1	-	-	-	-	-	-	8	1	-	3	-	-	17
8	1	1	-	-	3	-	-	-	-	-	-	-	-	-	-	27	-	-	1	-	1	34
9	-	-	-	-	4	-	-	1	1	-	-	-	-	-	-	16	2	-	-	-	1	25
Subtotal	6	1	1	2	46	2	5	1	3	-	1	-	2	-	8	221	36	11	12	1	9	368
EU3 (Trench 3) Level																						
2	-	-	1	-	1	-	1	-	-	-	-	-	-	-	-	6	2	-	-	-	1	12
3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	4	-	-	7
5	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	2
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4
Subtotal	-	-	1	-	1	-	1	-	-	-	-	1	-	1	-	13	2	-	4	-	1	25
GRAND TOTAL	6	1	2	2	53	3	6	1	3	1	1	1	4	1	8	270	39	11	18	1	9	442

Summary

Site 26Ek3092 is unique in the USX-West project area in that it contains stratified alluvial deposits with potential for buried residential features. The site appears to have served as a campsite locus during toolstone forays dating from sometime about 3000 B.C. to A.D. 1850; its deposits preserve direct evidence of subsistence pursuits and food products. Information from the site can address research questions associated with the economics of toolstone procurement as well as contribute to understanding the chronology of quarry use.

The remaining eight are characterized by small artifact assemblages and either eroded or disturbed site contexts. Test assessments indicate that none of these sites contain significant data relevant to identified research issues (Elston 1988).

Chapter 12. BITTERROOT RIDGE SITES

by Elizabeth E. Budy

Bitterroot Ridge comprises a series of narrow, southeast-sloping finger ridges cut by steep intermittent drainages (Figure 45). Basalt Canyon forms the northern margin of the complex and defines the south margin of the toolstone source area. The archaeological character of this area is conditioned by the absence of locally outcropping opalite, and sites here tend to be quite discrete without intervening background scatters.

Archaeological sites are located on narrow ridge tops or slopes and cultural materials are limited to surface (or near surface) colluvial deposits overlying shallow bedrock. Tabular andesitic basalt is exposed at the surface in places along the knoll and forms prominent talus stripes along steep, exposed slopes. Thin soils are reddish-brown sandy silts and silty loams overlying andesitic basalt. The absence of permanent water near the sites likely constrained use of these sites to short term occupation. Ephemeral pools are found in Basalt Canyon, but no permanent water is located along the ridgeline complex southwest of the canyon.

Sparse covers of low sage and grasses are characteristic on ridge tops; clumps of big sage edge drainage channels or grow in saddles where deeper soils have accumulated. Several plants with edible tubers are moderately abundant on thin soils edging ridgetops, including onion, sego lily, and bitterroot. It is thought that these, notably bitterroot, may have provided root crops for local use during prehistoric times and, together with grasses, provide explanation for the recovery of diverse types of grinding stones found at several sites.

Descriptive Site Summary

Ten sites are located on the finger ridges composing the Bitterroot Ridge Complex (Table 58): eight were tested and include three reduction stations, one reduction complex, and four reduction/residential complexes.

The four reduction sites are located on small benches at the edge of an elevated knoll on the upper, western perimeter of the project area. The three small reduction stations cover no more than 200 m^2 each and each contained a discrete debitage concentration defined as a feature. Reduction complex site 26Ek3093 encompasses a sparse debitage scatter (1.875 m^2 in area) surrounding six discrete reduction features. Given their elevated position relative to the drainages of Basalt Canyon and Little Antelope Creek, these sites provide convenient perches for viewing the surrounding countryside and may be so located relative to observing game movement.

Figure 45. Topographic setting, Bitterroot Ridge sites.

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Table 58. Descriptive Summary, Bitterroot Ridge Sites.

Site Number	Type	Features (n)	Maximum Site Area (sq m)
26Ek3093	Reduction Complex	6	1,875
26Ek3094	Isolated Artifact [NOT TESTED]	-	N/A
26Ek3095	Reduction/Residential Complex	25	15,000
26Ek3109	Undifferentiated Scatter [NOT TESTED]	-	2,700
26Ek3114	Reduction Station	1	100
26Ek3115	Reduction Station	1	100
26Ek3116	Reduction Station	1	200
26Ek3160	Reduction/Residential Complex	23	46,000
26Ek3165	Reduction/Residential Complex	2	4,500
26Ek3271	Reduction/Residential Complex	22	19,500

Four sites (26Ek3160, 26Ek3165, 26Ek3095, and 26Ek3271) in the Bitterroot Ridge Complex contained diverse subsistence-related tools intermixed in large reduction scatters. Located beyond the opalite source area, as demarcated on the southwest by Basalt Canyon, these sites are thought to represent repeatedly occupied reduction staging centers which sometimes served as short term campsites.

Except for site 26Ek3165, which is restricted to a small saddle (4,500 m^2 in area), the sites encompass large scatters (ranging from 15,000 to 46,000 m^2 in area) suggesting repeated uses of preferred locations. Within each large site are numbers of discrete artifact concentrations, each apparently a focus for a variety of reduction and subsistence-related activities, as well as dense, undifferentiated debitage and tool accumulations resulting from many different, but overlapping, uses. Recorded features primarily reflect thinning of large Quarry Bifaces, but various others contain, in addition, seed processing stones, stylized tools, pottery, and/or charcoal.

Testing Strategies

Since the Bitterroot Ridge sites are bedrock controlled and provide little opportunity for preserving buried cultural materials, assessment focused on defining surface artifact configurations; subsurface tests were limited to certain depositional contexts (Table 59).

Initially, close interval survey identified feature loci and located extra-feature artifacts for mapping and collection. At the three small reduction stations (26Ek3114, 26Ek3115, and 26Ek3116), feature concentrations were sampled by systematic surface skimming and all surrounding artifacts were point

plotted and collected. Tests at reduction complex site 26Ek3093 sampled one (or 20%) of the total features identified.

Table 59. Summary of Testing Procedures, Bitterroot Ridge Sites.

Site Number	FEATURES RECORDED Total (n)	Sampled (n)	FEATURE CONTEXT Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	NONFEATURE CONTEXT Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	RECOVERED COLLECTIONS Debitage (n)	Formed Artifacts (n)
26Ek3093	6	1	49.00	0.10	-	-	2,598	56
26Ek3095	25	5	28.31	0.60	-	-	30,445	371
26Ek3114	1	1	10.00	-	-	-	4,281	20
26Ek3115	1	1	10.00	-	-	-	1,898	12
26Ek3116	1	1	12.00	-	-	-	2,492	31
26Ek3160	23	6	50.00	0.10	-	1.20	23,933	545
26Ek3165	2	2	16.00	-	-	0.25	4,125	41
26Ek3271	22	5	67.00	0.75	-	0.20	53,510	495

Surface artifact collection at the reduction/residential sites recovered large, diverse tool assemblages; some preserved in discrete features, many in undifferentiated scatters of debitage. Since these tools include stylized artifacts and subsistence-related tools, in addition to large numbers of Quarry Bifaces, attention focused subsequently on features possibly preserving evidence of discrete episodes of site use. Representative and/or unique features from each site were selected for systematic surface skimming. Potential hearths, visible as charcoal stains after surface skimming, were sampled by subsurface excavations. Subsurface tests at sites 26Ek3160, 26Ek3165, and 26Ek3271 also probed areas where deeper soils occurred to check for buried cultural remains.

Chronology

Several Bitterroot Ridge sites preserve charcoal from prehistoric fires which, in future investigations, may be appropriate for radiocarbon assay. At present, charcoal deposits are rendered suspect by their near-surface contexts, as in the instance of hearths identified at sites 26Ek3093 and 26Ek3095, and by the likely inclusion of material from wildfires which recently burned over these sites.

Obsidian is present in the Bitterroot Ridge sites, notably at the reduction/residential complexes, and future investigations may yield useful obsidian hydration dates. At this time, the chronology of site occupations depends on time-sensitive projectile points and pottery.

Time sensitive projectile points suggest occupation of the area from about 3000 B.C. to protohistoric times (Table 60), with most intensive use during the Late Archaic (after about A.D. 500). Rosegate Series points are most common and compose a large class at site 26Ek3271. Desert Side-notched and Cottonwood types also are common; these late points date discrete reduction features at sites 26Ek3114 and 26Ek3116 and campsite loci at sites 26Ek3095 and 26Ek3160. Elko Series points are relatively common only at site 26Ek3160, and this large site appears, from other evidence, to have been used more intensively over a longer period than other locations on Bitterroot Ridge.

Thirty-nine Shoshoni Brownware pottery fragments, all apparently from one vessel, were recovered from Feature 1 at site 26Ek3160. The pottery dates this feature between A.D. 1300 and 1850, and is the only instance of pottery found in the Bitterroot Ridge sites.

Table 60. Projectile Point Types from Bitterroot Ridge Sites.

Site Number	Classifiable Types								Other		
	GSS	HBS	LSN	EAR	ECN	RSG	CTN	DSN	PPT	FRG	TOTAL
Reduction Sites											
26EK3093	-	-	1	-	-	-	-	-	1	-	2
26Ek3114	-	-	-	-	-	-	-	1	-	-	1
26Ek3115	-	-	-	-	-	-	-	-	-	-	0
26Ek3116	-	1	-	-	-	-	-	2	1	3	7
Reduction/ Residential Sites											
26Ek3095	2	-	-	-	1	2	2	2	3	2	14
26Ek3160	1	1	-	2	3	5	2	3	5	3	25
26Ek3165	-	-	-	-	-	-	-	-	-	2	2
26Ek3271	-	-	1	1	-	8	-	2	2	2	16
Total	3	2	2	3	4	15	4	10	12	12	67

Type Designations (after Thomas 1981)

GSS = Gatecliff Split Stem
HBS = Humboldt Series
LSN = Large Side-notched
EAR = Elko Earred
ECN = Elko Corner-notched
RSG = Rosegate Series
CTN = Cottonwood Series
DSN = Desert Side-notched

Other

PPT = Points Rejected by Thomas (1981) Key
FRG = Fragments

Assemblage Composition

Formed artifact collections from the Bitterroot Ridge sites include a diversity of stylized tools interspersed among reduction artifacts (Table 61). Quarry Bifaces are the largest

Table 61. Intersite Artifact Class Frequency Comparisons, Bitterroot Ridge Sites.

ARTIFACT CLASS	ARTIFACT FREQUENCY PER SITE							
	Reduction Sites				Reduction/Residential Complexes			
Lithic Processing/ Reduction Tools	26Ek3093	26Ek3114	26Ek3115	26Ek3116	26Ek3095	26Ek3160	26Ek3165	26Ek3271
Hammerstones	-	-	-	-	6	2	-	7
Scratched Stones	-	1	-	-	1	2	-	2
Other Percussion	1	-	-	-	1	2	-	8
Subtotal (%)	1(1.8)	1(5.0)	0(0)	0(0)	8(2.2)	6(1.1)	0(0)	17(3.4)
Reduction Artifacts								
Assayed Pieces	-	-	-	-	-	-	-	1
Cores	2	-	-	-	17	8	2	11
Quarry Bifaces	27	13	6	7	215	176	17	236
Preform Bifaces	5	-	-	-	6	16	2	12
Small Bifaces	6	1	1	1	56	169	6	85
Indeter. Bifaces	5	1	1	2	8	53	2	41
Subtotal (%)	45(80.4)	15(75.0)	8(66.7)	10(32.3)	302(81.4)	422(77.4)	29(70.7)	386(78.0)
Projectile Points								
Classifiable Types	1	1	-	3	9	17	-	12
Unclassifiable	1	-	-	4	5	8	2	4
Subtotal (%)	2(3.6)	1(5.0)	0(0)	7(22.6)	14(3.8)	25(4.6)	2(4.9)	16(3.2)
Maintenance and/or Processing Tools								
Scrapers	2	3	4	9	21	22	6	44
Knives	-	-	-	1	-	3	1	4
Gravers	1	-	-	2	1	3	-	5
Perforators	2	-	-	-	4	8	-	10
Spokeshaves	-	-	-	-	-	-	-	5
Multipurpose Flakes	1	-	-	1	4	1	-	2
Simple Flake Tools	-	-	-	1	2	2	-	-
Abraders	-	-	-	-	2	1	-	-
Planers	-	-	-	-	-	3	-	-
Subtotal (%)	6(10.7)	3(15.0)	4(33.4)	14(45.2)	34(9.2)	43(7.9)	7(17.1)	70(14.1)
Plant Processing								
Metates	1	-	-	-	9	3	3	2
Manos	-	-	-	-	1	3	-	2
Mortars	-	-	-	-	-	2	-	1
Pestles	-	-	-	-	1	1	-	1
Other	1	-	-	-	1	-	-	-
Subtotal (%)	2(3.6)	0(0)	0(0)	0(0)	12(3.2)	9(1.7)	3(7.3)	6(1.2)
Miscellaneous Artifacts								
Exotic/Decorated	-	-	-	-	1	1	-	-
Pottery	-	-	-	-	-	39	-	-
Subtotal (%)	0(0)	0(0)	0(0)	0(0)	1(0.3)	40(7.3)	0(0)	0(0)
Site Total	56	20	12	31	371	545	41	495

single class of artifacts recovered at any site and comprise more than 50% of several site assemblages; their frequency highlights the significance of this area as a biface staging center peripheral to the Tosawihi Quarries on the north. Small Bifaces, many of which appear to be directed toward tools such as drills, knives, scrapers, and, possibly, large dart point preforms, also are common at the large reduction/residential sites. At site 26Ek3160, these reduction forms are nearly as numerous as large Quarry Bifaces. Cores are constituent of most site assemblages, but compose a small percentage of the total reduction forms; it would appear that opalite toolstone material ordinarily arrived on these sites as bifacial roughouts. Coincident with the reduction debitage, is a small collection of specialized knapping tools such as hammerstones and "scratched stones" thought to have been used for preparing platforms.

Projectile points and Preform Bifaces are substantial constituents of site assemblages, present in the small reduction sites and moderately abundant in the large reduction/residential complexes. Scraping and perforating tools frequently are included in hunters' tool kits and may be used to maintain wooden or bone tools, prepare hides, and process meat, among other functions (Thomas 1983a, 1983b). A few of these tools, often in conjunction with points or preforms, commonly are found in discrete debitage concentrations suggesting toolstone reduction frequently was conducted in conjunction with hunting in the vicinity of Bitterroot Ridge.

Flaked stone maintenance and/or processing tools, some modified for hafting or otherwise stylized in outline shape, are most numerous and diverse at the large residential/ reduction complexes. Perforators include irregular flakes with bifacially modified points as well as drills with elongate tips and shaped bases thinned as if for hafting. Among scrapers, each manifesting use wear perpendicular to the edge, are both simple flake scrapers as well as carefully shaped end scrapers with thinned haft elements. A similar diversity of modified form is characteristic of the knives. Attention to controlled form reflects concern for having the right tool for the task at hand and signals a potentially wide range of activities conducted at these sites.

Groundstone artifacts, especially from the large site complexes, contribute to inferences of residential use. Compared to other functional tool types, groundstone composes only a small percentage and suggests no strong reliance on local plant foods. With one exception (an ignimbrite metate from site 26Ek3095), the seed grinding tools are made from locally available tuff/basalt or sandstone. Manos and pestle fragments tend to be carefully shaped, while mortars evidence only battered surfaces with slight or no development of concavities. The metates, on the other hand, reflect a range of use, from lightly ground and unshaped tablets to carefully modified metates with well

developed grinding troughs. At sites 26Ek3095, 26Ek3160, and 26Ek3165, metates are found in discrete clusters of other tools and debitage and are thought to represent the loci of small family camps. This suggests that toolstone was procured during early summer foraging and these features may be evidence of an "embedded strategy" (Elston 1988).

Reduction Sites: Context and Structure

Reduction complex site 26Ek3093 includes six feature concentrations all of which are situated similarly along the extreme east edge of a knoll top (Figure 46). The features reflect biface production, with some limited core reduction, and vary in size from 3 to 180 m^2 (Table 62). These features tend to be perched at the edge of the knoll and their size may in part be conditioned by slope and time elapsed since their creation. For example, all but Feature 5 are confined mostly to relatively flat ground while Feature 5, covering the largest area, composes two lobes of debitage lying on a (> 20%) slope. A Large Side-notched projectile point, a type which generally dates to before A.D. 1300 (Thomas 1981), also suggests this feature has been exposed to bioturbation and slope wash for more than 600 years.

Table 62. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Reduction Complex Site 26Ek3093.

FEATURE No.	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction OP	CR	QB	PB	SB	IB	Points PT	FG	Processing SC	PG	MP	GS	Total
1	Biface Reduction	28	-	-	3	-	-	-	-	-	-	-	-	-	3
2	Core & Biface	8	-	-	-	-	-	-	-	-	-	-	-	-	0
3	Biface Reduction	60	-	-	2	1	-	-	-	-	-	-	-	-	3
4	Complex Locus: Sample Feature	49	-	-	12	4	4	5	-	-	1	2	1	1	30
5	Core and Biface	180	1	2	7	-	1	-	2	-	1	1	-	-	15
6	Biface Reduction	3	-	-	-	-	-	-	-	-	-	-	-	-	0
-	Extra-Feature	N/A	-	-	3	-	1	-	-	-	-	-	-	1	5
															56

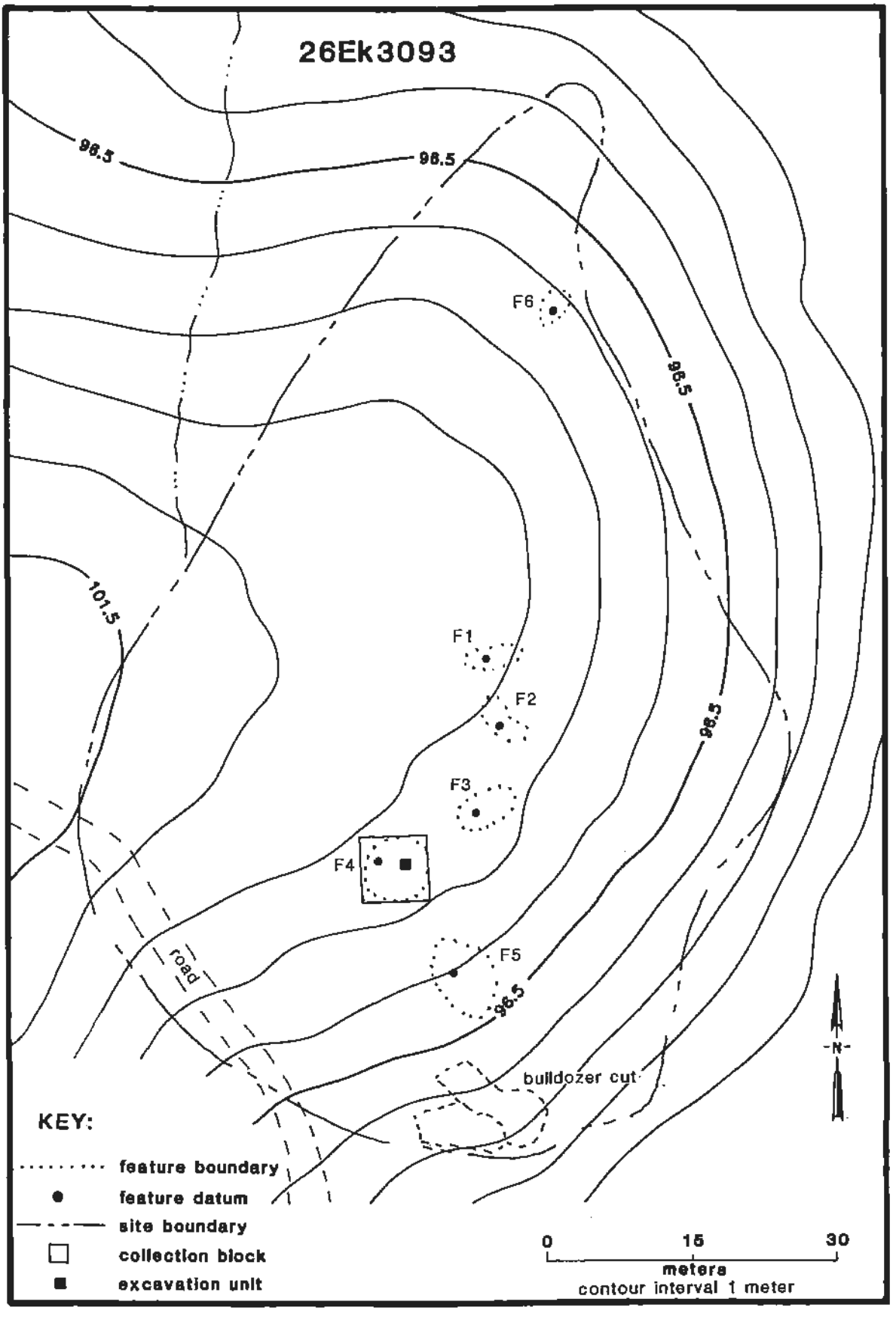
Key to Artifact Classes

Reduction Tools and Artifacts
SS = Scratched Stone
CR = Core
OP = Other Percussion
QB = Quarry Bifaces
PB = Preform Bifaces
SB = Small Bifaces
IB = Indeter Biface Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
GS = Groundstone Fragment

Projectile Points
PT = Classifiable Points
FG = Unclassifiable/ Fragments

Figure 46. 26Ek3093, site map.


26Ek3093
98.5
98.5
98.5
98.5
101.5
98.5
F1
F2
F3
F4
F5
F6
road
bulldozer cut
N
KEY:
feature boundary
feature datum
site boundary
collection block
excavation unit
0
15
30
meters
contour interval 1 meter

Similar in the kinds of associated artifacts, but situated on relatively flat ground (4% to 9% slope), Feature 4 was selected for complete surface collection. A 7 by 7 m grid was laid over the feature so as to totally enclose the scatter. Recovered surface debitage totalled 2528 items and was composed largely of opalite flakes (98.3%) with small quantities of opalite shatter (0.9%) and obsidian flakes (0.7%) (Table 63). Subsurface tests (screened through 1/8 in. mesh) yielded only 70 debitage items from 0.10 m^3 of sediment.

Table 63. Debitage from Sample Feature 4, Site 26Ek3093.

Collection	OPALITE DEBITAGE						OTHER		
	Flakes			Shatter			DEBITAGE		
Type	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
Surface	2,486	98.3	1.1	24	0.9	2.3	18	0.7	2,528
Subsurface	67	95.7	3.2	2	2.9	4.6	1	1.4	70

Prior to collection, Feature 4 was visible as a light density scatter surrounding two small concentrations of debitage. Materials appeared to be moving along the gently sloping ground to the southeast of the lobes and rejected bifaces were clustered along the lower edge of the scatter (Figure 47a). After surface skimming, an irregular ashy stain was exposed; a 50 cm by 1 m excavation unit was placed in the southeast portion of the stain so as to intersect the darkest charcoal concentration. Subtle differences in degree of soil compaction were observed during excavation with looser sediments filling a small pit observable in profile above a pebble line (Figure 47b). The ashy feature appears to be a small unlined hearth deflated by exposure at the surface; lack of soil oxidation and limited amounts of charcoal contained within it suggests a single, brief episode of use.

The distribution of artifacts in this features suggests a knapper was positioned central to, and slightly above, concentrations A and B (in the flattest portion of the feature) and produced a pile of small flakes at lobe A (n = 344; mean weight = 0.5 g) and another pile of larger flakes at Lobe B (n = 306; mean weight = 1.6 g). Debitage progressively diminishes in frequency with distance along the slope while discarded Quarry Bifaces tend to be concentrated the lower edge of the scatter in an apparent toss zone. Having generated the reduction scatter which defines our feature while situated about two meters from the hearth, the knapper seems to have moved in closer to the fire (where a scraper, a multipurpose tool, two perforators, and a point preform were found) to conduct some small maintenance or processing tasks.

Figure 47a. Plan of Feature 4, site 26Ek3093.

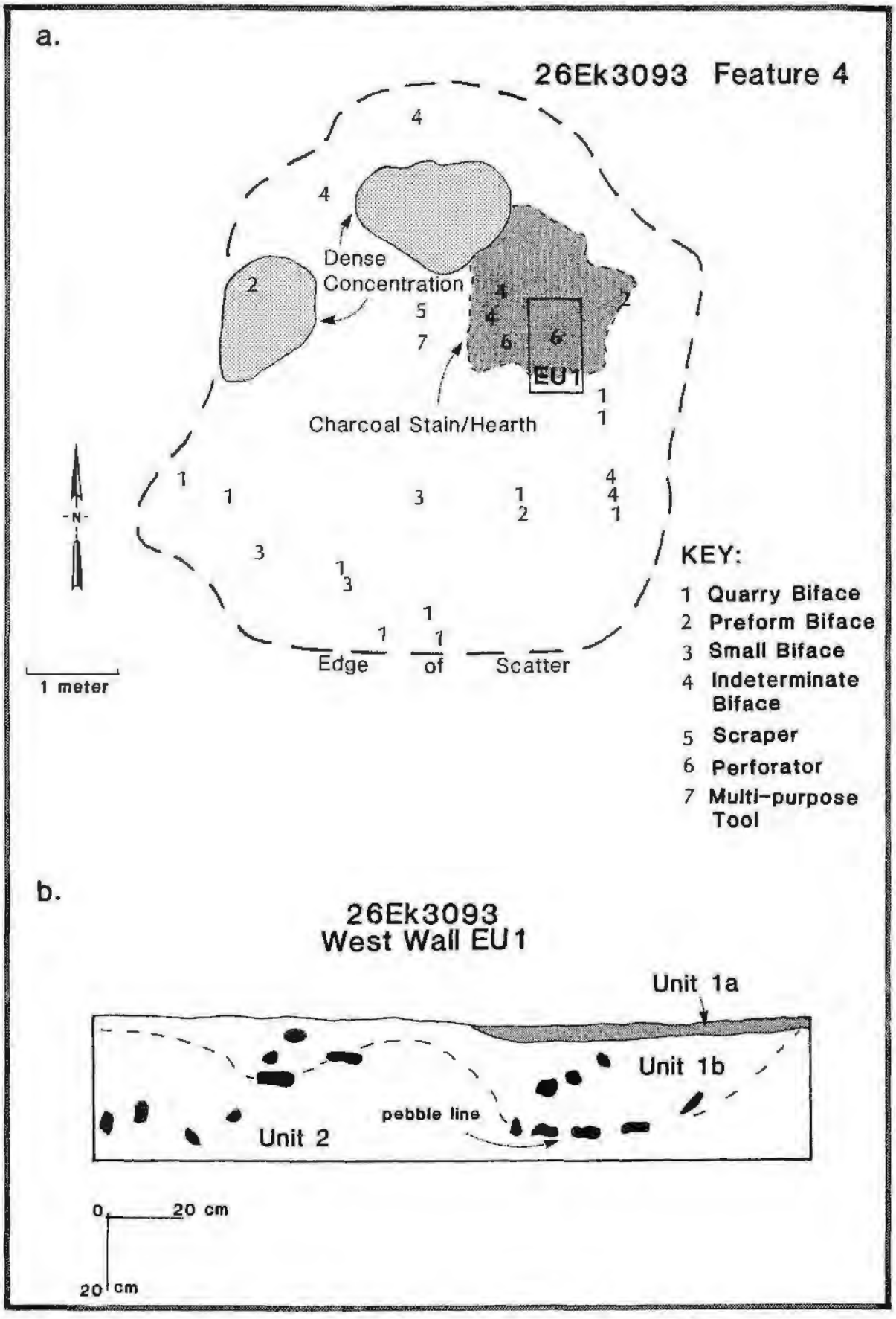
Figure 47b. Profile of hearth in west wall EU1, site 26Ek3093.

Key:

Unit 1a: ashy charcoal stain; dark grey (5YR 4/4) silt loam.

Unit 1b: loose upper layer; reddish brown (2.5YR 4/4) silt loam.

Unit 2: compact lower layer; reddish brown (2.5YR 2/5) silty clay loam.


a.
26Ek3093 Feature 4
Dense Concentration
Charcoal Stain/Hearth
EU1
Edge of Scatter
1 meter
N
KEY:
1 Quarry Biface
2 Preform Biface
3 Small Biface
4 Indeterminate Biface
5 Scraper
6 Perforator
7 Multi-purpose Tool
b.
26Ek3093
West Wall EU1
Unit 1a
Unit 1b
pebble line
Unit 2
0
20 cm
20 cm

Each of the isolated reduction sites (26Ek3114, 26Ek3115, and 26Ek3116) includes one small (<16 m^2) biface reduction feature, two of which are dated after A.D.1300 by Desert Side-notched projectile points. Though all appear to reflect brief biface production episodes, there are differences in relative debitage densities and in the quantities and kinds of other artifacts associated (Table 64).

Table 64. Artifact Classes Recovered from Sample Features and Extra-Feature Contexts at Small Reduction Sites, Bitterroot Ridge Complex.

			ARTIFACT CLASSES												
			Reduction					Points			Processing				
Site Number	Fea No.	Type	SS	QB	PB	SB	IB	PT	FG	SC	KN	PG	MP	OT	Total
26Ek3114	1	Biface Reduction	1	12	-	1	1	1	-	3	-	-	-	1	19
	-	Extra-Feature	-	1	-	-	-	-	-	-	-	-	-	-	1
26Ek3115	1	Biface Reduction	-	6	-	1	1	-	-	4	-	-	-	-	12
26Ek3116	1	Biface Reduction	-	2	-	1	2	3	3	8	1	2	1	1	24
	-	Extra-Feature	-	5	-	-	-	-	1	1	-	-	-	-	7

Key To Artifact Classes

Reduction Tools and Artifacts	Maintenance/Processing	Projectile Points
SS = Scratched Stone	SC = Scrapers	PT = Classifiable Points
QB = Quarry Bifaces	KN = Knives	FG = Unclassifiable/ Fragments
PB = Preform Bifaces	PG = Perforators and Gravers	
SB = Small Bifaces	MP = Multipurpose Flake Tools	
IB = Indeter Biface Fragments	OT = Other Simple Flake Tools	

Grids for systematic surface collection were placed over each feature so as to sample most (63% to 100%) of each. Recoveries summarized in Table 65 indicate each feature is dominated (>90%) by opalite flakes (mean weight ranges from 1.1 to 1.5 g) with very little other toolstone material.

Table 65. Sample Feature Debitage from Small Reduction Sites, Bitterroot Ridge Complex.

		Total	Skim	Mean	OPALITE DEBITAGE						OTHER DEBITAGE		
					Flakes			Shatter					
Site Number	Fea No.	Area (sq m)	Area (sq m)	Density (sq m)	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
26Ek3114	1	11	10	428	3,772	90.1	1.3	508	9.9	0.6	1	1.6	4,281
26Ek3115	1	16	10	190	1,785	94.1	1.1	111	5.8	1.4	2	0.1	1,898
26Ek3116	1	12	12	208	2,377	94.1	1.5	110	1.6	1.3	5	0.4	2,492

Feature 1 at site 26Ek3115, with the smallest assemblage and the lowest average debitage density (190 items per m^2), included six Quarry Bifaces, two other bifaces, and four scrapers. Debitage density at the biface reduction feature in site 26Ek3114, on the other hand, was much higher (average density of 436 items per m^2) and this feature contained a large collection of bifaces (n=14), 80% of which are stage II and stage III Quarry Bifaces; three scrapers and a Desert Side-notched projectile point also were recovered. The feature at site 26Ek3116 is similarly late in time, as indicated by two Desert Side-notched points, but debitage density is moderate (208 items per m^2). The feature yielded only two Quarry Bifaces, but also produced a large collection of other tools including eight scrapers, two perforators, a knife, a multipurpose tool, a simple flake tool, and three point preforms. Because many of these tools (especially scrapers and perforators), are thought to be associated with hide processing, it may be that a large mammal procured nearby was dressed out at this locus.

Reduction/Residential Sites: Context and Structure

Description of the complex structure at reduction/residential sites considers each site individually. The discussion is ordered by relative proximity to the quarry source area to the north, beginning with site 26Ek3095 on the edge of Basalt Canyon and concluding with site 26Ek3165 located on a ridgeline forming the southern perimeter of the project area.

Site 26Ek3095

Site 26Ek3095 is a large lithic scatter located on the north and east-facing slopes of a ridge marginal to Basalt Canyon (Figure 48). A narrow bench along the upper portion of the site was the focus of prehistoric activity; here, small concentrations of debitage and tools occur as more or less spatially discrete clusters, 25 of which were recorded as features. Bedrock is located near surface forestalling any significant subsurface accumulations of cultural materials. However, the distribution of artifacts in several surface features suggests the preservation of internal structure that may provide means to distinguish various types of site use and the organization of occupants and activities.

The 25 features recorded at the site include 4 complex loci containing dense reduction debris and seed processing tools, 1 eroded artifact scatter, 1 biface "cache," 13 biface reduction areas, and 6 loci containing both core and biface reduction residue (Table 66). Except for Feature 10, features are restricted in space, organized in content, and appear to be discrete activity areas.

Figure 48. 26Ek3095, site map.

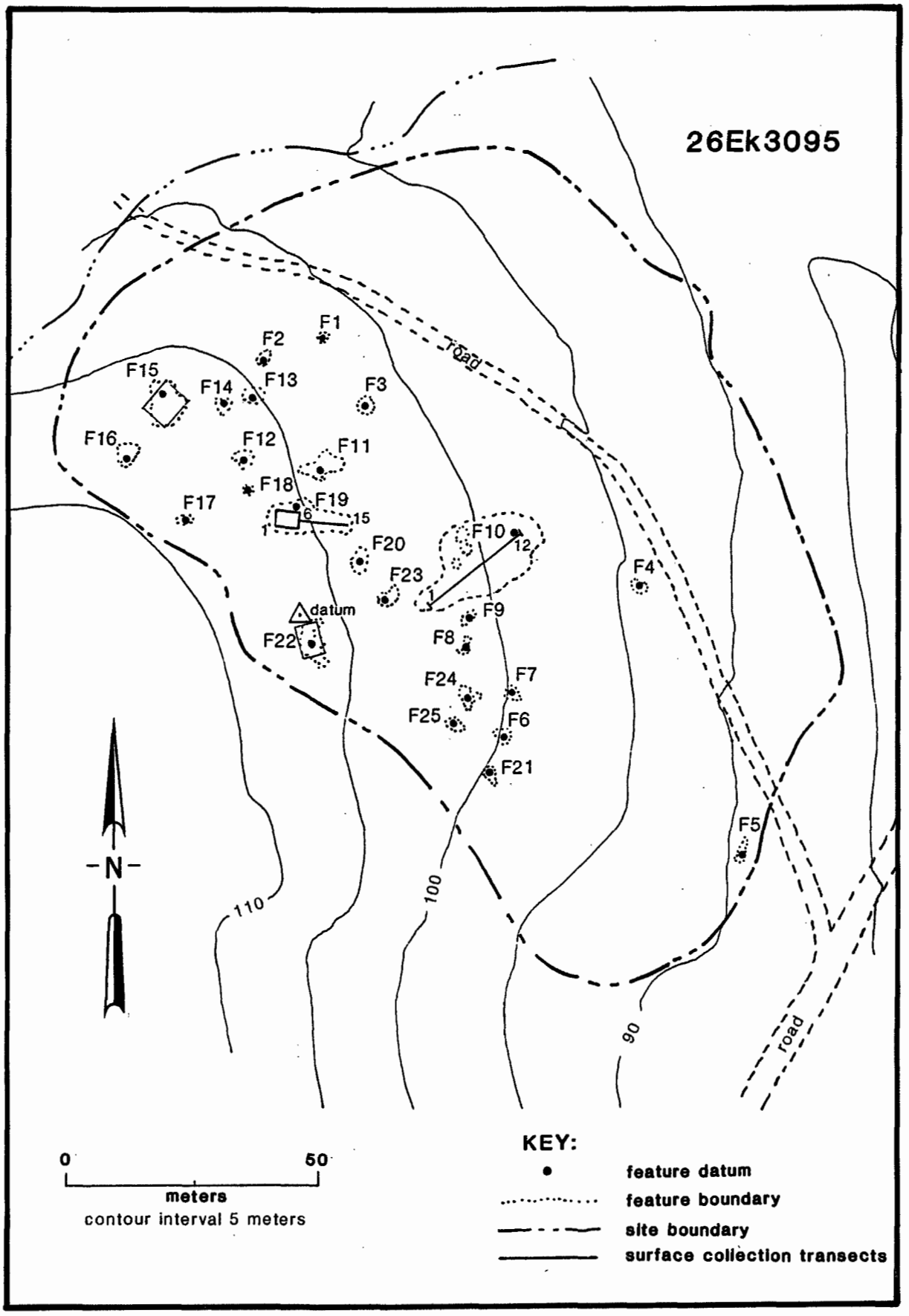

26Ek3095
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
F13
F14
F15
F16
F17
F18
F19
F20
F21
F22
F23
F24
F25
datum
road
road
1
6
15
1
12
N
110
100
90
0
50
meters
contour interval 5 meters
KEY:
feature datum
feature boundary
site boundary
surface collection transects

Table 66. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3095.

Fea No.	Type	Total Area (sq m)	ARTIFACT CLASSES																
			Reduction							Points		Processing							
			HM	SS	CR	QB	PB	SB	IB	PT	FG	SC	PG	MP	OT	AB	GS	SP	Total
1	Biface Reduction	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
2	Biface Reduction	7	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	4
3	Biface Reduction	7	-	-	-	5	-	1	-	-	-	1	-	-	-	-	-	-	7
4	Biface Reduction	7	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
5	Core & Biface	48	-	-	1	6	-	5	-	-	-	-	-	-	-	-	-	-	12
6	Core & Biface	78	-	-	1	7	-	1	1	-	-	-	-	-	-	-	-	-	10
7	Core & Biface	28	-	-	1	4	-	1	-	-	-	-	-	-	-	-	-	-	6
8	Biface Reduction	10	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
9	Biface Reduction	11	-	-	-	5	-	-	-	1	-	1	-	-	-	-	-	-	7
10	Eroded Scatter: Sample Feature	250	-	-	-	23	1	9	1	5	-	2	2	1	-	-	1	-	45
11	Core & Biface	24	1	-	-	6	1	-	-	-	-	3	-	-	-	-	-	-	11
12	Biface Reduction	11	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4
13	Biface Reduction	54	1	-	-	9	-	1	-	-	-	-	-	-	-	-	-	-	11
14	Core & Biface	20	2	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	4
15	Complex Locus: Sample Feature	48	-	-	2	17	-	4	4	-	-	3	-	-	2	1	4	-	37
16	Biface Reduction	42	-	-	-	3	1	-	-	1	1	1	-	-	-	-	-	-	7
17	Biface Reduction	24	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
18	Biface Reduction	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
19	Complex Locus: Sample Feature	75	2	-	4	19	1	3	-	2	-	2	1	1	-	1	2	1	39
20	Biface Reduction	50	-	-	-	7	-	-	-	-	-	-	-	1	-	-	-	-	8
21	Core & Biface	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
22	Complex Locus: Sample Feature	20	-	-	1	35	-	2	1	-	-	1	1	-	-	-	1	-	42
23	Biface Reduction	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
24	Biface Cache: Sample Feature	4	-	-	1	12	-	-	-	-	-	1	-	-	-	-	-	-	14
25	Complex Locus	9	-	-	-	2	-	-	-	-	-	1	-	-	-	-	1	-	4
-	Extra-Feature	N/A	-	-	5	41	2	28	1	2	1	5	1	1	-	-	3	-	92

Key to Artifact Classes

Reduction Tools and Artifacts
- HM = Hammerstones
- SS = Scratched Stone
- CR = Cores
- QB = Quarry Bifaces
- PB = Preform Bifaces
- SB = Small Bifaces
- IB = Indeter. Biface Fragments

Maintenance/Processing
- SC = Scrapers and Spokeshaves
- PG = Perforators and Gravers
- MP = Multipurpose Flake Tools
- OT = Other Simple Flake Tools
- AB = Shaft Abraders
- GS = Groundstone
- SP = Sandstone Pipe

Projectile Points
- PT = Classifiable Points
- FG = Unclassifiable/ Fragments

The 19 features recorded as biface or core and biface reduction stations have the simplest pattern of surface organization. Debitage, usually reflecting a restricted range of similar materials (by color, inclusions, graininess), is concentrated in small areas. Ten of these loci are restricted to less than 11 m^2 and appear to be places where a knapper spent a short time reducing stone. In most cases, a few broken Quarry Bifaces (from 1 to 5) of the same material as the debitage also are present and other tools are rare. The larger reduction features likely reflect both longer exposure at the surface, resulting in wider dispersal, and, as may be indicated by the more numerous rejected bifaces, more intensive energy invested in toolstone reduction. As with the small, discrete features, however, maintenance and/or processing tools are scarce and duration of use appears to have been quite brief.

Four complex loci (features 15, 19, 22, and 25) are characterized by small clusters of metate fragments and other specialized tools surrounded by dense scatters of reduction debris; these are thought to represent campsites. Two types of groundstone features were segregated based on size of the debitage concentration and numbers of reconstructed metates. Features 22 and 25 are small, averaging 15 m^2 in area, and contain only one metate each. Features 15 and 19 are large, averaging 62 m^2 in area, and contain portions of two or more metates.

Feature 22 defines a small area (20 m^2) of dense opalite reduction debris surrounding four large pieces from one basalt metate and debitage from the reduction of a small obsidian core. A 2 by 4 m surface collection grid was aligned along the narrow bench were materials were concentrated around the metate fragments (Figure 49). Surface collections recovered the highest average debitage density (1114 items per m^2) and the largest collection of Quarry Bifaces (n=35) of any feature sampled (Table 67). A 50 cm by 1 m excavation unit, placed in the obsidian reduction area, then sampled subsurface materials. Bedrock was encountered at 30 cm below surface, but cultural materials were all near the surface (from 0 to 10 cm BS) and likely were deposited at about the same time; only a small number of very small opalite flakes (but no obsidian) were found deeper than 10 cm below surface.

Although no evidence of a hearth was found, the collection of tools and debitage from Feature 22 suggests this was the locus of a short term camp at some time in the recent prehistoric past. The presence of the metate (a "woman's tool") suggests use by a small family group during early summer foraging; however, the density of the reduction debris is more consistent with the kinds of high energy reduction activities expected to result from a logistic foray for toolstone (ordinarily conducted by individual males or specialized task groups). It will be important to try to verify the relatedness

of artifacts in this feature in future data recovery so that indices of energy investments, group composition, and duration of occupation can be calibrated systematically.

Table 67. Debitage from Sample Feature Collections, Site 26Ek3095.

SURFACE COLLECTIONS

Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
10	250	0.75	108	80	98.8	1.0	1	1.2	0.4	-	-	81
15	48	12.00	399	4,612	96.4	0.9	158	3.3	1.2	13	0.3	4,783
19	75	6.56	818	5,041	93.9	1.2	289	5.4	2.3	38	0.7	5,368
22	20	8.00	1,114	8,482	95.2	1.1	346	3.9	1.3	86	1.0	8,914
24	4	1.00	603	582	96.5	1.4	15	2.5	10.6	6	1.0	603

SUBSURFACE COLLECTIONS

Fea No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
15	1 / D	20	0.10	577	94.7	0.2	17	2.8	0.5	15	2.5	609
19	2 / D	40	0.20	2,884	96.5	0.6	93	3.1	1.2	11	0.4	2,988
22	3 / D	30	0.15	2,429	94.5	0.3	131	5.1	1.0	10	0.4	2,570
24	4 / A	15	0.15	4,414	97.4	0.6	115	2.5	1.5	-	-	4,529

Key to Excavation Unit Type
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen

Both large groundstone loci, features 15 and 19, were sampled. A surface sample from Feature 15 was taken from a 3 by 4 m block centered on a cluster of groundstone fragments (Figure 50a). Two loci of concentration in Feature 19 were sampled separately. A 2 by 4 m block centered on a groundstone cluster in Locus 1, while nine 25 by 25 cm were located at one meter intervals along the slope through Locus 2 (Figure 50b). Debitage from these features is similarly dominated by small to medium sized flakes from several distinct opalite materials, but they differ somewhat in other constituents (see Table 67). Feature 19 has a higher debitage density, more flake tools, and two types of projectile points (Rosegate and Desert Side-notched); Feature 15 has twice as many metates, no projectile points, and few flake tools.

Figure 49. Plan of Feature 22, site 26Ek3095.

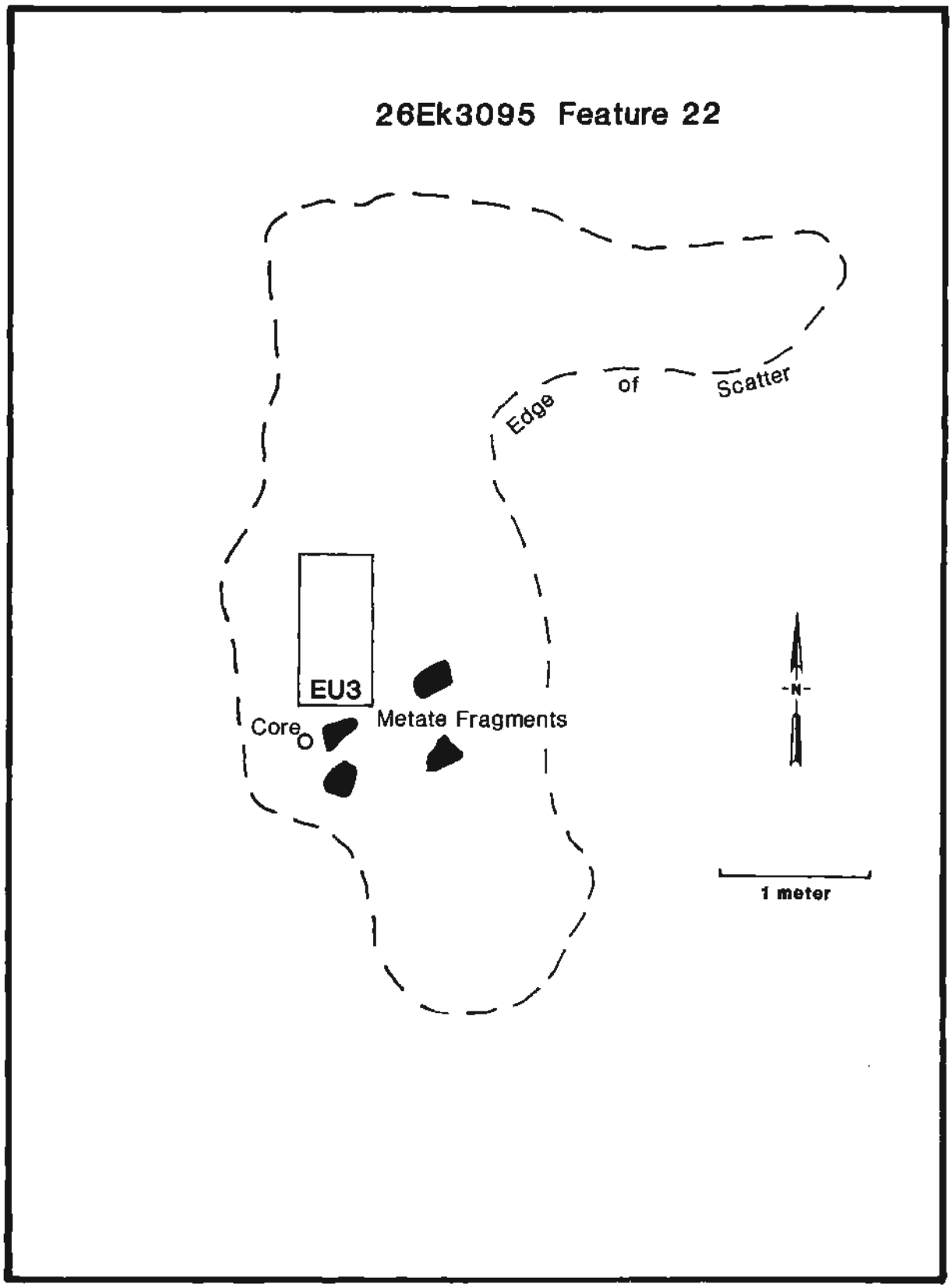
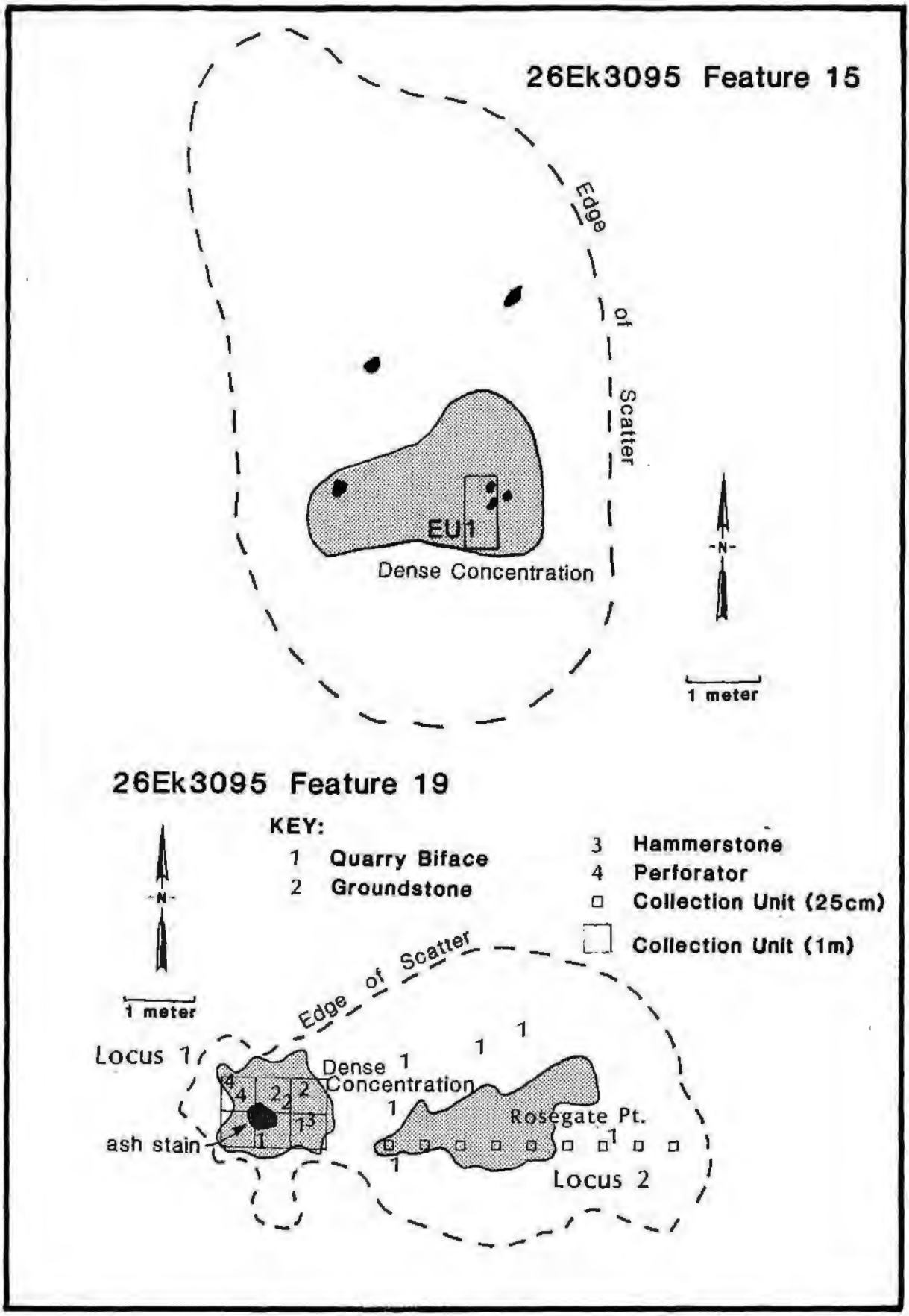

26Ek3095 Feature 22
Edge of Scatter
EU3
Core
Metate Fragments
N
1 meter

Figure 50a. Plan of Feature 15, site 26Ek3095.

Figure 50b. Plan of Feature 19, site 26Ek3095.


26Ek3095 Feature 15
Edge of Scatter
EU1
Dense Concentration
N
1 meter
26Ek3095 Feature 19
KEY:
1 Quarry Biface
2 Groundstone
3 Hammerstone
4 Perforator
Collection Unit (25cm)
Collection Unit (1m)
N
1 meter
Edge of Scatter
Locus 1
Dense Concentration
ash stain
Rosegate Pt.
Locus 2

Feature 15 contained four metates while Feature 19 contained one; in addition, fragments from a single distinctive ignimbrite metate appear in both. It seems likely that either a large piece was scavenged for reuse, or that small fragments were used as boiling stones or heating rocks. The fragments from Feature 19 have sharp, angular breaks (fire-fractured or more recent?) while those from Feature 15 are more eroded (boiling or longer exposure to the surface?). The pieces from Feature 19 were incorporated in a small, ashy hearth-like area which included a Desert Side-notched projectile point in two fragments. The base was found in level 3 of the excavation unit (20 to 30 cm BS); the tip was found on the surface (0 to 2 cm BS).

The variety of stylized tools, the heavy wear on metate fragments, and the presence of an arrow shaft abrader in both features suggest that these features are the loci of small family camps. Quite likely, these camps were used more than once, either by distinct groups or by the same family at different times.

The association of Desert Side-notched and Rosegate Series points with the two loci in Feature 19 suggest two distinct episodes of use. During the latest, apparently in summer when seeds were available, maintenance and processing activities centered around a small hearth in Locus 1 (see Figure 50a). On the other hand, the lower concentration in Locus 2, centered on the Rosegate Series point, contains evidence of reduction but not campsite use. Bifaces and debitage are more widely dispersed in Locus 2, consistent with an inferred longer exposure at the surface but few tools and no groundstone were present here.

Feature 15, with its numerous metates, lack of discernible hearth, and less clearly organized surface arrangements may be the relic of a somewhat older use area; one that was repeatedly reoccupied. If so, sufficient time has passed to obscure individual activity areas and former hearth locations.

Feature 24 was selected as a representative small biface reduction feature and possible biface cache area. The feature consists of a small (4 m^2) debitage scatter centered on the narrow bench at the south end of the site. Materials observed on the surface included a concentration of greyish-white opalite flakes and three Quarry Bifaces, including two crude Stage II biface fragments, and one complete Stage III biface, the only unbroken, unflawed one of its size and kind observed on the surface.

A 1 by 1 m sample unit was excavated to 15 cm below surface where bedrock was encountered. When combined with surface collections, total artifact recovery includes 5,132 debitage items, 12 Quarry Bifaces, 1 core, and 1 scraper (see tables 53

and 54). The debitage is dominated by small opalite flakes and reflects the progressive reduction of large Quarry Bifaces. The biface recovery also is consistent with the hypothesized cache.

Of the 12 Quarry Bifaces recovered from the 1 by 1 m collection unit, 9 are Stage III bifaces made from the same distinctive grey-speckled opalite. These bifaces were made on progressively smaller flakes, ranging from a very large, fairly thick, leaf-shaped form (specimen 2082-2) to a thin, lanceolate form with incipient haft (specimen 2081-3). All appear similar in manufacture, perhaps made by the same individual.

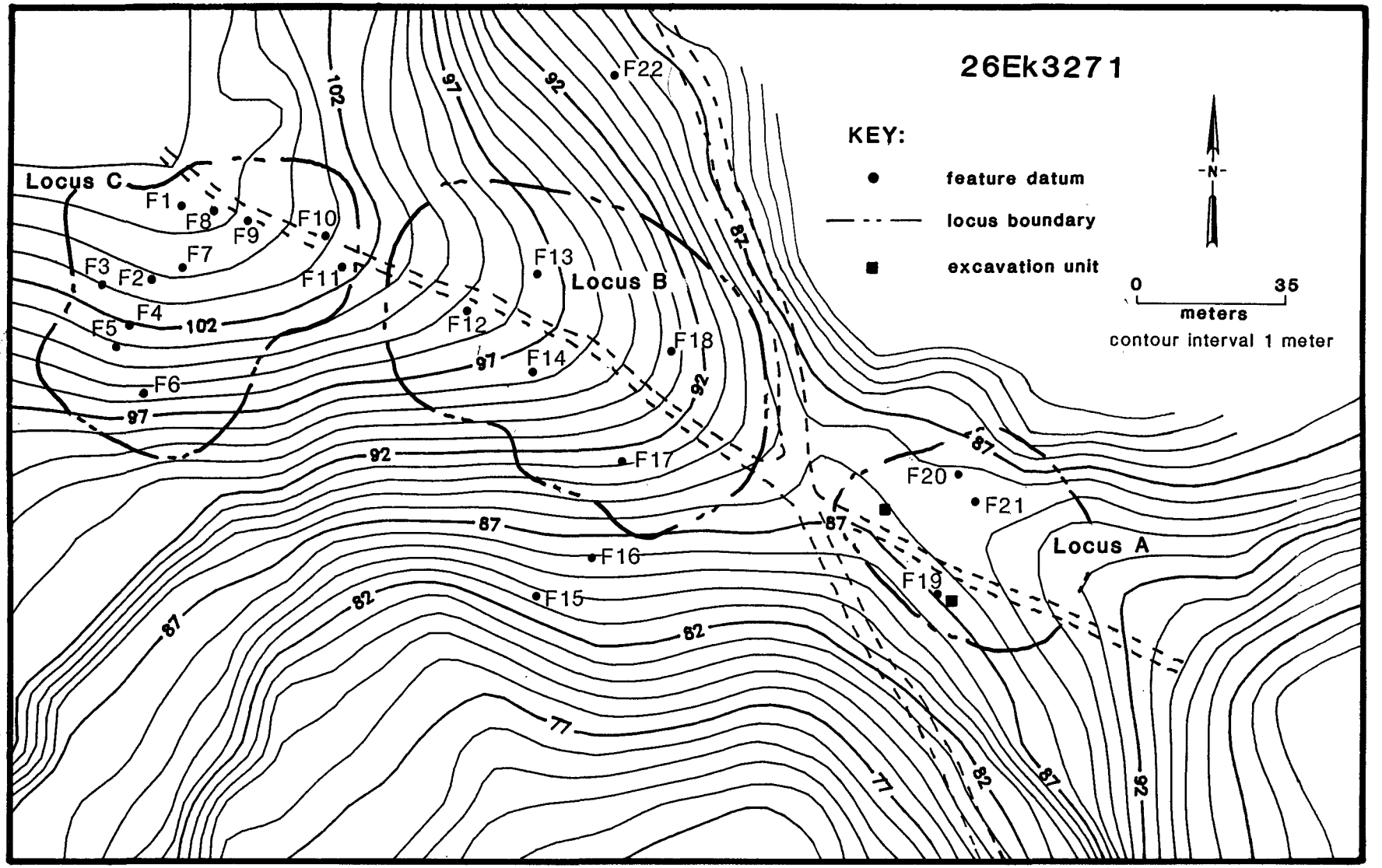
Feature 10 is unlike any other recorded on the site due to its large size (250 m^2), poor spacial definition, abundant and variable formed artifacts (see Table 66), and sparse debitage component (see Table 67). Twelve 25 by 25 cm surface units, located parallel to the slope through the area where most specialized tools were found, resulted in the recovery of only 81 items, mostly opalite flakes (95.4%) that are small in size (mean weight = 1.0 g). This indicates a low overall debitage density (108 m^2) background to the tool scatter.

Artifacts include a large (n=34) and varied collection of reduction bifaces, five projectile points, one mano, and several stylized cutting, scraping, and perforating tools (n=5). Projectile points include one Elko Corner-notched and one Desert Side-notched, as well as three small unclassifiable types; together, these reflect a time range between 1300 B.C. and the historic period. The possibility that some of the tools originate from buried features located on the bench above the scatter needs further investigation in data recovery.

Site 26Ek3271

Site 26Ek3271 occupies the crest of a narrow, southeast-sloping ridgeline and small saddle adjacent the steep southern slopes of Basalt Canyon (Figure 51). Relatively flat ground is limited to the saddle on the east, designated Area A, and a bench on the upper, northwestern edge of the site, designated Area C. Both areas contain discrete flaking stations which were recorded as features. The central site area, designated Area B, consists of a dense flake scatter with few segregatable artifact concentrations. In spite of the narrow, exposed, and strongly sloping (13%) terrain, which appears poorly suited for camping or other sustained use, Area B contained a large number and wide variety of flake tools; intensive reuse of the ridgeline crest is apparent in the thick accumulation of debitage and the large downslope scatter. However, the central site areas (ridgecrest and saddle) are intersected by roads and a water well site that have apparently obliterated significant portions of the site.

Figure 51. 26Ek3271, site map.


26Ek3271
KEY:
feature datum
locus boundary
excavation unit
N
0
35
meters
contour interval 1 meter
Locus C
Locus B
Locus A
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
F13
F14
F15
F16
F17
F18
F19
F20
F21
F22
102
97
92
87
82
77

When compared to assemblages from the two adjacent large reduction/residential complexes (sites 26Ek3095 and 26Ek3160), it is apparent that site 26Ek3271 contained large numbers of maintenance and/or processing tools (see Table 61), yet few of these artifacts are associated with spatially discrete features. In fact, the site retains little obvious structural organization in spite of the diversity of the assemblage as a whole. While this may be attributed in part to post-depositional disturbance in the central site area, much of the prehistoric pattern probably has been obscured by recurrent prehistoric uses of the same narrow ridgeline, especially for intensive biface reduction. Unlike site 26Ek3160 located on the ridge to the south, with its even larger undifferentiated scatter, there is little evidence that site 26Ek3271 was used intensively before about A.D. 500; more than 50% of the classifiable projectile points are Rosegate Series which date to between A.D. 500 and 1300 (see Table 60).

The most clearly organized site activities reflect manipulation of large Quarry Bifaces. The significance of this ridgecrest as a locus of biface reduction appears to be related both to its proximity to the quarry sources to the north and to the elevated position of the landform relative to surrounding terrain.

Twenty-two concentrations were recorded as features, 16 of which (or 72.72%) are discrete biface reduction areas (Table 68). Except where dispersed by movement along slopes, features tend to be restricted spatially and appear to result from single reduction episodes; usually, these features contain as residue several rejected and/or broken Quarry Bifaces. Four flaking loci (features 5, 6, 7, and 16) likewise contain cores, shatter, and larger flakes as well as biface thinning residue from the same opalite material. The two remaining loci (features 12 and 18) likely reflect former short term campsite areas whose patterns have been obscured by reuse and/or other disturbance.

The predominance of biface thinning at site 26Ek3271 is apparent in all systematic collections of debitage, both in the high proportions of flakes to shatter as well as in the relatively consistent average weights of debitage items (Table 69). The intensity of this activity likewise is reflected in the high average density of debitage from sample feature collections, notably in features in the central site area (features 12 and 18) and on the saddle (feature 21). Subsurface tests indicate bedrock is located generally within 20 cm below surface; no hearths or other cultural charcoal features were exposed.

Table 68. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3271.

Fea No.	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction HM	OP	SS	AS	CR	QB	PB	SB	IB	Points PT	FG	Processing SC	KN	PG	MP	GS	Total
1	Biface Reduction	32	-	-	-	-	-	-	-	2	1	-	-	-	-	1	-	-	4
2	Burned Scatter:																		
	Sample Feature	18	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	2
3	Biface Reduction	30	-	-	-	-	-	-	1	-	-	-	-	2	1	1	1	-	6
4	Biface Reduction	20	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
5	Core Reduction	10	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2
6	Core & Biface	77	1	-	-	-	-	5	-	-	1	-	-	-	-	-	-	-	7
7	Core & Biface	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8	Biface Reduction	20	-	-	-	-	-	1	-	2	-	-	-	2	-	-	-	-	5
9	Biface Reduction	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	Biface Reduction	15	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2
11	Biface Reduction	80	-	-	-	-	-	1	2	5	1	-	-	1	-	-	1	-	11
12	Complex Locus:																		
	Sample Feature	60	1	3	1	1	3	38	3	16	8	2	1	25	1	3	-	-	106
13	Biface Reduction	40	-	-	-	-	-	5	-	2	1	1	-	-	-	-	-	-	9
14	Biface Reduction	30	-	-	-	-	-	13	1	2	2	-	-	-	-	-	-	-	18
15	Biface Reduction	25	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	2
16	Core & Biface	40	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
17	Biface Reduction	15	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	4
18	Mortar Locus:																		
	Sample Feature	5	-	-	-	-	1	4	-	1	2	-	-	2	1	-	-	1	12
19	Biface Reduction:																		
	Sample Feature	18	-	-	-	-	2	6	-	2	-	-	-	1	-	-	-	-	11
20	Biface Reduction	17	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	7
21	Biface Reduction:																		
	Sample Feature	5	-	-	-	-	-	14	-	-	-	-	-	4	-	-	-	-	18
22	Biface Reduction	20	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	3
-	Extra-Feature	N/A	4	3	1	-	5	132	5	53	23	8	3	11	1	10	-	4	263

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
SS = Scratched Stone
OP = Other Percussion
AS = Assayed Piece
CR = Cores
QB = Quarry Trajectory Bifaces
PB = Preform Trajectory Bifaces
SB = Small Trajectory Bifaces
IB = Indeter. Biface Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
KN = Knives
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
GS = Groundstone

Projectile Points
PT = Classifiable Points
FG = Unclassifiable/Fragments

Table 69. Summary of Sample Feature and Other Debitage Collections, Site 26Ek3271.

SURFACE COLLECTIONS

Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
2	18	18	69	1,214	97.5	1.3	26	2.1	4.5	5	0.4	1,245
12	60	44	829	35,721	97.9	1.3	471	1.3	2.7	275	0.7	36,467
18	5	2	783	1,551	99.0	0.9	8	0.5	2.8	7	0.4	1,566
19	18	0	-	-	-	-	-	-	-	-	-	0
21	5	3	1,417	4,216	99.2	1.4	24	0.6	4.1	11	0.3	4,251

SUBSURFACE COLLECTIONS

Fea No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
12	3 / D	20	0.10	367	93.6	0.7	23	5.9	9.8	2	0.5	392
12	4 / D	20	0.10	338	96.0	0.5	12	3.4	0.7	2	0.6	352
18	6 / D	30	0.30	2,341	96.9	0.4	67	2.8	1.9	9	0.4	2,417
19	1 / A	20	0.20	1,076	96.2	0.9	17	1.5	0.8	26	2.3	1,119
21	5 / D	10	0.05	1,480	97.8	0.2	25	1.7	0.7	8	0.5	1,513
-	2 / A	20	0.20	3,906	93.3	0.6	186	4.4	1.7	96	2.3	4,188

Key to Excavation Unit Type
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen

Feature 2, encompassing a small (18 m^2) area on the gently sloping ridgetop in Area C, was collected completely by systematic surface skimming. In addition to taking entirely the residue of what appeared to be a small, biface reduction episode, collections from Feature 2 were designed to address the effects of wildfire on surface debitage. Soil stained with charcoal and burned sagebrush stumps observed over the entire site area provided clear evidence of a recent wildfire, and the differential effects of heat on stone artifacts at Feature 2 suggested a useful opportunity to segregate transformations resulting from wildfire from those produced by intentional heat treatment. At Feature 2, the exposed upper surfaces of flakes were seen to be crazed and/or vitrified while the under surfaces, contacting the soil, were either dull, sugary, or otherwise unaffected by heat. This difference was especially noticeable on those flakes composing a small concentration adjacent a charcoal stain and two burned sagebrush stumps (Figure 52a). Field personnel noted that the concentration may have underlain a desiccated, collapsed sagebrush plant which, when it burned, produced the effects observed.

Two (features 12 and 18) of the five features defined within the dense scatter comprising Area B were systematically surface collected; subsurface probes were conducted by placing a 50 cm by 1 m excavation unit in each.

Feature 12 is a discrete concentration of debitage surrounded by a large area (60 m^2) of more dispersed debitage (Figure 52b). Surface skimming recovered 36,467 items of debitage and 38 Quarry Bifaces. Combined with the numbers of other artifacts and tools (n=68), including two Rosegate Series points and 25 scrapers (see Table 68), the scatter suggests campsite use coincident with intensive biface reduction.

Feature 18 composed a small, partially disturbed scatter of debitage associated with a large basalt mortar and several small fire-altered rocks. Explorations hoped to discover an associated hearth, but erosion and road construction appear to have obscured such a feature if indeed one ever was present.

The saddle on the eastern portion of the site offered flat ground suitable for campsite use and explorations in Area A were designed to discover hearths and/or food preparation areas. The centers of features 19 and 21 were probed and sidewalls examined for charcoal and/or rocklines, but none were observed. Similarly, an excavation unit (EU2) was located where a metate and several broken (fire-cracked?) cobbles were found on the surface, but excavation exposed no subsurface features. Although site 26Ek3271 is inferred to be a short term residential location, based on the kinds and variety of tools recovered, no residential features were preserved. Lack of preservation of hearths may be attributed to the lack of sediment accumulation on the narrow sloping landform and the rapid deflation of charcoal and ash deposits on this exposed ridgeline.

Site 26Ek3160

Site 26Ek3160, one of the largest sites (46,000 m^2) recorded in the Tosawihi vicinity, is located on a broad, southeast trending ridge; the drainages to either side are ephemeral, likely to contain water only during runoff (Figure 53). The site contains a diverse artifact assemblage (see Table 61) indicative of an array of subsistence activities conducted here in conjunction with opalite toolstone reduction. Particularly interesting is the abundance of Small Bifaces (n=169) at this site. In many respects, the site poses difficulties for interpretation because of an apparent history of reuse over a long period of time.

The crest of the ridge central to the site is covered by a nearly continuous flake scatter, of variable but generally high density, where few distinct features are discernible. Although

Figure 52a. Plan of Feature 2, site 26Ek3271.

Figure 52b. Plan of Feature 12, site 26Ek3271.

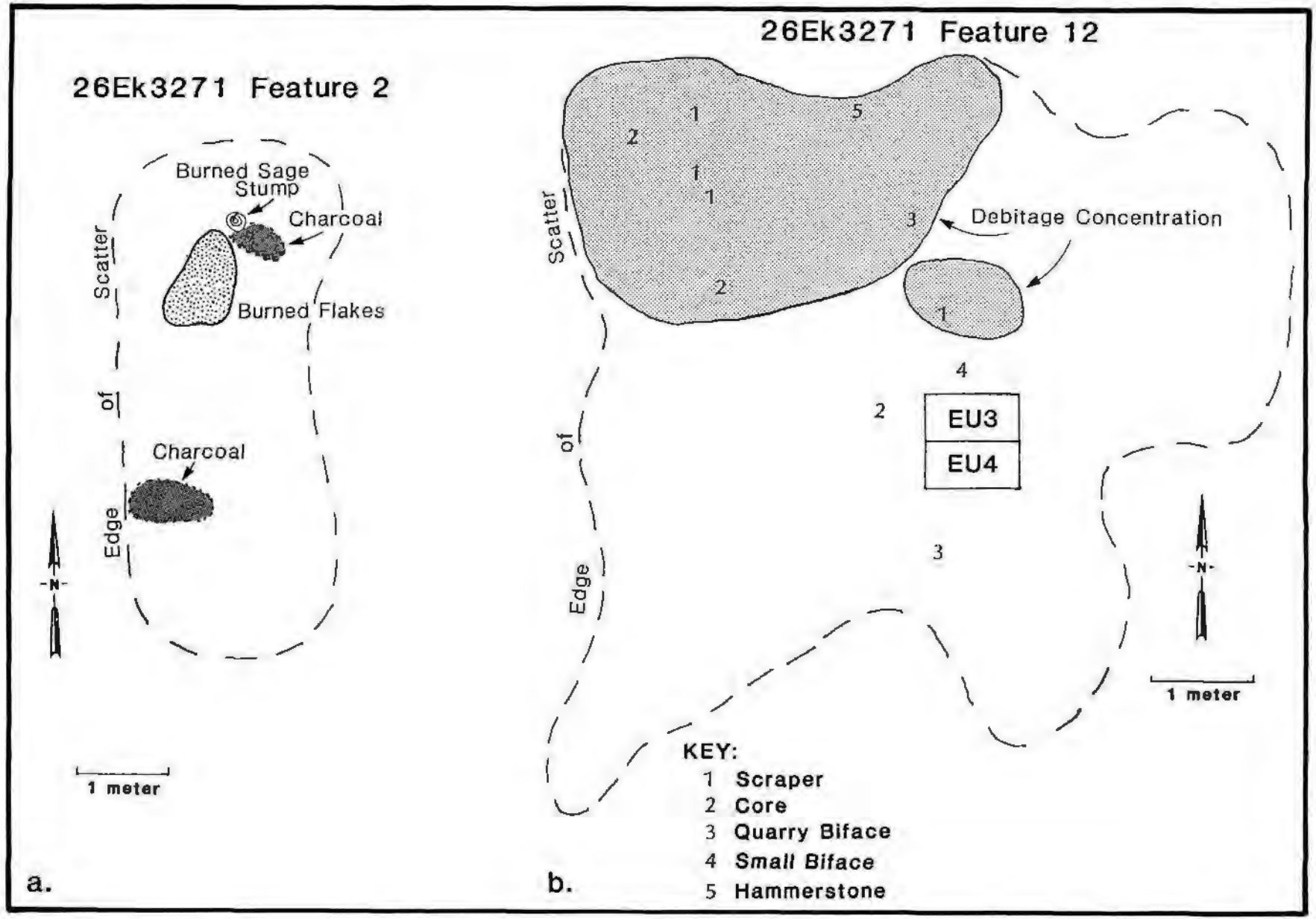
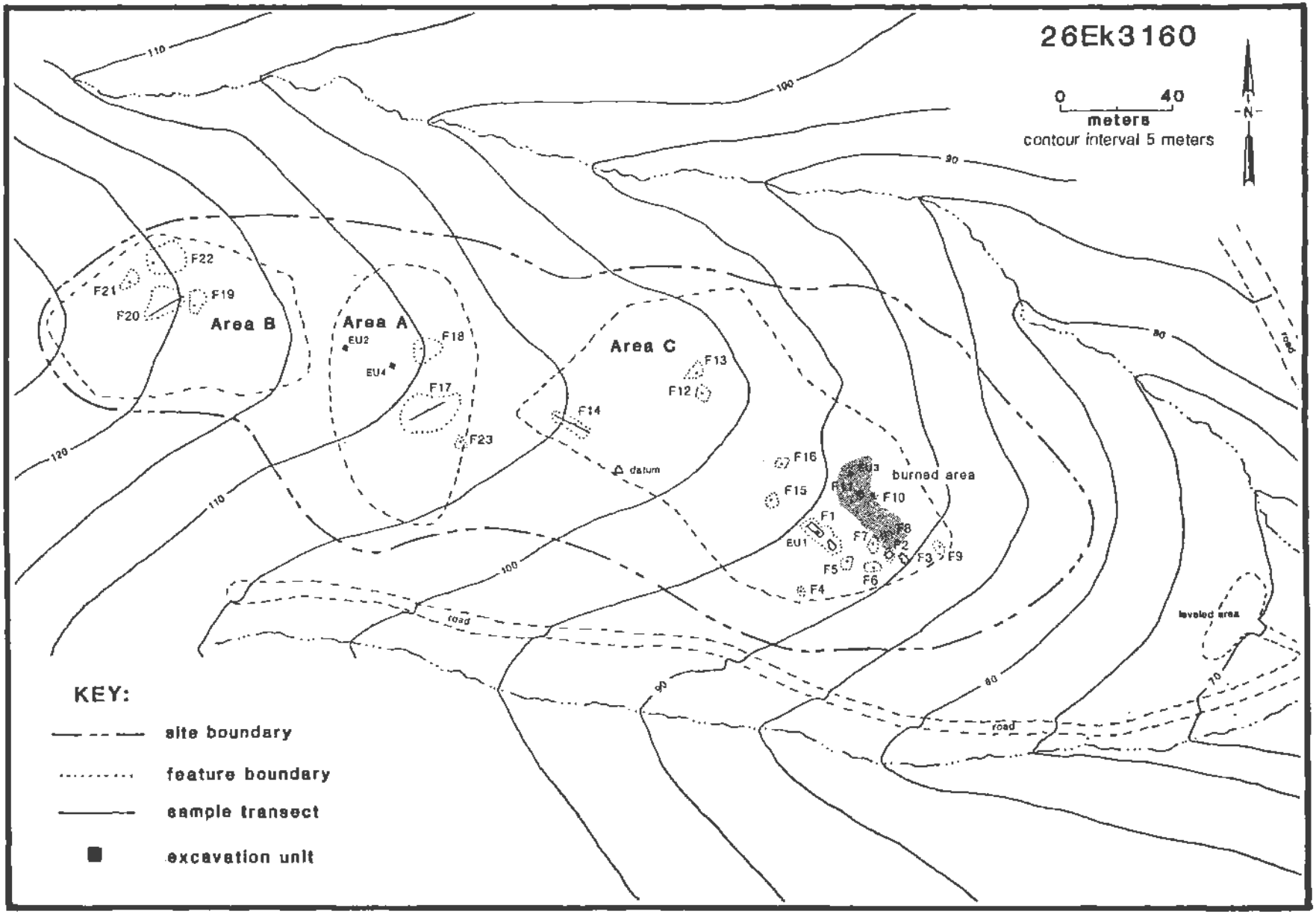

26Ek3271 Feature 2
Burned Sage Stump
Charcoal
Burned Flakes
Charcoal
Scatter of Edge
N
1 meter
a.
26Ek3271 Feature 12
Scatter of Edge
Debitage Concentration
EU3
EU4
N
1 meter
KEY:
1 Scraper
2 Core
3 Quarry Biface
4 Small Biface
5 Hammerstone
b.

Figure 53. 26Ek3160, site map.


26Ek3160
0 40
meters
contour interval 5 meters
N
Area A
Area B
Area C
EU1
EU2
EU4
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F12
F13
F14
F15
F16
F17
F18
F19
F20
F21
F22
F23
datum
burned area
leveled area
road
road
road
110
100
90
80
120
110
100
90
80
70
KEY:
site boundary
feature boundary
sample transect
excavation unit

23 artifact concentrations were segregated as features, these compose only a small proportion of the many different, and apparently separate, past site uses. A large (40%) proportion of the formed artifacts were collected from nonfeature contexts, that is, from the accumulation of materials composing the background scatter. Regular reuse of this ridgeline for several thousand years of prehistory is suggested by the projectile point data (see Table 60). Located beyond the extent of modern roadways and other recent disturbances, site 26Ek3160 provides a rich arena for future archaeological investigation.

Three site areas, designated A, B, and C, were defined on the basis of debitage densities and physical setting. On the upper, western edge of the site, Area B is characterized by a light to moderate density scatter of off-white opalite debitage situated on the crest of the ridge. Four reduction scatters (features 19 through 22) were recorded here; biface reduction flakes prevail, as they do elsewhere across the site, and Quarry Bifaces dominate the artifact collections (Table 70). Most features in Area B cover large areas (76 to 185 m^2), probably dispersed by slope movement and/or bioturbation. Groundstone artifacts found in features 19 and 20 (a mortar and a metate, respectively), in conjunction with several other processing tools, suggest these features are campsite loci. Feature 20 was selected for controlled surface collection, but due to the shallow bedrock here, no subsurface tests were conducted.

Feature 20 was sampled by taking five 1 by 1 m surface scrapes at two meter intervals along a transect established parallel to the slope. The debitage is composed largely (92.8%) of small to medium sized flakes (mean weight = 1.2 g) and small amounts of shatter (6.1%) (Table 71) and includes fragments of both Quarry and Small Bifaces (see Table 70).

Central to the site, Area A is a light scatter of opalite debitage situated on a flat, gentle slope extending over the side of the ridge crest. Only three reduction loci (features 17, 18, and 23) are visible on the surface as discrete artifact concentrations; however, pockets of sediment contain buried cultural materials.

Feature 23 delimits a discrete, light density scatter (30 items per m^2) containing a mortar, two point preforms, a simple flake tool, and nine reduction bifaces; the artifacts suggest food preparation incidental to biface thinning and possible campsite use. Features 17 and 18 are large flake scatters. Feature 18 (110 m^2) seems to have been primarily affected by slopewash, contains no definable concentration, and yielded one Quarry Biface. Covering 240 m^2 in area, Feature 17 is a debitage scatter containing three interior flake concentrations whose distinctiveness have been somewhat blurred by slopewash and/or overlapping uses. A large collection of formed artifacts was recovered including both reduction artifacts (n=18) and processing tools (n=2) as well as two projectile points; one projectile point is classified as a Rosegate type.

Table 70. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3160.

Fea No.	Type	Total Area (sq m)	ARTIFACT CLASSES																			
			Reduction								Points		Processing									
			HM	OP	SS	CR	QB	PB	SB	IB	PT	FG	SC	KN	PG	MP	OT	AB	PL	GS	CE	Total
1	Complex Locus: Sample Feature	135	1	1	2	1	26	1	8	8	5	-	8	-	-	-	-	-	2	2	39	104
2	Burned Scatter: Sample Feature	6	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	3
3	Biface Reduction: Sample Feature	9	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
4	Biface Reduction	8	-	-	-	-	2	-	1	3	-	-	-	-	1	1	-	-	-	-	-	8
5	Core & Biface	24	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
6	Biface Reduction	4	-	-	-	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	3
7	Core & Biface	20	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
8	Burned Scatter	7	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
9	Biface Reduction	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	Burned Scatter	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	Burned Scatter	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
12	Biface Reduction	7	-	-	-	-	4	1	3	1	-	1	-	-	1	-	1	-	-	-	-	12
13	Biface Reduction	48	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	3
14	Biface Reduction Sample Feature	140	-	-	-	-	1	1	4	1	1	-	-	-	-	-	-	-	-	-	-	8
15	Biface Reduction	49	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2
16	Biface Reduction	48	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
17	Core & Biface: Sample Feature	240	-	-	-	2	9	1	4	2	1	1	-	1	1	-	-	-	-	-	-	22
18	Biface Reduction	110	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
19	Complex Locus	76	-	-	-	-	3	-	2	1	-	-	-	-	1	-	-	-	-	1	-	8
20	Complex Locus: Sample Feature	185	-	-	-	-	3	1	5	-	1	-	-	-	1	-	-	-	-	-	1	12
21	Core & Biface	17	-	-	-	1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	4
22	Biface Reduction	180	-	-	-	-	3	-	-	1	-	-	1	-	-	-	-	-	-	-	-	5
23	Complex Locus	30	-	-	-	-	6	2	2	1	-	-	-	-	1	-	1	-	-	1	-	14
-	Extra-Feature	N/A	-	1	-	4	107	7	134	34	9	6	12	2	4	-	-	-	-	4	-	325

Key to Artifact Classes

Reduction Tools and Artifacts
- HM = Hammerstones & other Percussion
- SS = Scratched Stone
- OP = Other Percussion
- CR = Cores
- QB = Quarry Bifaces
- PB = Preform Bifaces
- SB = Small Bifaces
- IB = Indeter. Biface Fragments

Maintenance/Processing
- SC = Scrapers and Spokeshaves
- KN = Knives
- PG = Perforators and Gravers
- MP = Multipurpose Flake Tools
- OT = Other Simple Flake Tools
- AB = Abraders
- GS = Groundstone
- CE = Ceramic Fragments
- PL = Planers

Projectile Points
- PT = Classifiable Points
- FG = Unclassifiable/Fragments

Table 71. Summary of Sample Feature and Other Debitage Collections, Site 26Ek3160.

SURFACE COLLECTIONS

Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
1	135	17	621	9,842	93.2	1.2	646	6.1	3.5	71	0.7	10,559
2	6	4	573	1,150	50.2	0.7	1,140	49.8	0.7	-	-	2,290
3	9	8	304	2,247	92.3	2.1	184	7.6	0.8	3	0.1	2,434
14	140	8	358	2,841	99.2	0.9	-	-	-	23	0.8	2,864
17	240	8	315	2,411	95.6	0.8	81	3.2	0.7	29	1.2	2,521
20	185	5	191	886	92.8	1.2	58	6.1	0.6	11	1.2	955

SUBSURFACE COLLECTIONS

Fea No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
1	1 / F	20	0.10	480	97.4	1.6	13	2.6	20.0	1	0.2	494
-	2 / B	60	0.60	445	93.4	1.0	16	3.4	8.6	9	1.9	470
-	3 / C	20	0.20	>669	52.0	0.8	616	47.9	1.2	1	0.1	1,286
-	4 / C	40	0.40	> 44	73.3	0.7	15	25.0	0.7	1	1.6	60

Key to Excavation Unit Type
B = 1 by 1 m, 1/4 in. screen
C = 1 by 1 m, 1/4 in. with 1/8 in. quad
F = 50 cm by 1 m, 1/4 in. with 1.8 in. quad

Variable density of debitage at Feature 17 was sampled by taking eight 1 by 1 m surface scrapes at two meter intervals along the long axis of the feature (perpendicular to the slope). Flake density ranges from a moderate 189 items per m^2 in the least concentrated areas to a maximum of 477 items per m^2, but mean flake weight is consistent for all units (0.8 $\pm$ 0.1) and similarly reflects biface thinning. The surface distribution suggests that several (at least three) discrete biface reduction activity areas have been blended somewhat by erosion. The concentrations may reflect refuse generated by one individual or by several knappers working in concert, but the similarity in debitage visibility and composition suggests a similar length of exposure on the surface, likely dating to some time between A.D. 500 and 1300 (based on the Rosegate projectile point).

Two 1 by 1 m excavation units (EU2 and EU4), placed in nonfeature contexts in Area A, sampled the extent of buried cultural remains. Unit 2 was excavated to a depth of 60 cm

below surface and produced 470 pieces of debitage and 7 formed artifacts. The debitage appears to be distributed rather evenly under a near surface peak where a mano, biface and scraper were found. Rodent turbation is extensive, but the depth of cultural materials may derive from buried cultural surfaces and provide clear research potential for future studies. In contrast, Unit 4 was excavated to a depth of 40 cm below surface but yielded only a small debitage assemblage (see Table 71).

Area C, occupying the toe of the ridgeline, is characterized by dense, overlapping scatters composed of diverse toolstone materials (opalites, cherts, and obsidian) and containing numbers of functionally different tools. Within this, 16 features were identified as more or less discrete concentrations. Recorded features include eight biface reduction, two core/biface reduction, one core reduction, four burned reduction scatters and one complex (metate/pottery) locus. Features 3 and 14 (probably reduction scatters), are located at alternate ends of Locus C and varying in size and artifact associations were systematically sampled.

Feature 14 covers a large area (140 m^2) on the ridge crest at the western (upslope) end of Area C. Surface debitage was sampled by taking eight 1 by 1 m surface scrapes at two meter intervals parallel to the slope. The feature contains moderate (average 358 items per m^2) to dense (772 items per m^2) debitage which appeared to be predominantly composed of biface thinning flakes. The biface assemblage is mostly (63%) Small Bifaces, but also include one large Quarry Biface and a biface fragment. An unclassifiable projectile point and a point preform also were recovered.

Feature 3 is contained within a small area (9 m^2) on the lower, east edge of Area C where a single Quarry Biface was recovered within a moderate density (average 304 items per m^2) debitage concentration. A 2 by 4 m grid was centered over the feature and recovered most (88%) of it. Debitage is comprised of off-white opalite (probably limited to a single toolstone variety) and includes numbers of large flakes. This suggests preliminary trimming of bifacial roughouts transported from a single source area.

Reduction features 2, 8, 10, and 11 are located in an area where lithics have been exposed to fire (see Figure 53). Feature 2, which evidenced quantities of burned debitage, was sampled with four surface units taken from a a 2 by 2 m block in the center of the concentration. Small pieces (mean weight = 0.7 g) of thermally produced shatter compose (49.8%) of the debitage collection; flakes likewise are blackened, crazed, and/or fractured by heat. It is apparent that the flakes were exposed to fire after they were produced, and there is no indication of intentional heat treatment. Debitage from an excavation unit (EU3) located at the north edge of the burned

area similarly is affected by heat; 48% consists of thermal shatter and burned materials were found to a depth of 20 cm below surface. The source of the fire(s) which produced these effects on surface and subsurface debitage within a spatially restricted area, begs further definition. Do these burned materials reflect their inadvertent inclusion in prehistoric fires (hearths, ovens, heat treatment pits) or simply their redeposition after an ancient localized wildfire?

Feature 1 is unique among loci recorded at the site, both in the diversity of its artifact assemblages, and in the complexity of its surface arrangements. Feature 1 is a large area (135 m^2) containing a continuous light density flake scatter surrounding two discrete debitage concentrations and a scatter of Shoshoni Brownware pottery (Figure 54).

Twelve surface units, arranged in a 2 by 6 m block, were centered in the westernmost (upslope) reduction concentration. Debitage averages 818 items per m^2, and includes small thinning flakes as well as large secondary flakes in a variety of opalite materials; some obsidian and exotic (nonlocal) cherts also were reduced here. Included in the surface units, and somewhat scattered around its perimeter, were 18 Quarry Bifaces, 6 Small Bifaces, 8 indeterminate fragments, and a projectile point preform. The assemblage indicates that this area was used intensively to reduce large bifaces procured in the nearby quarries. Although a Rosegate Series projectile point also was found, the recovery of a Cottonwood and three Desert Side-notched points within the spatially organized context suggests that the debitage was produced during single period of use. Likewise, the association of seed processing tools (two manos and one metate fragment) and several scrapers (n=8) likely indicate campsite use during this interval.

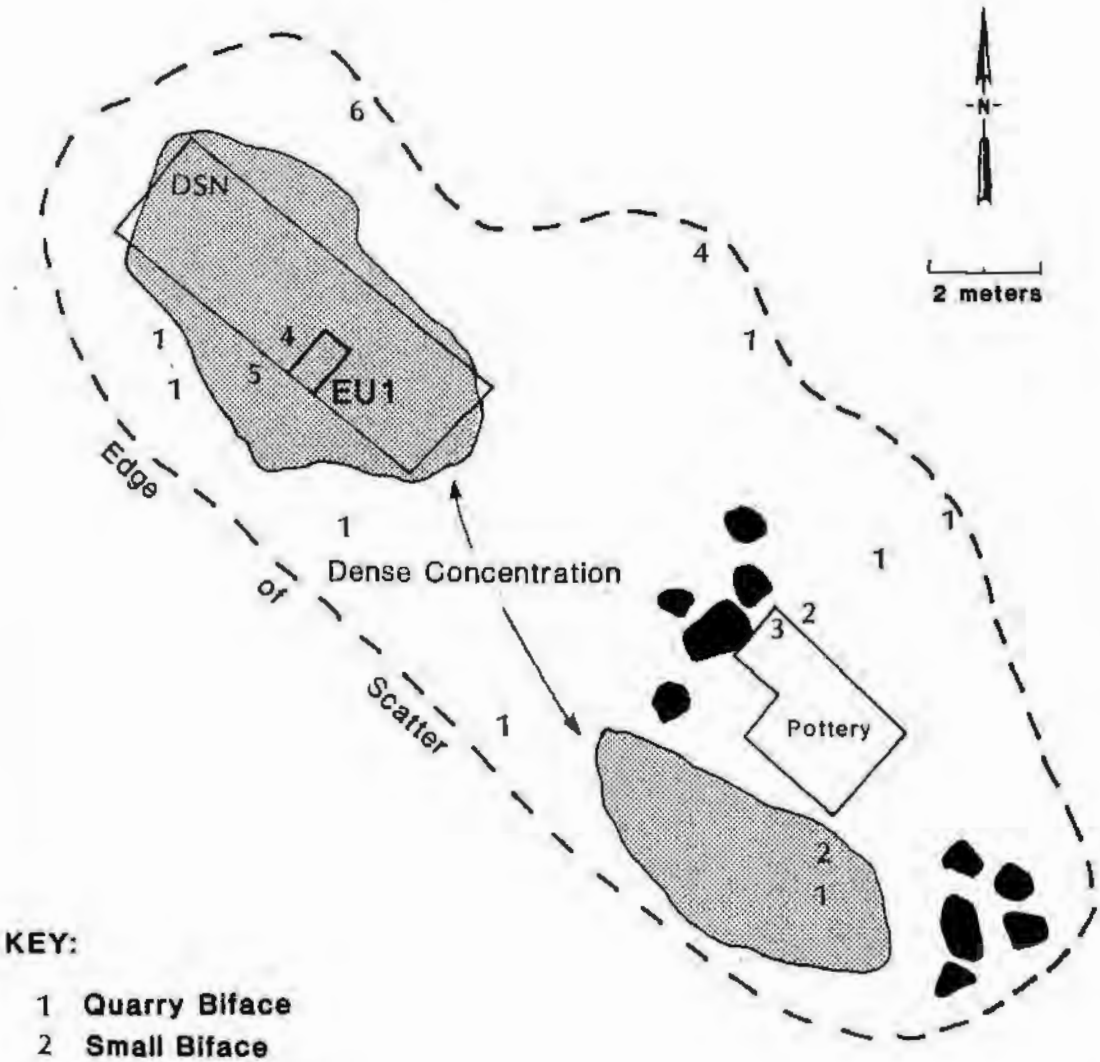
A scatter of 39 Shoshoni Brownware pottery sherds (apparently representing one pot drop) was located among several basalt boulders, and adjacent to another dense concentration of debitage at the east end (downslope) of Feature 1. Five 1 by 1 m surface units, enclosing the pottery scatter, were collected. Debitage of light to moderate density and two Quarry Bifaces were recovered in the pottery locus, but several (n=5) other reduction artifacts were scattered among the boulders. The Shoshoni pottery in the lower area and the Desert Side-notched points in the upper suggest a contemporaneity of Late Archaic use at this complex feature.

Site 26Ek3165

Site 26Ek3165 is located in a small, broad saddle that forms part of an unnamed ridgeline on the south margin of the project area (Figure 55). Debitage is scattered on the slopes of the knoll slopes surrounding the saddle and is concentrated in

Figure 54. Plan of Feature 1, site 26Ek3160.

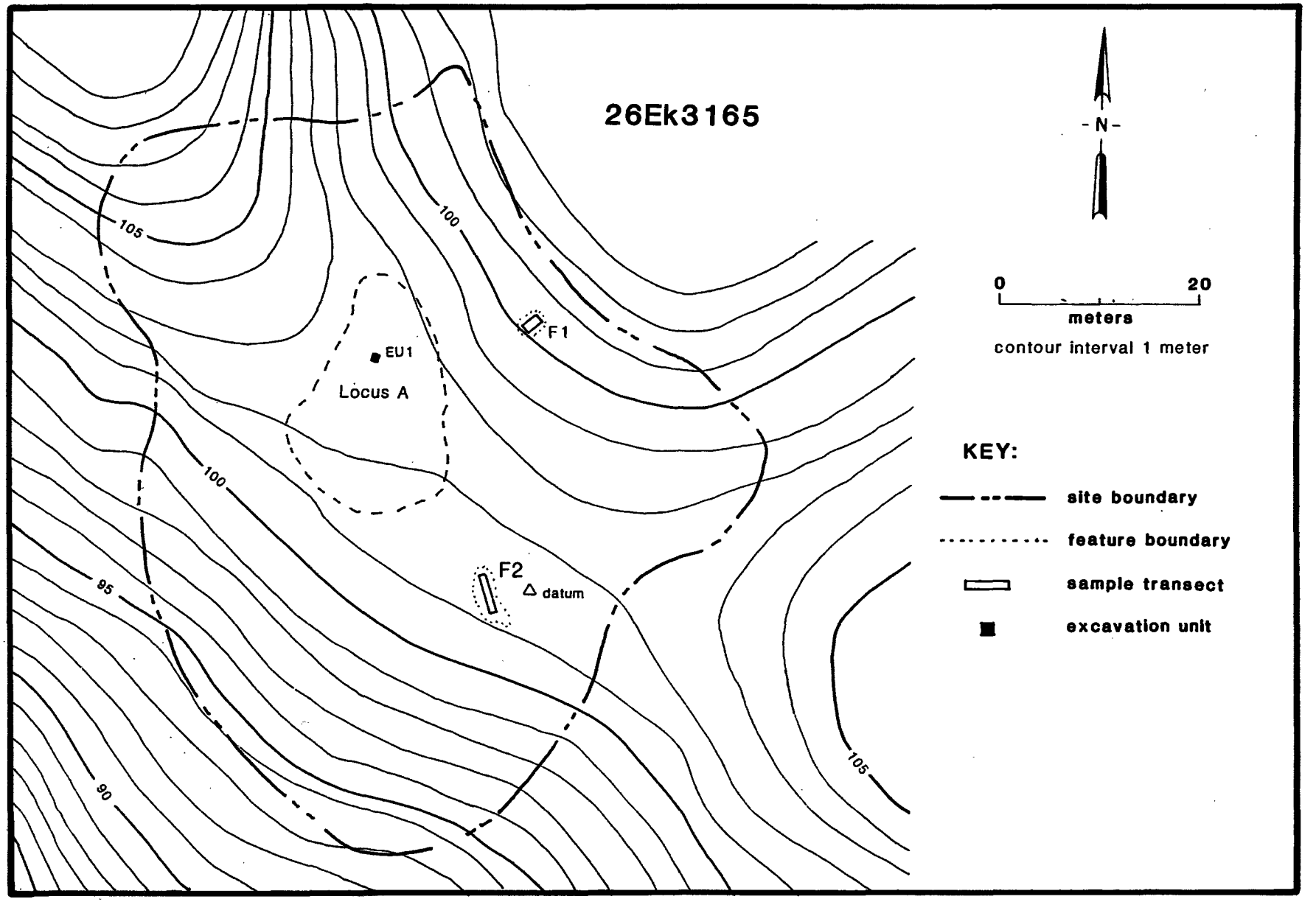
26Ek3160 Feature 1



KEY:

1	Quarry Biface
2	Small Biface
3	Projectile Point
4	Groundstone
5	Chopper
6	Flake Tool
DSN	Desert Side-notched Pt.
☐	Surface Collection Units

Figure 55. 26Ek3165, site map.


26Ek3165
- N -
0
20
meters
contour interval 1 meter
KEY:
site boundary
feature boundary
sample transect
excavation unit
105
100
100
95
90
105
EU1
Locus A
F1
F2
datum

two small reduction features, each centered around a single metate. Both features are located on the eastern portion of the site. Formed artifacts scattered across the site include two cores, five Quarry Bifaces, six Small Bifaces, and one projectile point preform. Locus A was defined as an area central to the saddle where accumulated sediments provide potential for buried cultural materials.

Features 1 and 2, both containing a single metate within a discrete debitage scatter, offer an interesting comparison. Both features were sampled by surface skimming. A 2 by 4 m grid block grid was imposed to collect most (80%) of Feature 1; a 1 by 8 m collection transect, oriented parallel to the slope, sampled materials (21% of surface area) scattered along the long central axis of Feature 2. While both indicate seed processing, differences in overall size, debitage density, and associated artifacts (Table 72) reflect subtle distinctions in organization of activities and duration of use of these features.

Table 72. Summary of Debitage Collections, Site 26Ek3165

SURFACE COLLECTIONS

Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	Total
1	10	8	215	1,710	99.7	0.9	6	0.3	4.0	1,716
2	38	8	284	2,244	98.8	1.2	27	1.2	2.6	2,271

SUBSURFACE COLLECTIONS

Fea No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	Total
-	1 / *B	30	0.25	135	97.8	0.9	3	2.2	0.4	138

Key to Excavation Unit Type
B = 1 by 1 m, 1/4 in. screen
* last level excavated as a 50 cm by 1m unit, 1/4 in. screen

Feature 1, with its small average flake size (mean weight = 0.9 g), near absence of shatter (0.3%), paucity of Quarry Bifaces (n=2), and absence of other tools, save the metate, suggests food preparation but not campsite use. On the other hand, Feature 2, with two distinct surface debitage concentrations, includes more variable flake sizes (mean flake

weight ranges from 0.9 to 2.0g), more variable opalite materials, numerous Quarry Bifaces (n=7), and six other tools (two spokeshaves, three scrapers, and one multipurpose flake tool) in addition to its metate. An unclassifiable obsidian projectile point, an opalite preform, and one Small Biface also were found. The recovered assemblage is consistent with use of Feature 2 as a short term camp.

A 1 by 1 m excavation unit was located in the center of the saddle adjacent to a large basalt metate in the depositional zone designated Locus A. Though only a light scatter of debitage was noted on the surface, subsurface excavation recovered 138 debitage items and three Quarry Bifaces. The bifaces and debitage were concentrated in the upper 20 cm below surface, loosely compacted in a silty loam; materials diminished below a contact with a more compact silty clay layer. Two of the Quarry Bifaces, a Stage II and a Stage IV, were found stacked one upon the other somewhat embedded in the clayey soil at 19 cm below surface. The apparently purposeful placement of these bifaces may signal a cache pile nearby while the other debitage recovery suggests a shallow buried use area, perhaps associated with the large metate. Further investigation will be necessary to define relationships, if any, between surface metate, the shallow subsurface debitage layer, and a possible biface cache.

Summary

Reduction complex 26Ek3093 and small reduction sites 26Ek3114, 26Ek3115, and 26Ek3116, contribute to an understanding of toolstone reduction strategies on the periphery of the Tosawihi Quarries. Tests at Site 26Ek3271 recovered a wealth of data indicating intensive reuse of its ridgeline setting for biface thinning, likely coincident with short term camping, but disturbance to the site is extensive. The three remaining large reduction/residential complexes (26Ek3095, 26Ek3160, and 26Ek3165) contain significant data.

Site 26Ek3095 is considered significant because of its high research potential and clear patterns of spacial organization. The features associated with seed processing tools at 26Ek3095 are inferred campsites whose artifacts provide clues to the organization of groups using nearby quarries. Data from these features can be used to assess group size and sex composition, subsistence activities, seasonality of site use, and duration of stay. Data from the biface cache (Feature 24) may be used to model an episode of biface reduction, quite possibly conducted by a single individual, and so develop indices of the amount of energy invested in such an event.

The large artifact collection and the diversity of functional tools and reduction bifaces highlight the

significance of site 26Ek3160 as a staging center and short term campsite peripheral to the quarry zone. It is notable that 40% of the formed artifacts were recovered from nonfeature contexts where time, bioturbation, erosion, and overlapping use, have blurred formerly discrete activity areas into nearly continuous scatters of debitage. Some of the earlier discrete features may be distinguished, if preserved, in soil pockets in Area A, and any containing charcoal can be used for radiocarbon dating. Features with internal spatial organization, such as Feature 1, also provide valuable data about reduction strategies and domestic activities that can address several previously identified research issues.

Site 26Ek3165, the southernmost site in the project area, offers significant potential relevant to developing gravity models (see Elston 1988) and for observing possible change in reduction strategies with increased distance from the primary quarry source area. The two clearly delimited metate loci can be usefully compared to other inferred campsite features at nearby sites. Though lacking clear chronological markers for the present, temporal differences in site use likely are present which will segregate the apparently more recent surface features from likely earlier discrete features now possibly buried in Locus A.

Part V. USX-East Study Area

The USX-East Study Area is introduced in Chapter 13, followed by site descriptions organized geographically; Ramadan Ridge in Chapter 14, Corral Fan in Chapter 15, Undine Gorge in Chapter 16, and Holeplug Ridge in Chapter 17.

Chapter 13. INTRODUCTION TO USX-EAST

by Steven G. Botkin

The USX-East project area, some 0.4 miles due east of USX-West, occupies about 160 acres of the Little Antelope Creek watershed. It is contiguous along its western extreme with the southern boundary of the Tosawihi Quarries (site 26Ek3032). Raven's (1988) survey recorded 37 prehistoric sites in USX-East, of which 31 were explored in the course of testing. The results of these investigations are presented in the following four chapters.

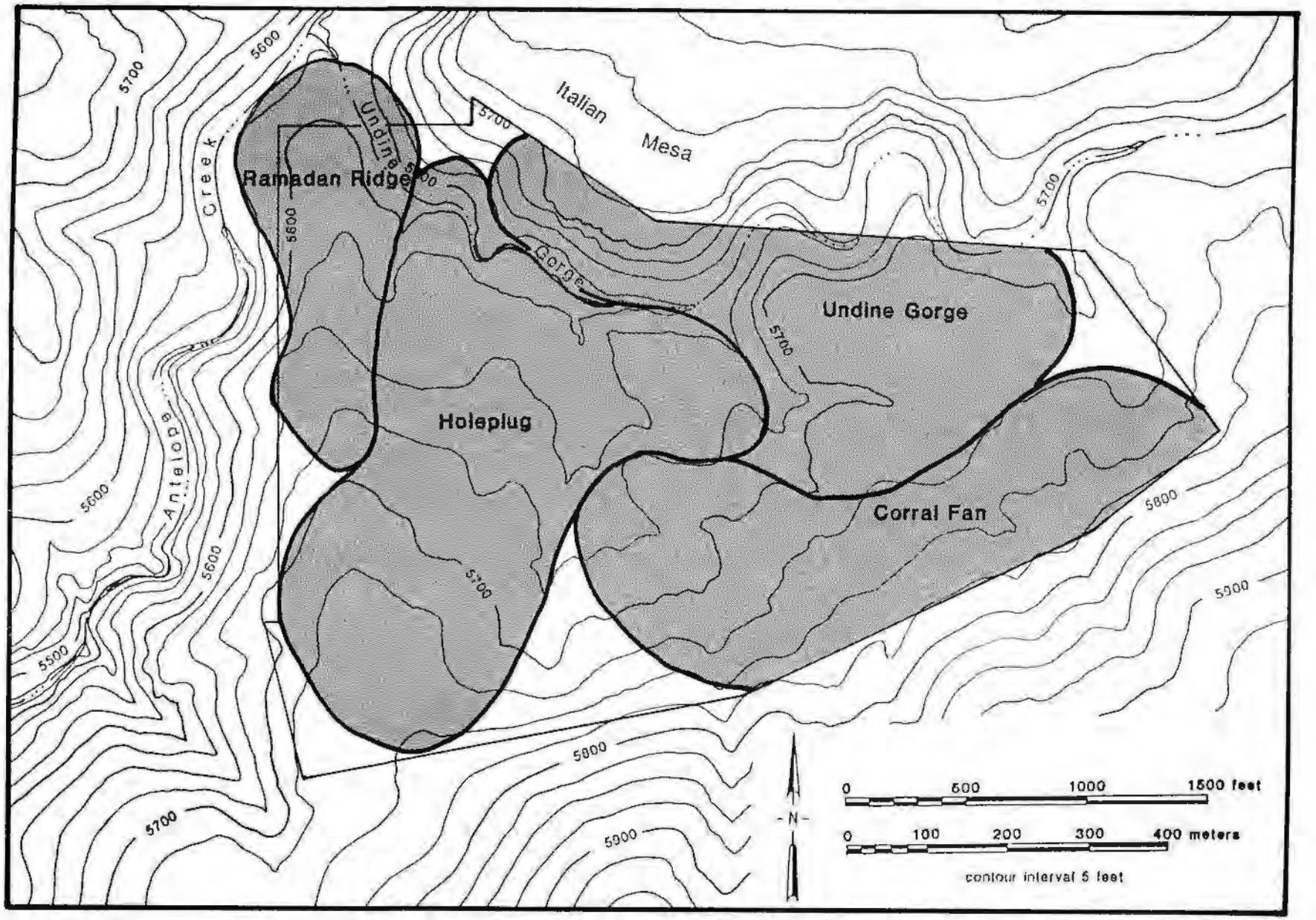
Archaeological sites in USX-East, like those in USX-West, contain artifact assemblages and cultural features with considerable variety in their composition and size, and they occur over a wide range of geographic contexts. However, all the sites appear to be derived from aboriginal extraction and processing of opalite toolstone. Pertaining to this theme, USX-East contains an array of site types that include pit, outcrop, and cobble quarries of assorted sizes, and numerous rockshelters. As well, several locations display attributes suggestive of residential occupation. Beyond these superficial similarities, however, tests suggest that the archaeological records of USX-East and West differ in some considerable, albeit subtle, ways.

In marked contrast to USX-West, toolstone sources in USX-East are more numerous, and are widespread. Moreover, we observe that surficial site boundaries in USX-East seem less clear because they are less topographically constrained and they are blurred further by a ubiquitous background lithic scatter of variable density. Boundaries of most large sites in the East are arbitrary, enclosing constellations of spatially discrete cultural features aggregated on the basis of inferred function, relative proximity to one another, and/or on shared topographic position. Given these attributes, it appears that unlike USX-West, the prehistoric record of the USX-East area is quite similar to that of the Tosawihi Quarries (26Ek3032) proper (cf. Elston et al. 1987).

Recall from Chapter 2 that, for heuristic purposes, the USX-East test arena has been divided into four subareas named for prominent landforms they contain: Ramadan Ridge, Holeplug Ridge, Undine Gorge, and Corral Fan (Figure 56). These units are employed to segregate the area-specific chapter discussions which follow.

Ramadan Ridge encompasses the broad, gently inclined lower (northern) half of the north trending ridgeline from which it takes its name. Two sites occur within it; both were tested. They are large quarry pit/reduction complexes which, in contrast

Figure 56. USX-East project area and archaeological subareas.


Ramadan Ridge
Undine Gorge
Italian Mesa
Undine Gorge
Holeplug
Corral Fan
Antelope Creek
5700
5600
5500
5800
5900
N
0 500 1000 1500 feet
0 100 200 300 400 meters
contour interval 5 feet

to other sites of this type in the project area, contain artifact assemblages of sufficient functional diversity to imply some residential use as well. Given its extreme western position in the project area, the boundaries of Ramadan Ridge sites abut and, in places, subsume localities within the Bedrock Bend, Middle Little Antelope Canyon, and Big Meadows site neighborhoods of the Tosawihi Quarries (cf. Elston et al. 1987:36, 40-41).

Named for the long low rise that arcs northward from the highest elevations of Ramadan Ridge, the Holeplug subarea occupies the central portion of USX-East. It encompasses a broad swath of undulating landscape that includes the southern crest and northeastern slopes of Ramadan Ridge and, after falling gradually downward to the north, is bounded by the southern margin of Undine Gorge. Nineteen sites occur within it; all, save one, were tested. The area lacks opalite outcrops and the archaeological record is composed of reduction complexes and isolated reduction stations. The only quarry activity observed occurs at an extensive but apparently little used cobble field.

The northernmost tier of sites examined are distributed along Undine Gorge, a seasonal drainage transiting the project area from east to west. The western half of the unit is dominated by the cliff of silicified tuff that forms the terminus of Italian Mesa, while its eastern extent attains a more gently rolling aspect encompassing knolls along the southern bank of the meandering gorge. Ten of the twelve sites here were tested. Surface and near surface opalite outcrops along the eastern knolls were quarried intensively; the walls of rockshelters in the steep rocky buttresses to the west show evidence of minor toolstone extraction.

Corral Fan spans the southern quarter of the project area where it comprises a portion of the mildly dissected northwestern foot slopes of the high ridge dominating the horizon to the south. Containing only four prehistoric sites, Corral Fan represents the area of lowest site density in USX-East. An isolated quarry pit at its eastern extreme exploits the sole opalite exposure within the area and was the only site tested there. The three remaining sites are extensive but diffuse lithic scatters which lack discernible cultural features or internal organization.

Discussions in the next four chapters follow the organization scheme employed in Parts III (North Access Corridor) and IV (USX-East) of this volume.

Chapter 14. RAMADAN RIDGE

by Steven G. Botkin

From its base in Big Meadows at the confluence of Little Antelope Creek and Undine Gorge, Ramadan Ridge rises gradually southward in a succession of broad, nearly flat benches to span the entire western quarter of USX-East (Figure 57). Ramadan Ridge is contiguous on the north to the large residential localities in Big Meadows of the Tosawihi Quarries. It is not surprising to find indications of residential use at the two Ramadan Ridge sites tested, in addition to toolstone procurement and processing.

Along the ridgecrest a relatively shallow colluvium of sandy silt with abundant gravels overlays beds of toolstone-quality silicified tuffs, or opalite. At numerous but widely scattered locations, especially on slopes between benches, opalite bedrock appears in low ledges or is weathered into extensive cobble fields; the majority of these exposures show evidence of aboriginal manipulation.

A chain of small pools in Little Antelope Canyon bottom, monitored during 1988 field work, held water until late June; a more persistent water source occurs in Big Meadow some 300 meters north of the study area where an apparently perennial spring now feeds a stock pond. Little Antelope Creek is a link in the most direct foot route between Tosawihi Quarries and the Humboldt River. For people transiting this corridor, Ramadan Ridge and the comparatively well watered flats immediately north are the nearest suitable campsites to the opalite toolstone sources (Elston et al. 1987:40).

Vegetation within the subarea is essentially identical to that of the surroundings and appears to have offered no particular inducement to site occupation. Shallow soils along the crest of Ramadan Ridge host a sparse cover of low sagebrush, rabbitbrush, and phlox, while locally dense stands of tall sagebrush and understory grasses are supported by patches of deeper soils on the lower ridge slopes. However, more productive plant foods occur immediately outside the study area, within Big Meadow and along the courses of its influent drainages.

Descriptive Site Summary

Two sites within the Ramadan Ridge subarea (26Ek3170 and 26Ek3171) were recorded (Raven 1988) and subjected to testing (Table 73).

Figure 57. Topographic setting, Ramadan Ridge sites.

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Table 73. Descriptive Site Summary, Ramadan Ridge.

Site No.	Type	Maximum Number of Features	Site Area (sq. m)
26Ek3170	Quarry Pit/Reduction/Residential Complex	13	31,000
26Ek3171	Quarry Pit/Reduction/Residential Complex	8	6,770

Sites 26Ek3170 and 3171 occupy major benches of Ramadan Ridge and their locations offer broad views of the western portion of the USX-East area including Ondine Gorge and its confluence with Little Antelope Creek.

Site 26Ek3170 is a fan-shaped scatter of debitage and artifacts encompassing an area of 31,000 m^2. The site contains 12 discrete lithic concentrations recorded as features, a quarry pit feature and a large central area where debitage density is high. Site 26Ek3171 covers only 6,770 m^2 and contains 6 lithic features and 2 quarry pits.

Although dominated by the residue of opalite quarrying and the early stages of biface reduction, the diversity of both assemblages suggests that the Ramadan sites hosted a wider array of activities than implied by their original classification as "Quarry Pit/Reduction Complexes" (Raven 1988:6). The presence of groundstone, scrapers, and other flake tools, as well as drills, perforators, and numerous projectile points and point preforms points toward residential use of the sites in addition to quarrying.

Testing Strategies

Following close interval reconnaissance of each site following procedures outlined in Chapter 2, cultural features from each site were selected for special scrutiny. In addition, surface testing and excavation were conducted outside features in the large zone of dense but internally undifferentiated lithic scatter (Table 74).

Table 74. Summary of Testing Procedures, Ramadan Ridge Sites.

			FEATURE CONTEXT				NONFEATURE CONTEXT		RECOVERED COLLECTIONS	
Site Number	FEATURES Total (n)	RECORDED Sampled (n)	Surface Skim Area (sq m)	Trench Cross Section (n)	Stratigraphic Profile (n)	Column Samples (n)	Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	Debitage (n)	Formed Artifacts (n)
26Ek3170	13	2	9.75	1	1	-	5	0.8	9,458	136
26Ek3171	8	2	5.4375	2	3	20	-	1.4	5,265	51

At 26Ek3170, two of thirteen cultural features were sampled. Feature 1, a quarry pit and reduction station centered on a 3 m long opalite outcrop, was tested with a discontinuous transect of 12 25 by 25 cm collection units, shovel-skimmed and screened at 1 m intervals along the long axis of the feature and bisected with a backhoe trench. Feature 9, a small (3 by 2.5 m) biface reduction station was collected totally through shovel-skimming and screening. Composition of the high density zone in the site's northwestern quadrant was sampled by placing a line of 1 x 1 m discretionary surface collection units across it from east to west, proceeding from near the crest of the ridge well down its western slope; a total of 5 collection units was shovel-skimmed and screened. To explore the depth and nature of deposition in the same area, 2 1 by 1 m excavation units were dug, one along the line defined by the surface collection units, the other near the zone's northern extreme.

Similar procedures were applied to 26Ek3171, where three cultural features were sampled. A small, high density core reduction station was collected in its entirety by shovel-skimming and screening. The smaller (6 m diameter) of the two quarry pits occurring at the site was sampled by shovel-skimming and screening units along two transects arrayed on cross axes. In addition, a hand excavated trench along one of the axes exposed the internal structure of the feature. The larger (9 m diameter) quarry pit was bisected by a backhoe trench. Detailed stratigraphic profiles were prepared and samples of all principal stratigraphic components were collected from both trenches.

Additionally, three 1 by 1 m excavation units were placed in non-feature settings in the western portion of the site where soil color and the abundance and diversity of cultural materials suggested that subsurface components were likely to occur.

Chronology

Neither of the Ramadan Ridge sites yielded sufficient charcoal or other remains suitable for direct radiometric assay. Our present chronological perspective is provided solely by the relative dates offered by stylistically time-sensitive artifact classes - projectile points and pottery. These indicators suggest a predominantly late occupation of the site (Table 75).

The projectile point assemblage from 26Ek3170 implies site use largely after ca. A.D. 1300; 3 Desert Series points (2 Desert Side-notched and 1 Cottonwood Triangular) were retrieved from surface and buried contexts. However, a single truncated, edge-ground basal fragment of an obsidian stemmed projectile point at least hints of occupation as early as 8000 B.P. (Elston 1986). Three large point preforms; one in obsidian and two of heat-treated white opalite, could not be classified on the basis

of Thomas's (1981) key. Of these, the obsidian piece is equivocal but provocative; it consists of a robust, colaterally flaked, truncated fragment which may also represent the proximal portion of a stemmed point.

Table 75. Projectile Point Types from Ramadan Ridge Sites.

Site Number	Classifiable Types STM	CTN	DSN	Unclassifiable OOK	TOTAL
Quarry Pit/ Reduction Complex					
26EK3170	1	1	2		4
26Ek3171			1	1	2
Total	1	1	3	1	6

Classifiable Types
STM = Great Basin Stemmed
CTN = Cottonwood Series
DSN = Desert Side-notched

Unclassifiable
OOK = Points out of Thomas (1981) Key

Temporally diagnostic artifacts from 26Ek3171 are exclusively late. Projectile points include a Desert Side-notched and an obsidian lanceolate piece with a concave base. The latter is not classifiable but probably referable to the Cottonwood type of the Desert Series (Hester and Heizer 1979). Both points suggest a post-A.D. 1300 occupation of the site, a chronology supported by the presence of eight sherds of Promontory Grey Ware (Madsen 1977, 1986) recovered from a non-feature context.

Assemblage Composition

As depicted in Table 76, assemblages recovered from 26Ek3170 and -3171 are quite similar, with reduction artifacts and their associated lithic processing tools comprising roughly 80% of the assemblages from both sites. Quarry Bifaces dominate formed artifact counts, representing approximately half of the collection from 26Ek3170 and some 40% of that at 26Ek3171. However, cores are rarely encountered. Small Bifaces are the largest class of tools at 26Ek3170.

Table 76. Intersite Artifact Class Frequency Comparisons, Ramadan Ridge Sites.

ARTIFACT CLASS	Quarry/Reduction/Residential	
	26Ek3170	26Ek3171
Lithic Processing/ Reduction Tools		
Hammerstones	1	7
Scratched Stones	-	1
Other Percussion	5	-
Subtotal (%)	6 (4.2%)	8 (10.8%)
Reduction Artifacts		
Assayed Pieces	-	4
Cores	4	1
Quarry Bifaces	71	30
Preform Bifaces	3	-
Small Bifaces	33	10
Indeterminate Bifaces	1	-
Subtotal (%)	112 (78.3%)	45 (60.8%)
Projectile Points		
Classifiable	4	1
Unclassifiable	-	1
Subtotal (%)	4 (2.8%)	2 (2.7%)
Maintenance and/or Processing Tools		
Scrapers/Spokeshaves	10	6
Perforators/Gravers	1	1
Multipurpose Flakes	3	-
Indeterminate Flakes	5	-
Knives	-	3
Subtotal (%)	19 (13.3%)	10 (13.5%)
Plant Processing		
Manos	1	1
Metates	1	-
Subtotal (%)	2 (1.4%)	1 (1.4%)
Miscellaneous Artifacts		
Stone Pipes	-	-
Ceramic Sherds	-	8
Subtotal (%)	0 (0.0%)	8 (10.8%)
Site Total	143	74

The remaining formed artifacts, between 15% and 26% of each assemblage, represent a diverse array of implements whose functions were presumably ancillary to and supportive of the more narrowly defined toolstone-oriented endeavors. In addition to hunting implied by the occurrence of projectile points, groundstone artifacts recovered from both of the sites suggest at least minimal processing of plant foods as well. Other flaked stone tools include implements bearing a wide variety of working edges and range from simple, minimally modified flakes employed as expedient scrapers and cutters, to highly stylized, carefully executed perforators, end scrapers, and knives. These artifacts are distributed unevenly, primarily in extra-feature contexts, rather than in direct association with toolstone production features.

The Ramadan Sites

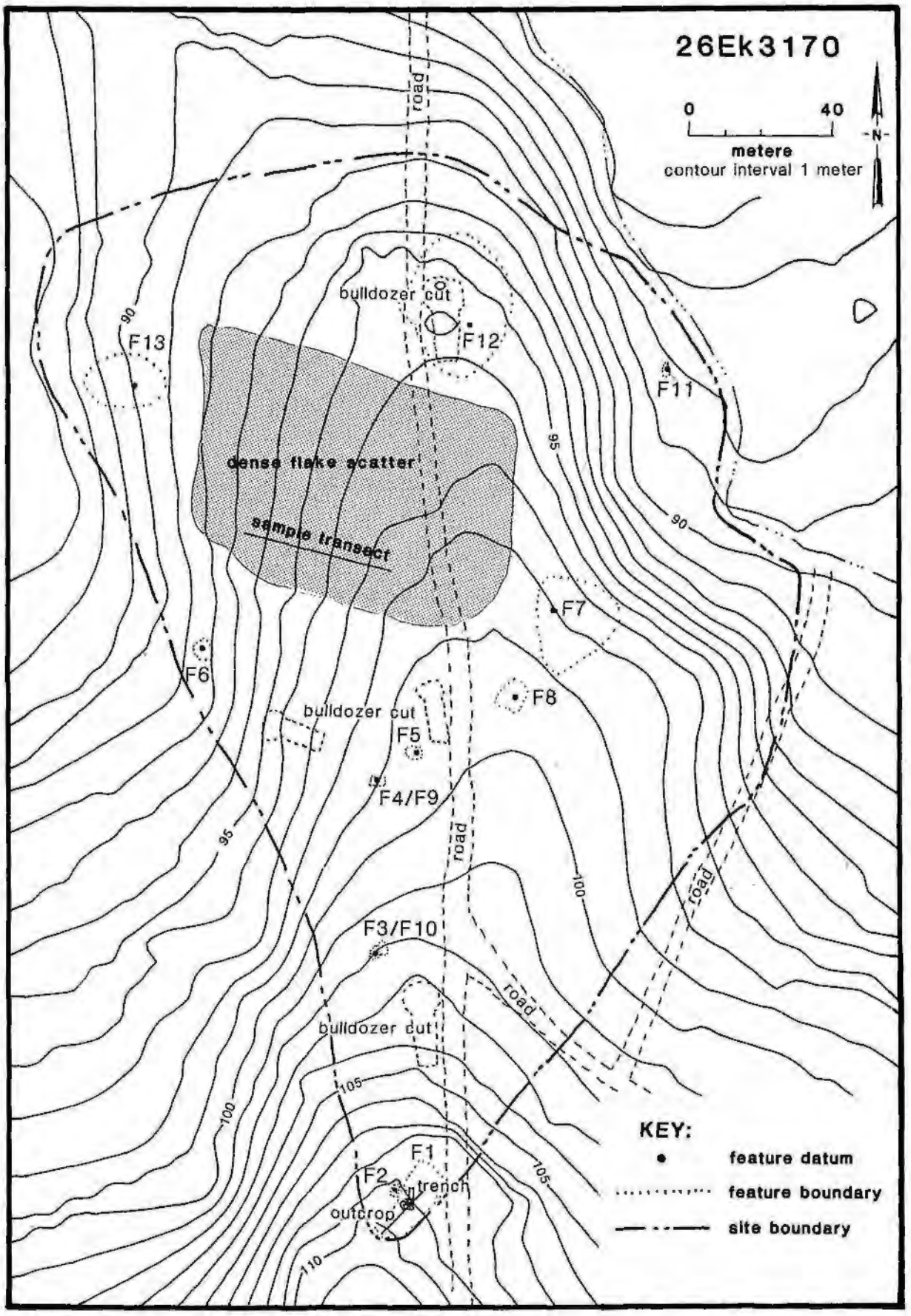
Consideration of the context and structure of the resources occupying the Ramadan Ridge subarea are offered by presentation of testing results on a site-by-site basis. In doing so we rely mostly on descriptions of data obtained from cultural features that were selected as Sample Features and qualitative information gathered in extra-feature site contexts. For the remaining features, where data are largely qualitative and descriptive, our presentations are correspondingly general and more summary in nature.

Site 26Ek3170

Site 26Ek3170 occupies the entire first bench on Ramadan Ridge (Figure 58). If its northern boundary is coterminous with that of the Tosawihi Quarries site (26Ek3032) and is more administrative (for purposes of the National Register) than archaeological. Only a slight undulation in the ridgeline serves to differentiate 26Ek3170 from habitation Locality 27 in the Big Meadows archaeological neighborhood (Elston et al. 1987). As defined by topography and artifact distribution, 26Ek3170 also includes the quarry pit localities 23 and 26 of 26Ek3032 although these fall outside the USX-East study and were not examined during the testing program.

Even after these deletions, the site remains the most extensive in the USX-East project area, covering the ridge between elevations of 5585 to 5660 ft. amsl (Figure 58). Over this expanse are scattered 13 discrete cultural features (12 reduction stations and a quarry pit), as well as a large zone in the site's northwestern quadrant marked by a nearly continuous, moderate density scatter of debitage and artifacts (shaded on Figure 58).

Figure 58. 26Ek3170, site map.


26Ek3170
0
40
metere
contour interval 1 meter
-N-
road
bulldozer cut
F12
F13
F11
dense flake scatter
sample transect
F7
F6
F8
bulldozer cut
F5
F4/F9
road
road
road
F3/F10
bulldozer cut
F1
F2
trench
outcrop
90
95
100
105
110
KEY:
feature datum
feature boundary
site boundary

Although largely intact, the site has suffered historic disturbance in that two major dirt roads meet south of its center, one of which bisects the site. The intersection has served recently for heavy equipment deployment. During the winter of 1987-1988 large vehicles apparently became mired, and their consequent extrication virtually obliterated ca. 1000 m^2 of the site surface. Additionally, several older bladed scrapes occur throughout the site, one of them directly intruding a cluster of reduction stations (Feature 12).

The thirteen cultural features that occur on site 26Ek3170 include a single quarry pit and a dozen reduction stations; their sizes and the types of formed artifacts recovered from them are summarized in Table 77.

Table 77. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3170.

Fea No.	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction HM	OP	CR	QB	SB	PB	IB	Points PT	Processing SC	PG	MP	OT	GS	Total
1*	Quarry Pit/ Core Reduction	145	-	-	1	5	-	-	-	-	1	-	-	-	-	7
2	Biface Reduction	75	-	-	-	2	-	-	-	-	-	-	-	1	-	3
3	Biface Reduction	13	-	-	-	1	-	-	-	-	-	-	-	-	-	1
4	Core & Biface Reduction	63	-	-	-	-	-	-	-	-	-	-	1	-	-	1
5	Biface Reduction	50	-	-	-	4	2	-	-	-	-	-	1	-	-	7
6	Biface Reduction	44	-	-	-	4	-	-	-	-	-	-	-	-	-	4
7	Core & Biface Reduction	560	-	-	1	9	1	-	-	-	-	-	-	1	-	12
8	Biface Reduction	79	-	-	-	1	2	-	-	-	-	-	-	-	-	3
9*	Biface Reduction	6	-	-	-	2	-	-	-	-	-	-	-	-	-	2
10	Core & Biface Reduction	71	-	-	-	2	-	-	-	-	-	-	-	2	-	4
11	Biface Reduction	5	-	-	-	1	-	-	-	-	-	-	-	-	-	1
12	Biface Reduction	1420	-	-	-	9	2	-	-	-	-	-	-	-	-	11
13	Biface Reduction	189				7					1					8
-	Extra-Feature	N/A	1	5	2	24	26	3	1	4	8	1	1	1	2	79

* Sample Feature

Key to Artifact Class:

Reduction Tools and Artifacts
HM = Hammerstones
OP = Other Percussion
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces
IB = Indeter. Biface Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Other
GS = Groundstone

Projectile Points
PT = Classifiable Points

Located at the southern extreme of the site, quarry pit Feature 1 was manifest on the surface as a small shallow depression ca. 3 m long, adjacent to the downhill side of a low, linear, dike-like outcrop of opalite; the outcrop, some 3 m long and 0.5 m wide, runs perpendicular to the axis of the slope (Figure 59). Our discontinuous collection across the feature returned 1247 cultural items, of which 980 are opalite flakes and 261 are pieces of opalite shatter. From this sample, as well as from other surface contexts, the feature yielded five Quarry Bifaces, a core, and one flake scraper, all of opalite. The sample shows that density and average weight of debitage are greatest upslope of the pit, which apparently constitutes the principal reduction workshop of the feature. In this zone flakes are significantly larger (6.26 to 14.35 gm) than in the downslope scatter (3.96 to 4.9 gm), suggesting that either colluvial processes account for the uneven distribution of flake sizes or, alternatively, that different stages of toolstone processing occurred in the two locations.

A backhoe trench perpendicular to the outcrop, extending 3 m upslope and 5 m downslope, reveals the feature in profile (Figure 60). Upslope of the outcrop, 20 cm of colluvial soil overlies weathered red tuff. Downslope, the berm of the quarry pit comprised of soil and opalite quarry waste, overlies 30 cm of weathered tuff, which in turn overlies toolstone quality opalite. The opalite outcrop protrudes through the tuff, but rises only some 10 to 20 cm above the ground surface; the face of the outcrop is steepest on the downslope side. These relationships suggest that the opalite dike is actually a layer of opalite between two layers of tuff, all three of which have been tilted toward the vertical and planed off by erosion. The shallow, trench-like quarry pit, about 1.5 m wide and 30 cm deep, was excavated along the downslope face of the outcrop. The berm of soil and quarry waste parallels the pit on its downslope side, but contains few flakes, chunks, and cores compared to other such features tested at other sites in the project area. The small size of the pit and the relatively small amounts of quarry waste in its berm suggest that the toolstone source was not intensively developed.

As is the case at all other sites in the project area, the twelve features labeled "reduction stations" at 26Ek3170 occur as localized concentrations of debitage, visually distinct from the background artifact scatter that blankets the sites. Cultural features are distributed throughout the site, positioned with a preference for flatter slopes. Most features are located off the main axis of the ridge line, but any features in this position would have been destroyed by the road. Feature inventories suggest that they are composed predominantly of opalite waste flakes and angular shatter created during the processing of toolstone, and that all save one (Feature 4) include fragments of Quarry Bifaces; these presumably were produced, broken, and subsequently discarded at the features

Figure 59. Plan of Feature 1, site 26Ek3170.

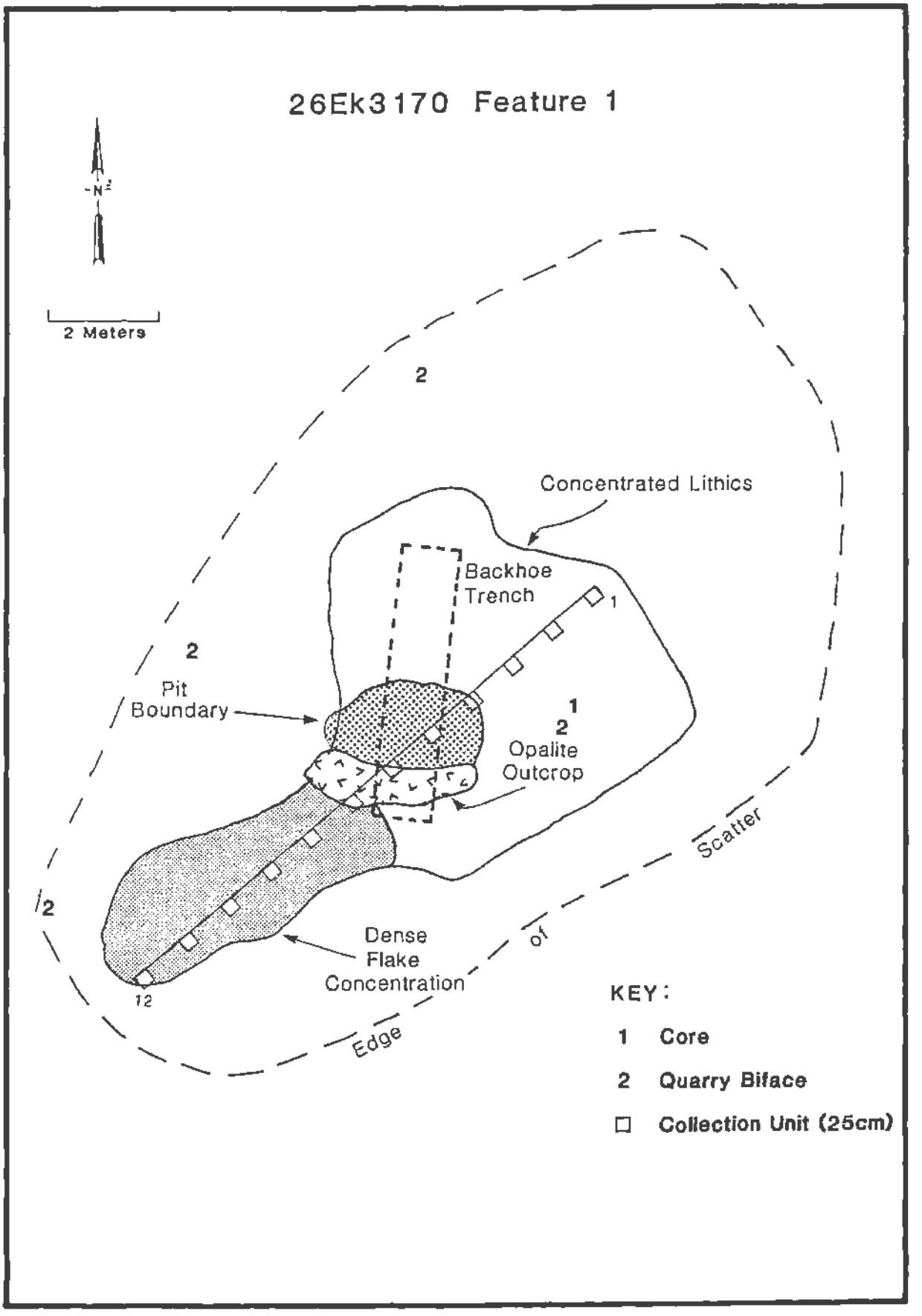
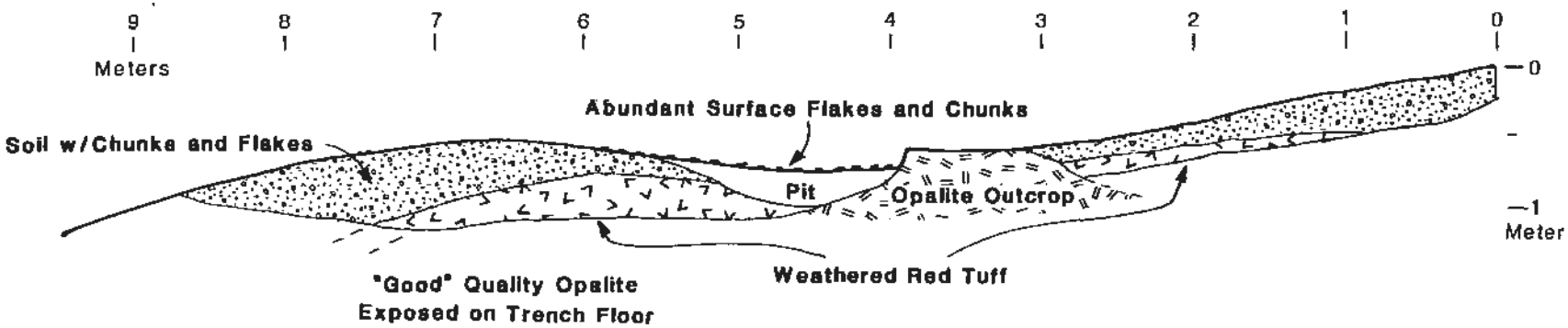
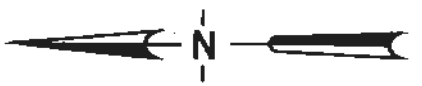

26Ek3170 Feature 1
N
2 Meters
2
Concentrated Lithics
Backhoe
Trench
1
2
Pit
Boundary
1
2
Opalite
Outcrop
2
Dense
Flake
Concentration
12
Edge
of
Scatter
KEY:
1 Core
2 Quarry Biface
Collection Unit (25cm)

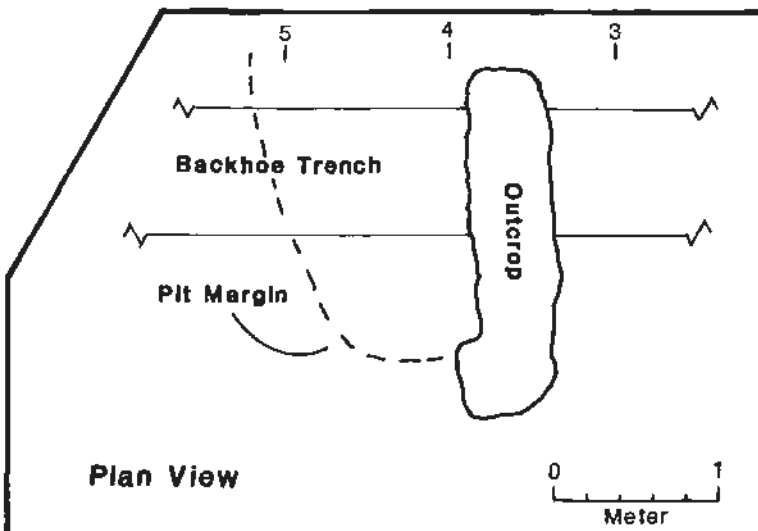
Figure 60. 26Ek3170, Feature 1, Trench 1, east wall profile.

26Ek3170

Schematic Profile East Wall, Trench 1







during the reduction process. Augmenting the preponderance of opalite debris, almost half of the features include obsidian debitage in their inventories (Features 3, 4, 7-10), and most (n=7) contain small flake tools such as scrapers, not directly attributable to toolstone processing tasks. Overall sizes and the number of lithic concentrations defining the features vary widely, from diminutive Feature 11 (5 m^2) with one concentration to mammoth Feature 12 whose four concentrations of reduction debris and intervening moderate density scatter encompasses some 4400 m^2. We observe that features located in the southern half (upslope) of the site tend to be smaller and more clearly defined than those in the north, where, perhaps owing to the higher density of the background lithic scatter, we were less able to differentiate feature boundaries confidently from the abundant background debris.

The origins of reduction features and the degree to which post-depositional factors color our perception of them remains obscure at 26Ek3170 and at all other sites in the project area. Obviously, they were affected by colluvial processes and bioturbation, although the magnitude and direction of these actions is unknown. In all cases, debitage concentrations are elongated ellipses in plan view, their long axes parallel to the direction of slope, with most abundant accumulations of affiliated debris occurring contiguous and immediately downslope of the concentrations. At several locations, particularly Feature 11, the two dense concentrations of cultural materials which define the feature occur coincident with a pair of rodent backdirt piles. Lithic concentrations (e.g. Feature 7 and 13) occurring within dense stands of tall sagebrush may suggest that the shelter afforded in such contexts enticed toolstone processors to locate there. Given, however, that copses of tall sage co-occur with the deepest soil accumulations, they may instead indicate contexts most conducive to intensive rodent burrowing likely to bring materials to the surface. In addition, stands of sagebrush may serve merely to impend the colluvial transport of surface artifacts which over time accrete to become discernible as concentrations.

Quarry Pit Feature 9

The total collection of cultural materials from the upper 2 cm of Feature 9 supported our initial field observation that this 3 by 2.5 m concentration of artifacts had functioned as a biface reduction station. Debitage density was high, ca. 378 items per m^2, composed of 2674 opalite flakes and 162 fragments of opalite shatter. Two Stage II Quarry Bifaces of opalite accompany the debris, and these, corroborated by the relatively high mean weight of individual waste flakes indicate that initial phases of biface manufacture created the scatter. Although no tools were recovered, non-opalite debitage occurs in the feature as well. Three obsidian flakes hint at more than

exclusively quarry related activities, as does the occurrence of 13 flakes of rhyolite and a single flake of basalt. These last two material types, however, commonly are employed for percussion tools throughout the project area and may instead represent the attrition of hammerstones used in biface reduction. Opalite composing the debitage and bifaces appears to consist of material from a common source and, on the basis of visual inspection, is of the same color and texture as that occurring at the quarry pit of Feature 1 located some 100 m upslope.

The northwestern quadrant of the site (shaded area in Figure 58), with a dense debitage scatter and a high incidence of apparently isolated artifacts, proved difficult to assess since its structure was reflected by subtle differences in surface artifact density over a large area. A line of 5 1 by 1 meter shovel scrapes along the sample transect (Figure 58) was placed to help quantify variation in this area. Recovery rates obtained are summarized in Table 78.

Table 78. Debitage Recovered from Discretionary Surface Collections, Site 26Ek3170.

	OPALITE DEBITAGE				OTHER DEBITAGE			
Unit	Flakes		Shatter		Flakes		Shatter	
Number	(n)	(Av Wt [g])	(n)	(Av Wt [g])	(n)	(Av Wt [g])	(n)	(Av Wt)
1	46	3.10	4	0.45	2	6.50	-	-
2	119	2.13	28	1.27	2	0.20	-	-
3	1158	1.56	44	2.05	3	2.30	-	-
4	62	1.79	12	1.58	-	-	-	-
5	50	3.33	13	3.77	1	0.80	-	-

Table 78 merits note in two particulars. First, the absolute flake density peaks strongly toward the center of the area, in concert with flakes of the smallest mean size (1.56g). Second, the ratio of flakes to shatter also reaches its highest peak (26.3:1) at this point. This suggests that, generally, later stage reduction was occurring in the center of the area, with earlier stage reduction carried on along the peripheries. Noteworthy, too, is the great color diversity of opalite recovered from all of the collection units suggesting that the zone consists of a palimpsest of numerous reduction episodes, often involving material from different off-site sources.

Because of the abundance and diversity of surface materials occurring in this northwestern quadrant, as well as to the apparent possibility of depth in the silty deposits, two 1 by 1 m excavation units were placed to test the vertical distribution of artifacts. One (Excavation Unit 1) was coincident with Discretionary Surface Collection Unit 1; the other explored an expanse to the north.

The two units exposed basically similar profiles, of which the west wall of Unit 2 is given as example (Figure 61). An upper, humic layer of loose sandy silt, high in organics, occupies the upper 3 to 6 cm. It is underlain by 15 to 20 cm of somewhat bioturbated silt loam, and contains occasional angular to sub-rounded cobbles of rhyolite, tuff, and opalite. This stratum grades to a clayey silt at 20 to 30 cm below the surface; both units were terminated at 40 cm, where increasing proportions of rhyolite tuff clasts rendered further excavation fruitless. Recovered cultural materials are presented in Table 79.

Table 79. Artifact Collections from Excavation Units 1 and 2, Site 26Ek3170.

	ARTIFACT CLASSES											
			Reduction			Points	Processing		Opalite Debitage		Other Debitage	
	HM	AP	QB	SB	PB	PT	SC	GS	F	S	F	S
Excavation Unit 1	-	-	-	-	1	3	2	-	1949	202	424	-
Excavation Unit 2	1	1	3	1	-	-	-	1	890	271	21	-

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
AP = Assayed Pieces
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces

Projectile Points
PT = Classifiable Points

Maintenance/Processing
SC = Scrapers
GS = Groundstone (metate)

Debitage
F = Flakes
S = Shatter

While in Unit 1 about 90% of the cultural items were recovered in the upper 20 cm of the deposit, over 40% from Unit 2 came from levels 20 to 40 cm below surface. In both units opalite waste flakes dominate the assemblage, but like surface contexts in the same area, a diverse variety of stone tools occurs as well, including three of the four classifiable projectile points, and a metate.

The second bench of Ramadan Ridge is occupied by 26Ek3171 (Figure 62). Like 26Ek3170, lying some 100 m downslope to the north, the site juxtaposes functionally distinct activity areas; two quarry pits and a cobble quarry lie interspersed with reduction stations and a large indistinct zone scattered with abundant and diverse materials.

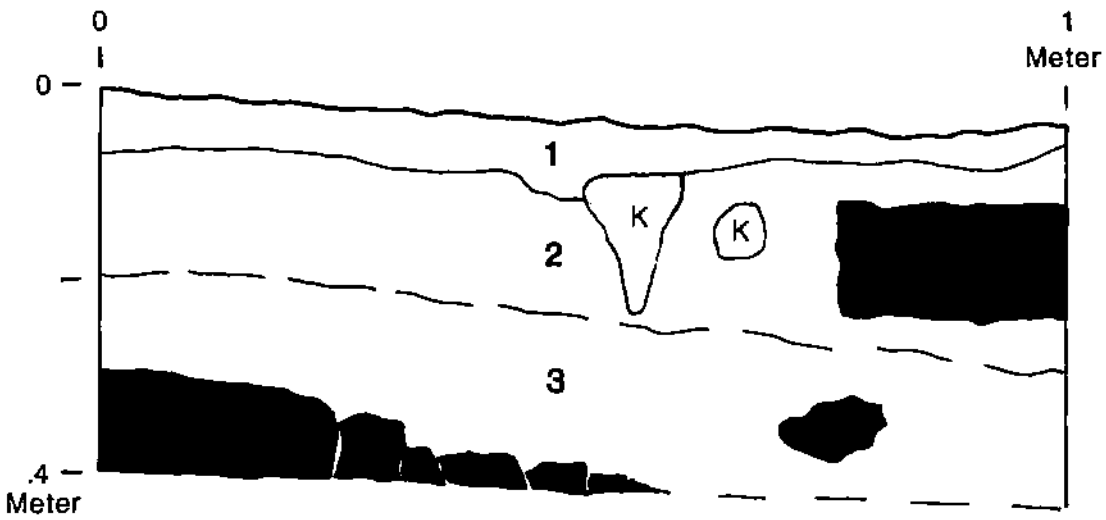
Eight cultural features occur on the relatively flat surface of the bench, with which the boundaries of the site are coterminous. Various of these features have been compromised by historic and modern mining activities; a bladed road runs along the ridge crest from north to south, and several bladed scrapes

Figure 61. 26Ek3170, excavation unit 2, west wall profile.

1. Fine sandy silt with organics (root zone). 10YR 6/2.
2. Silt loam with fine to coarse sand. 10YR 5/2.
3. Clayey silt. 10YR 4/3.

26Ek3170

WEST WALL, UNIT 2

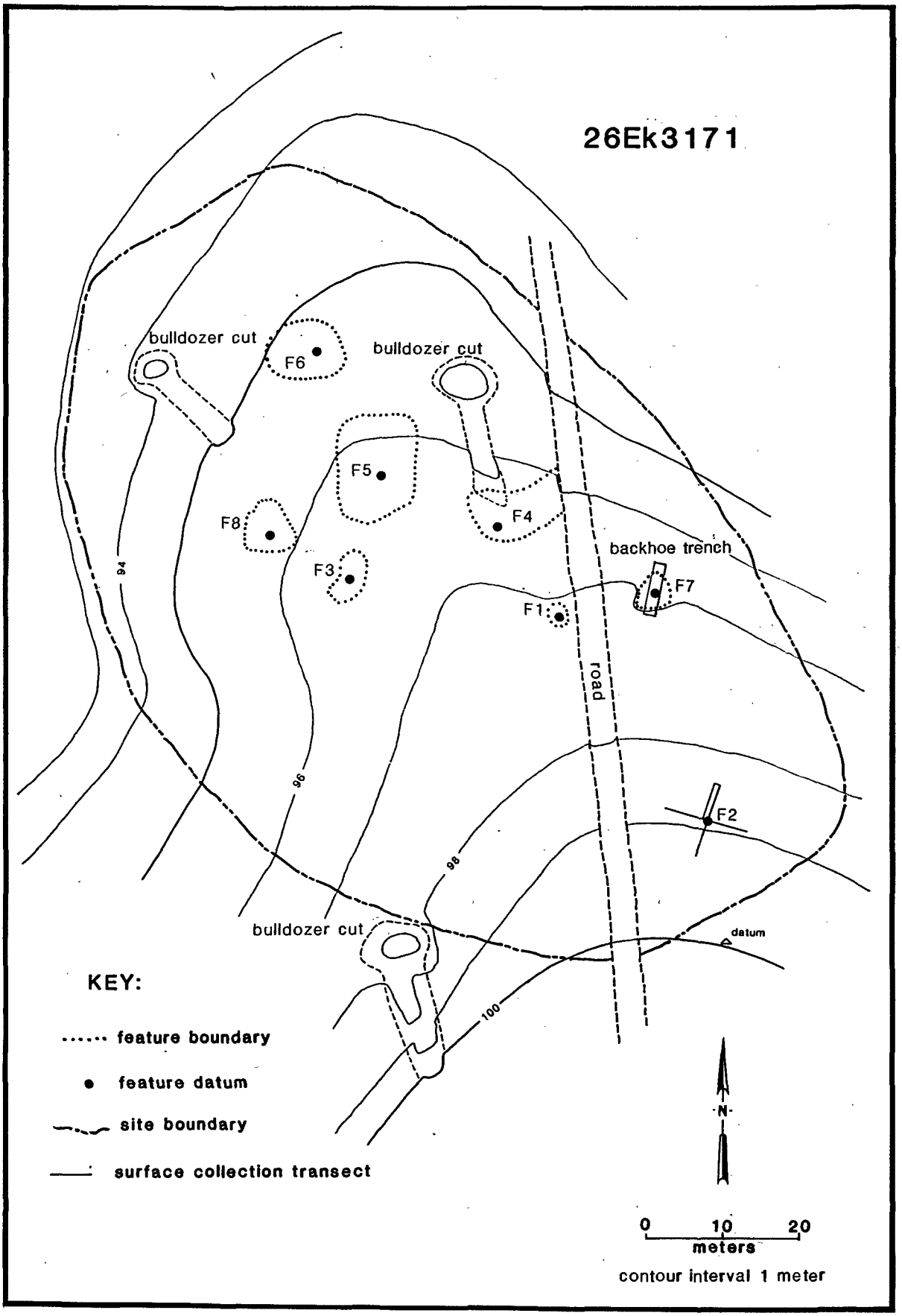


KEY:

K **krotovina**

rock

Figure 62. 26Ek3171, site map.


26Ek3171
bulldozer cut
F6
bulldozer cut
F5
F8
F4
F3
backhoe trench
F7
F1
road
94
96
98
100
F2
bulldozer cut
datum
KEY:
feature boundary
feature datum
site boundary
surface collection transect
N
0
10
20
meters
contour interval 1 meter

occur within the site precinct. The cobble quarry of Feature 4 has been intruded by one such scrape. And, Feature 7, a quarry pit, served as the station of a recent exploratory drilling operation, with the consequence that its surface sustained major impact. Its interior was penetrated by the drill hole, and its contents infused with drilling fluids. In addition to surface disturbance, a scatter of refuse testifies to several decades of intermittent 20th century use, some of it likely related to a small mineshaft that lies just upslope to the south of the site.

26Ek3171

From the vista provided by comparison of the relative frequencies of artifact types and the diversity of prehistoric behaviors implied by them, 26Ek3171 appears to have hosted activities roughly identical to those evidenced at 26Ek3170, but in microcosm (Table 80; cf. Table 76). However, owing perhaps to the comparatively greater abundance of opalite source material offered at 26Ek3171 by two quarry pits (Features 2 and 7; Figure 62) and an extensive cobble field (Feature 4), toolstone manipulation here appears to have included relatively greater emphasis on the most incipient steps in the processing of the stone.

Table 80. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3171.

Fea		Total Area	ARTIFACT CLASSES												
			Reduction						Points			Processing			
No.	Type	(sq m)	HM	SS	AS	QB	SB	PT	FG	SC	KN	PG	GS	CS	Total
1*	Core Reduction	189	3	3	1	-	8	-	-	-	-	-	-	-	13
2*	Quarry Pit/Core Reduction	140	2	-	2	3	-	-	-	1	-	-	-	-	8
3	Core Reduction	16	-	-	-	-	1	-	-	-	-	-	-	-	1
4	Cobble Quarry/ Core Reduction	227	-	-	-	3	1	-	1	2	-	1	-	-	8
5	Biface Reduction	177	-	-	-	3	3	1	-	-	-	-	-	-	7
6	Biface Reduction	63	-	-	-	1	-	-	-	2	-	-	-	-	3
7	Quarry Pit/Biface Reduction	55	2	-	-	6	-	-	-	-	-	-	-	-	8
8	Biface Reduction	28	-	-	-	2	-	-	-	-	-	-	-	-	2
-	Extra- Feature	N/A	-	1	2	4	4	-	-	1	3	-	1	8	21

* Sample Feature

Key to Artifact Class

Reduction Tools and Artifacts
HM = Hammerstones
SS = Scratched Stone
AS = Assayed Piece
QB = Quarry Trajectory Biface
SB = Small Trajectory Biface

Maintenance/Processing
SC = Scrapers and Spokeshaves
KN = Knives
PG = Perforators and Gravers
GS = Groundstone
CS = Ceramic Sherd

Projectile Points
PT = Classifiable Point
FG = Unclassifiable/Fragment

Inventory suggests that fully one half of the eight features recorded at the site (Features 1-4) contain debitage assemblages comprised chiefly of massive angular shatter and large primary flakes indicative of quarrying, and the preliminary transformation of these pieces into minimally reduced Quarry Bifaces. Although comparable in overall size to features at 26Ek3170, those at 26Ek3171 appear to be somewhat less densely littered with cultural debris and are composed of fewer discernible concentrations of artifacts. Only Features 4 and 7 evidence multiple debitage concentrations (n=3 and 2, respectively); the remaining features are defined by only a single lithic cluster each. Like its neighbor on the north, the majority of features at 26Ek3171 also include tools customarily associated with maintenance and processing rather than toolstone procurement. Among these features, Feature 4 is noteworthy for the number and variety of such tools, and Feature 5 for a Desert Side-notched projectile point. A high incidence of such non-quarrying and reduction tools also occurs outside feature boundaries.

Feature 1

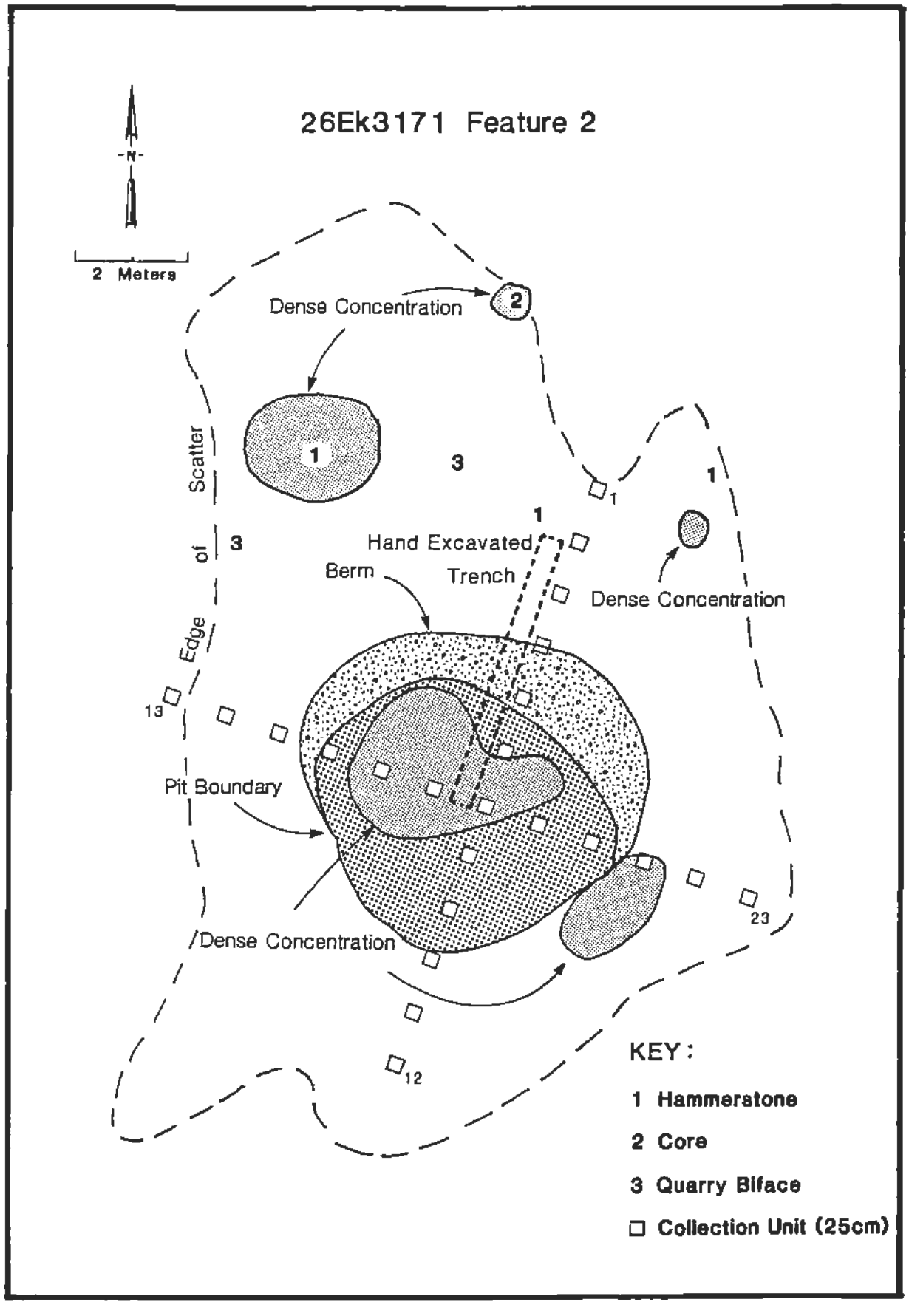
The single lithic scatter tested, a small (ca. 2 m diameter), circular concentration of reduction debris, yielded a sample of 2703 cultural items, of which 1874 are opalite flakes and 794 are pieces of opalite shatter. The mean weight of flakes in the assemblage (10.46 gm) is sufficiently robust to support the field assessment that the feature represents an early stage reduction station, a conclusion enhanced further by the incidence of 6 Stage 2 Quarry bifaces, a pair of Stage 3 Quarry Bifaces, and a single core. The small area of the feature and relative uniformity of material suggest that it resulted from a single reduction episode.

Feature 2

The surface of Feature 2, the smaller (6 m diameter) of the quarry pits at the site, yielded few artifacts (2 Stage 2 and 1 Stage 4 Quarry Biface, and a pair each of hammerstones and assayed pieces). Collection units arrayed along intersecting baselines recovered 1440 cultural items, composed of 582 opalite flakes and 838 pieces of opalite shatter. The abundance of flakes climbs gradually as each line crosses the pit berm from the exterior, and declines somewhat in the interior of the pit. This suggests either that the berm was the area in which primary reduction was concentrated, or that previously accumulated debitage was thrown out of the pit during the course of further excavation (Figure 63).

The pit contains a large (40 by 60 by 37 cm) subrounded, battered opalite boulder exposed near its center. This boulder

Figure 63. Plan of Feature 2, site 26Ek3171.


26Ek3171 Feature 2
-N-
2 Meters
Dense Concentration
2
1
3
Scatter
of
3
Edge
1
Hand Excavated
Trench
Berm
Dense Concentration
1
1
13
Pit Boundary
Dense Concentration
23
12
KEY:
1 Hammerstone
2 Core
3 Quarry Biface
Collection Unit (25cm)

is similar to boulders in the bottom of Little Antelope Creek, but the feature lies ca. 25 meters above the creek. Such boulders are common in the study area, relicts of Pliocene/Pleistocene Little Antelope Creek (Mark Bartlett, Touchstone Resources Company, personal communication 1988).

The shallow (70 cm deep) trench, hand excavated from the center of the feature through its northern (downslope) berm is offered in profile by Figure 64. In the center of the pit, the upper layers are a 1 cm lag deposit of opalite flakes and angular chunks of tuff overlying 2-3 cm of black (10YR 2/1), duff-like organic material comprised of partially decomposed vegetation and charcoal, the latter presumably derived from recent range fires.

Below the duff is 40 to 50 cm of dark brown (10YR 3/3) cobbly, gravelly silt loam, with abundant large clasts of tuff and opalite. Opalite toolstone is more abundant than tuff in the upper 20 cm of this deposit, while equal amounts of these materials occur in the lower portion.

Below ca. 50 cm from the surface lies a dark reddish brown (5YR 3/4) gravelly, cobbly, sandy clay. Tuff is mostly absent, and the opalite clasts seem less dense - either they are more highly weathered or they are poorly silicified. This material is probably not a cultural deposit; perhaps it is the undisturbed B horizon above the bedrock.

Interpretation of the stratigraphic record at this feature is difficult because the deposits were not very well observed in the shallow trench. We assume that the upper 50 cm of the sediment in the pit was derived from toolstone extraction and processing, but these deposits seem to lack the internal stratification marking sequent quarrying episodes observed elsewhere.

Feature 7

Feature 7 is a large, open quarry pit over 6 m in diameter and at least 80 cm deep, surrounded by a berm of opalite cores and flakes on the down-slope side, particularly dense in the northwest quadrant of the feature. A backhoe trench was cut through Feature 7 along its north-south axis (Figure 65).

The ground slopes down to the north in the vicinity of the feature. A shallow (20 to 30 cm) mantle of colluvial soil overlies tuff bedrock. The upper 10 to 30 cm of bedrock is highly weathered and fractured into angular blocks, 10 to 20 cm in diameter; orange clay (probably a weathering product of the tuff) fills the cracks between blocks. Below the weathered zone, the bedrock is solid and, in places, more silicified. Feature 7 was apparently excavated through the weathered bedrock into an underlying pocket of silicified tuff or opalite.

Figure 64. 26Ek3171, Feature 2, north and south wall profiles.

1. Organic duff. 10YR 2/1.
2. Brown gravelly silt loam with opalite cobbles. 10YR 3/2.
3. Brown silt loam, increasingly plastic, with opalite and tuff cobbles. 7.5YR 3/2.
4. Gravelly, sandy clay. 5YR 3/4.

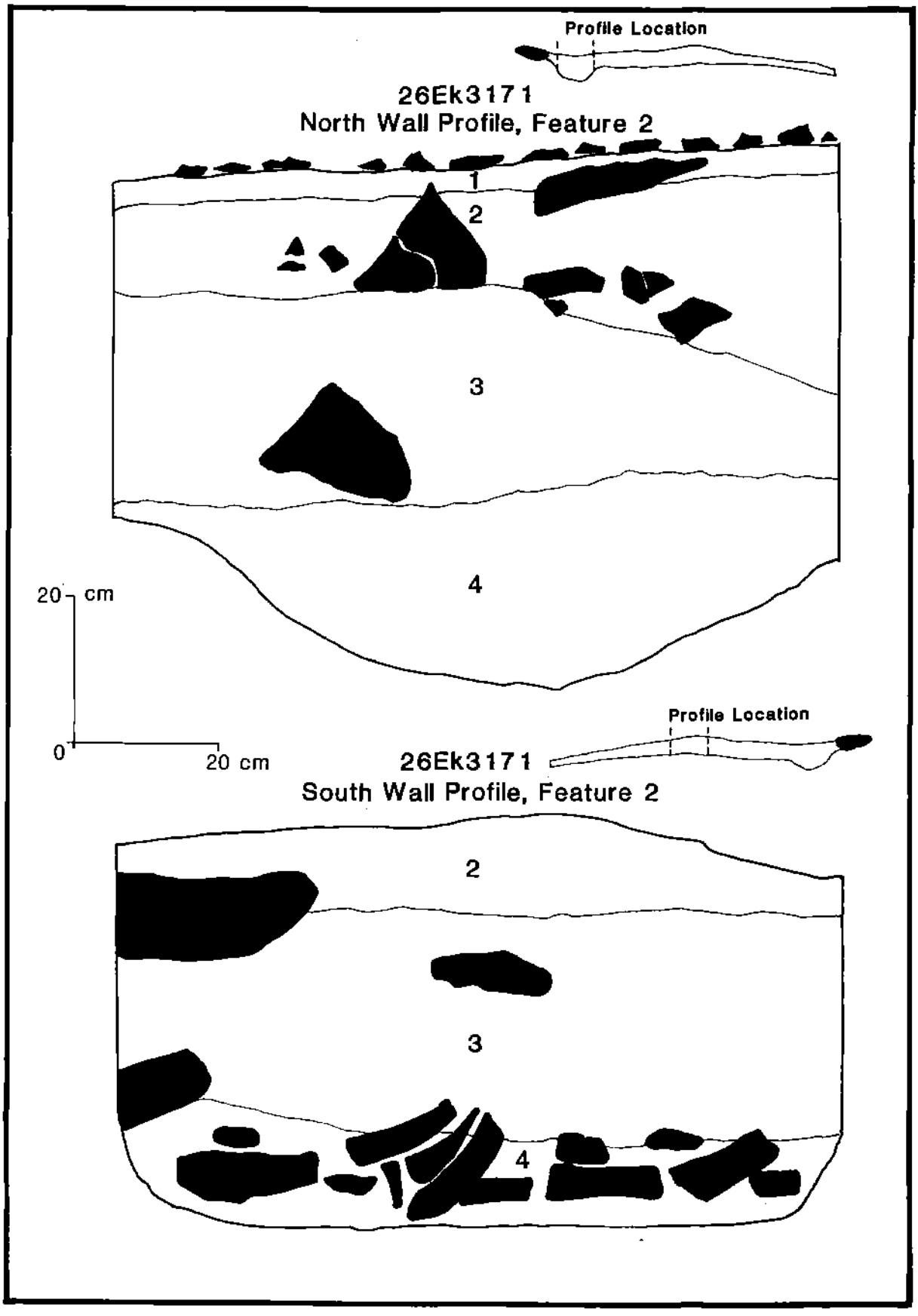
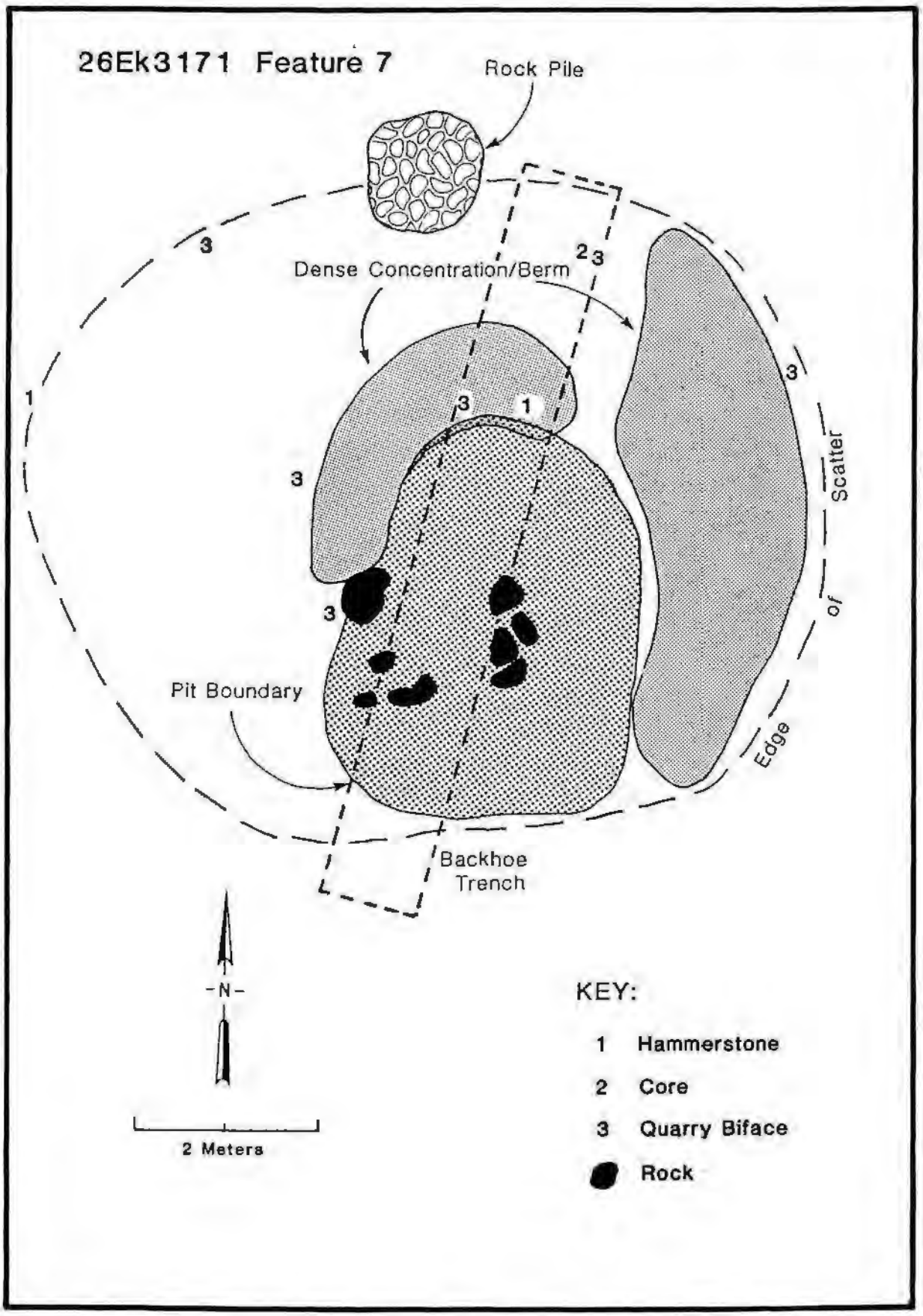

Profile Location
26Ek3171
North Wall Profile, Feature 2
1
2
3
4
20 cm
0
20 cm
Profile Location
26Ek3171
South Wall Profile, Feature 2
2
3
4

Figure 65. Plan of Feature 7, site 26Ek3171.


26Ek3171 Feature 7
Rock Pile
Dense Concentration/Berm
Pit Boundary
Backhoe Trench
Edge of Scatter
-N-
2 Meters
KEY:
1 Hammerstone
2 Core
3 Quarry Biface
Rock

The stratigraphic record at Feature 7 is complex and not easily deciphered (Figure 66). Rather than being continuous across the profile, or obviously truncated by later excavations, the strata are intercalated lenses, seldom more than 2 m in length. While there are trends in their relationships, it is not possible at this point to discern obvious stratigraphic horizons that relate to different periods of quarry use. There do, however, seem to be only a few basic types of sediment. While strata are numbered, it was not possible for the numerical order to reflect completely vertical position in the stratigraphic column.

The trench profile suggests that Feature 7 was not created during a single episode of quarrying, but gradually assumed its present size and configuration over time, beginning downslope and working mostly upslope to the south. In other words, the pit was backfilled more or less continually on the north side as excavation proceeded southward. This means that some of the pit fill is topsoil overburden, some is quarry waste, some is processing debris, and some is slopewash.

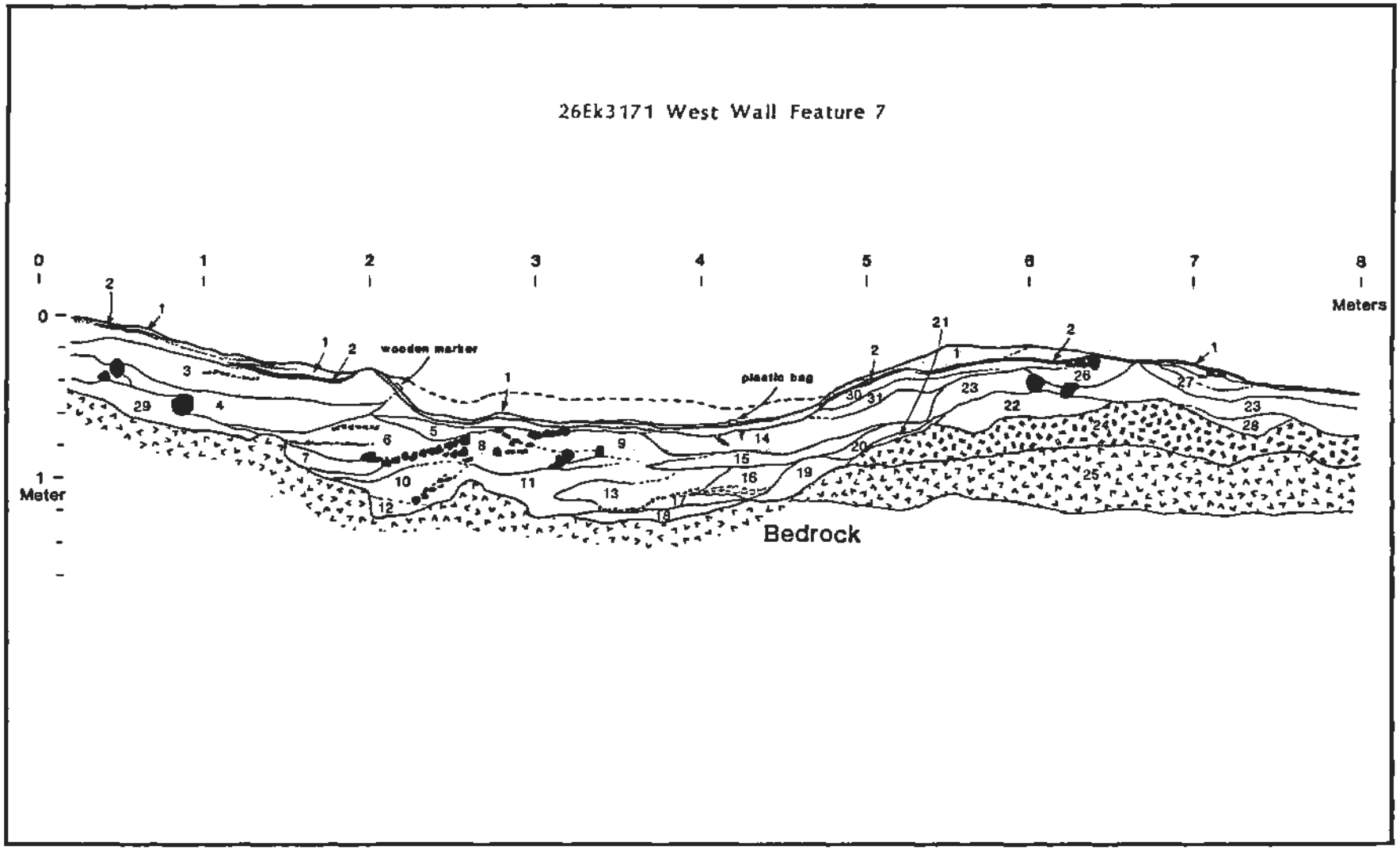
Several units contain small flecks of charcoal. Since we have not recognized burned rock in this feature, we assume that the charcoal has accumulated in the pit layers through natural means after the occurrence of local brush fires.

Perhaps the entire pre-quarry pit soil profile is preserved beneath the berm on the north side of the pit. Here one can see silicified bedrock (Unit 25) overlain by weathered bedrock (Unit 24), overlain by strong brown (7.5YR 4/6) cobbly clay loam (Unit 22), overlain by dark brown (10YR 3/3) silt loam (Unit 23). The upper two units in this sequence suggest in situ A and B horizons, respectively. Unit 3 on the south side of the feature is probably equivalent to Unit 23. The upper 5 to 10 cm of Unit 3 has platy structure common to A horizons observed elsewhere in the study area.

Unit 2 is a layer of charcoal-rich soil about 1 cm thick. Unit 2 directly overlies Unit 3 on the southern margin of the feature, and is at the undisturbed surface on the outside slope of the northern berm. Burned sagebrush stumps and roots are embedded in or extend somewhat above Unit 2, which seems to mark the last large brush fire in the project area during the summer of 1986 (S. Jaynes, personal communication).

There are two types of strata probably representing sediments accumulated as slope wash in the bottom of the pit during intervals when it was not in active use. One type is brown clay loam with varying amounts of opalite and tuff clasts. The origin of fines in such units is probably the clay in the weathered bedrock and the overlying B horizon exposed by the quarrying operations. For instance, Unit 18 in the pit bottom, resting on an excavated bedrock surface (between 3.2 and 4.3 m)

Figure 66. 26Ek3171, Feature 7, west wall profile (stratigraphic units are described in text).


26Ek3171 West Wall Feature 7
0
1
2
3
4
5
6
7
8
Meters
0
1 Meter
wooden marker
plastic bag
Bedrock

is comprised of fine opalite chips and angular fragments in a matrix of brown (10YR 4/3) clay and silt. Similar deposits are Unit 12 and the southern portion of Unit 8. Units with more clay and fewer opalite or tuff clasts are Units 7, 10, 11, 13, and 19.

Another type of slopewash accumulation is represented by dark brown (10YR 3/3) silt loam that closely resembles the undisturbed upper soil horizon. Units 3, 15, 20, and 21 represent this type of deposit.

Layers with large, angular chunks of opalite and tuff, in combination with flakes and cores, are probably quarry waste and processing debris. Such layers are often openwork with little or no finer matrix; clasts in such layers are often fist-sized and larger. As pit fill, such deposits include Units 5, 8, 14, and 16, while Unit 28 is similar material deposited on the outside of the northern pit berm. Unit 20 is comprised mostly of flakes and probably represents only processing debris.

Units 4 and 6 may also represent a mixture of slopewash and debris accumulations; they are redder, and contain more sand and more flakes than the slopewash units previously described.

Feature 7 has suffered recent disturbance, apparently from drilling. A rectangular pit 3 m long, 2 m wide, and 20 cm deep was excavated in its center. The recent pit cut into prehistoric deposits of quarry waste and opalite processing debris. This material was thrown out as backdirt onto the downslope (northern) berm of the prehistoric feature. The high surface density of debitage in the northwest quadrant of the feature is mostly an artifact of the recent pit excavation.

Gray drilling mud and a red slurry apparently comprised of drilling mud and drill cuttings forms a layer in the bottom of the recent pit and lenses at the surface on the pit margins. Slurry is also found in the interstices of prehistoric strata filling the quarry pit, particularly in the layers of coarse openwork quarry debris (Units 14 and 16) on the north side. The slurry either has trickled down into the lower strata from the bottom of the recent pit, or it has moved laterally from the drill hole.

In summary, Feature 7 is a large quarry feature excavated in several episodes through the colluvial soil and weathered bedrock, into a deposit of silicified tuff or opalite toolstone. The quarry pit is filled with a few basic types of sediment either produced by active quarrying and toolstone processing or passive accumulation of material through natural processes of deposition. Dates of quarrying episodes may be obtained from charcoal observed in some strata.

Excavation Units

Three excavation units in non-feature contexts in the western and northwestern portions of the site disclosed that cultural deposits extend to a depth of 40 to 50 cm over a relatively large area. The broad, moderately flat surface of the ridge is devoid of natural exposures of opalite, but appears to have constituted the "workshop" zone in which toolstone extracted from Features 2 and 7 was further reduced (Table 81). Additional to the distinct cultural features, most of the western and northwestern portions of the site are littered with a light to moderate density scatter of debitage exhibiting considerable variety in color and texture. Surficial evidence suggests that the soft silt loams supporting the scatter have undergone significant churning by rodents, perhaps resulting in the dispersal and burial of discrete feature components; our excavation units were placed to test the internal constituency of the deposit.

Table 81. Artifact Collections from Excavation Units 1-3, Site 26Ek3171.

	ARTIFACT CLASSES								
	Reduction			Processing		Opalite Debitage		Other Debitage	
	AP	QB	SB	SC	GS	F	S	F	S
Excavation Unit 1	1	-	-	-	-	138	100	-	-
Excavation Unit 2	2	1	1	1	1	278	95	1	-
Excavation Unit 3	-	-	-	1	-	179	146	1	-

Key to Artifact Classes

Reduction Tools and Artifacts	Maintenance/Processing	Debitage
AP = Assayed Pieces	SC = Scrapers	F = Flakes
QB = Quarry Trajectory Bifaces	GS = Groundstone (mano)	S = Shatter
SB = Small Trajectory Bifaces		

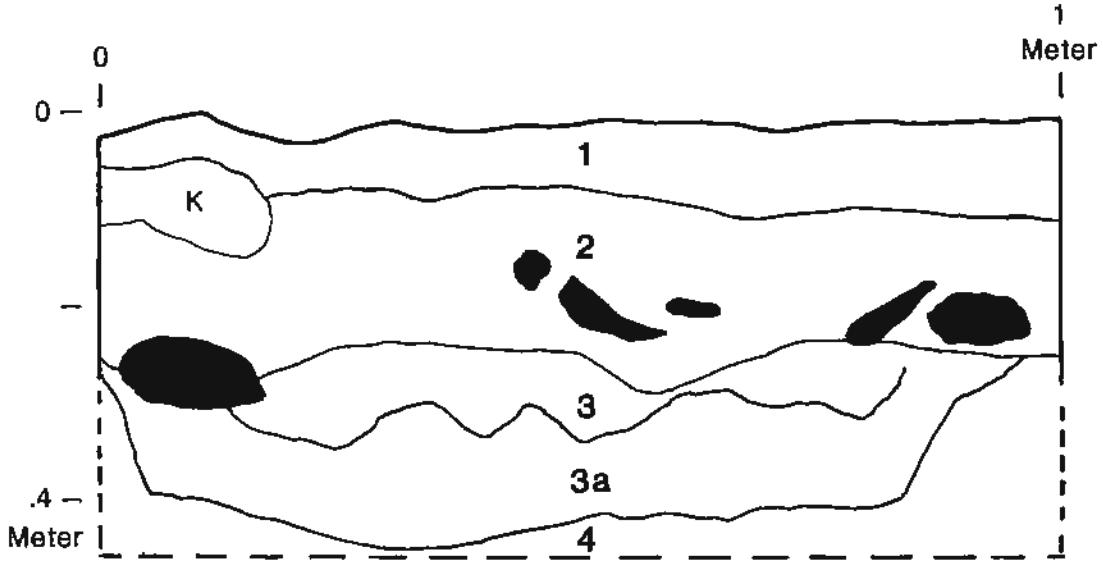
All 3 units exhibit similar profiles, of which a single example (Unit 2) is isolated for discussion (Figure 67). An uppermost zone (5 to 10 cm) of silt loam, incidentally stained by the 1985 brush fire and thus given a dark, midden-like color, contains in all units 30% to 50% of the flakes and shatter recovered. The zone is underlain by about 20 cm of silt loam in which, coincident with a general decline in flakes and shatter, the incidence of larger rocks (opalite and tuff) increases. The lowest zones (25 to 40 cm) comprise indistinctly separated units in which the incidence of clays and large rocks increases to a basal level of weathered bedrock. Small percentages of flakes

Figure 67. 26Ek3171, excavation unit 2, east wall profile.

1. Platy silt loam with rootlets; 10YR 3/2 (wet)
2. Crumb silt loam; 10YR 3.5 (wet)
3 Silty clay loam; 10YR 4/3 (wet)
3a. Silty clay loam, compact, with concentration of large rocks; 10YR 4/3 (wet)
4. Unexcavated; large chunks of butterscotch opalite (weathered bedrock)

26Ek3171

EAST WALL, UNIT 2



KEY:

(K) **krotovina**

rock

and apparently cultural shatter continue to occur to the deepest excavatable levels, although the limited size of our exposures did not allow us to determine whether the opalite beds at these levels had served as primary lithic sources; we suspect that they may have done so, since the size of flakes tends to increase with depth. In addition, Stage I bifaces (two specimens) and a core were recovered below 30 cm in Excavation Unit 3, the only such artifacts yielded by the units.

Summary

Although expressed to varying degrees, both 26Ek3170 and -3171 contain functionally diverse assemblages of artifacts and features which are probably best considered components of general exploration for opalite toolstone and occupation of Ramadan Ridge. Proceeding south uplsope along the ridge from Locality 27 of 26Ek3032 test results suggest that there is a decline in residentiality of sites and an increasing dominance of quarry and early stage reduction activity. It appears that 26Ek3170 is not only coterminous with Locality 27, but also that the two sites share intimate functional relationships. The residential aspect of 26Ek3170 is less strongly developed, probably a function of its somewhat greater distance from the confluence of drainages upon which residential activity appears to have been focused. And while quarry and reduction features occur within 26Ek3170, the overall assemblage and the featureless but artifact-rich northwestern quarter of the site suggest several functions other than the toolstone procurement and processing that dominates many of the other assemblages of the project area. In this respect the site stands functionally (as well as geographically) intermediate between Locality 27 and 26Ek3171. At 26Ek3171, located some 400 m from the drainage confluence supporting habitation at Locality 27, toolstone procurement received greater emphasis and residential attributes, although present (ground stone, ceramics, and relatively high assemblage diversity) are reduced.

The significance of 26Ek3170 and -3171 derives from the degree to which their data may contribute to the suite of research issues developed by Elston (1988 and Chapter 1, this volume) for the Tosawihi Quarries and their immediate vicinity. Among the site's most valuable data categories is likely to be their role as multifunctional activity areas and possible base camps for individuals engaged in both toolstone procurement and in those activities (hunting, gathering, food preparation, equipment maintenance, residence) performed in support of lithic procurement forays. Data in hand suggest that these behaviors are responsible to some degree for the creation of the Ramadan archaeological remains. More extensive exposure of areas on the sites that lack cultural features but contain diverse surface assemblages will help illuminate such activities.

Because the sites contain features of distinct classes (quarry pits, cobble quarries, core and biface reduction workshops) as well as what appear to be large zones that may prove to have residential function, they have potential for investigation of site structure. Comparison of extraction and reduction strategies employed at the open, horizontal quarry pits of Ramadan Ridge with those employed at other kinds of toolstone sources, as well as with those employed at quarry pits that are not coincident with residential functions, will shed light on problems of toolstone economics. In addition, further study of Features 2 and 7 and 26Ek3171 will afford a better understanding of the internal structure of quarry pits and contribute to a clarification of site formation processes.

Chapter 15. CORRAL FAN

by Steven G. Botkin

Corral Fan spans the southeastern quarter of USX-East (Figure 68). It contains the lowest density of sites in the project area and is most distant from documented residential bases (i.e., Locality 27 of 26Ek3032 in Big Meadow). It lacks surface water and is exposed to weather. The local mixed tall sage/low sage community, duplicates that of the immediate surroundings.

The landscape consists of gently undulating north-facing uplands composed of a series of broad finger ridges and intervening shallow gullies forming the mildly dissected northwestern foot slope of the skyline ridge well south of the project area. Corral Fan is a mineralogical transition zone where, as slopes rise southward from the banks of Undine Gorge, opalite outcrops become more rare while exposures of unsilicified tuff become more common. The light brown sandy colluvial soils contain abundant angular cobbles and gravel of rhyolite tuff. They remain unsounded except where trenched at 26Ek3200. There, ca. 30 cm of colluvial deposits cover tuff bedrock. Soils are generally shallow throughout the area.

Descriptive Site Summary

Four sites were recorded in the Corral Fan subarea (Table 82); three, 26Ek3196, 26Ek3194, and 26Ek3199, are large but diffuse lithic scatters occupying the tops of low finger ridges and knolls along the southern fringe of the project area. Assemblages are dominated by opalite secondary flakes and the occasional early stage opalite biface fragments and cores. None of these sites contains lithic concentrations sufficiently dense or discrete to be identified as cultural features (Raven 1988) and none was tested. The only subarea site tested is the quarry pit and associated reduction debris of 26Ek3200.

Table 82. Descriptive Summary, Corral Fan Sites.

Site Number	Type	Maximum Features (n)	Site Area (sq m)
26Ek3176	Diffuse Lithic Scatter [NOT TESTED]	-	4,240
26Ek3194	Diffuse Lithic Scatter [NOT TESTED]	-	8,840
26Ek3199	Diffuse Lithic Scatter [NOT TESTED]	-	1,180
26Ek3200	Quarry Pit/Reduction Complex	1	240

Figure 68. Topographic setting, Corral Fan sites.

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Site 26Ek3200 is the easternmost and smallest of the open sites tested in USX-East, and is one of the highest elevation (5760 ft amsl); it also is the most isolated. The site rests on a small bench above a minor seasonal drainage, coincident with the outcropping of a pair of opalite ledges (Figure 69).

The site is defined by a scatter of large opalite flakes intermixed with numerous initial stage Quarry Bifaces. Apparently unmodified opalite cobbles and slabs abound. An area centered on the rock outcrops was designated Feature 1 (Figure 70). Here, a dense scatter covers an area 24 m by 14 m, with densest concentrations downslope from the principal bedrock ledge where a roughly circular depression (4m diameter) and associated berm define a quarry pit. A second, smaller depression (3 m diameter) lies immediately north of the quarry pit, and may constitute a more incipient, but abandoned, effort. Much of the toolstone currently exposed on the site surface, including many cultural specimens, exhibits extensive colonies of lichen. In places, this growth nearly blankets the exposed faces of several contiguous stones. Lichen is especially dense and widespread in the vicinity of the lesser depression, suggesting that stones in this area may have lain undisturbed longer than elsewhere.

Testing Strategies

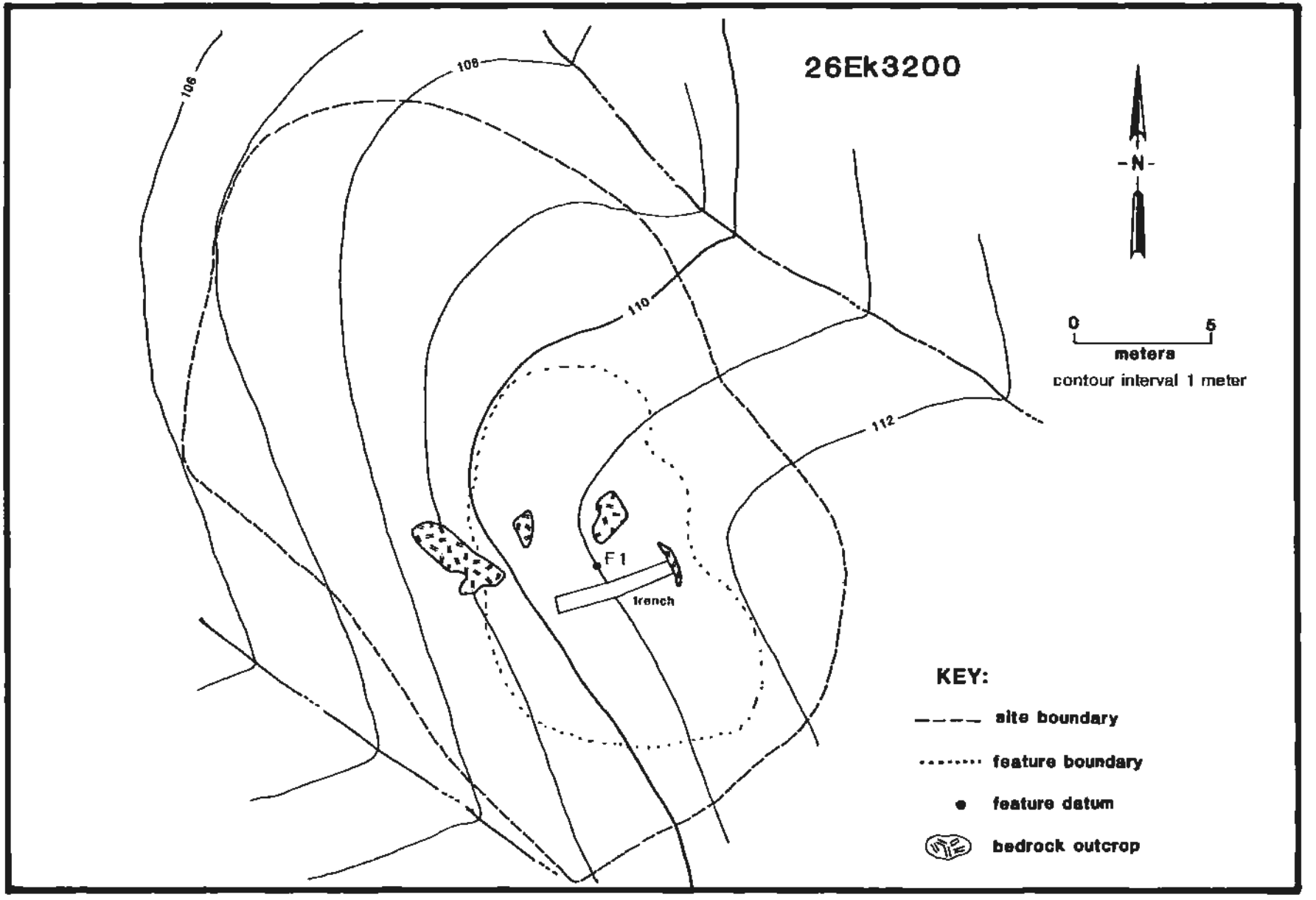
In order to sample the surface composition of the quarry pit and its surrounding accumulation of tailings, a series of 12 25 cm by 25 cm units was shovel-skimmed and screened at one meter intervals along a baseline transect parallel to the slope, extending downslope from above the outcrop ledge, across the pit and berm, to the base of the talus. Then, a one meter wide trench was hand excavated parallel to the surface collection baseline to expose internal stratigraphy. One wall of the trench was drawn in profile, and bulk samples of the principal stratigraphic components were collected (Table 83).

Table 83. Summary of Testing Procedures and Artifact Collections at Quarry Pit/Reduction Site 26Ek3200.

FEATURES RECORDED			FEATURE CONTEXT			RECOVERED COLLECTIONS					
			Subsurface	Strati-							
Total	Sampled	Total Area	Excavation Volume	graphic Profile	Column Samples	Debitage	Reduction		Processing		Other
(n)	(n)	(sq m)	(cu m)	(n)	(n)	(n)	HM	QB	SC	CH	BS
1	1	242	1	1	17	1,188	1	12	1	1	1

Key to Artifact Classes: Reduction Tools: HM = Hammerstone; QB = Quarry Biface. Maintenance/Processing Tools: SC = Scraper; **CH = Chopper. Other: **BS = Bison Scapula. ** = Possible digging tools

Figure 69. 26Ek3200, site map.


26Ek3200
106
108
110
112
N
0
5
meters
contour interval 1 meter
F 1
trench
KEY:
site boundary
feature boundary
feature datum
bedrock outcrop

Chronology

The age of the cultural deposits remains unknown. Neither temporally diagnostic artifacts nor obsidian were recovered. Examination of the trench sidewall bisecting the quarry pit suggests that Unit 10 of Horizon II contains buried charcoal and may, upon further exposure, produce quantities sufficient for radiocarbon assay. If adequate micro-climatic controls could be established for the area, lichenometry might prove informative in chronological assessments of surface contexts.

Assemblage Composition

Formed artifacts are almost exclusively those related to procurement of toolstone and initial stages of its reduction (Table 83). All twelve Quarry Bifaces recovered occurred on the surface; half are Stage 2 forms, five are Stage 3, and one has been thinned secondarily to reduction Stage 4. A large quartzite slab (ca 1.4 kg) with battered, step-fractured edges was found a few meters downslope from the quarry pit. Although categorized on morphological grounds as a "chopper," its tabular shape and damaged edges suggest its possible use as a digging or hoe-like implement, presumably employed in the excavation of the depression.

A quartzite hammerstone and a fragment of the proximal portion of a Bison sp. scapula were recovered from the trench sidewall within the quarry pit. The latter piece may represent the remnant of a digging tool; the broad, robust form of the original unfragmented bone could have proven useful in digging or scooping to remove liberated debris from the pit. This inference is supported by the recovery of a similar specimen from site 26Ek3208 at Red Hill in USX-West and from comparable quarry contexts elsewhere (cf Ahler 1986).

The only artifact whose implied function is not attributable directly to toolstone extraction/processing tasks is an opalite flake scraper obtained from shovel-skim Unit 2 located immediately upslope from the quarry pit.

Site Context and Structure

Of all sites tested, 26Ek3200 constitutes the purest expression of unifunctional toolstone procurement. The opalite source material there occurs in relatively isolated geographic context, yet appears to be of superior quality. This probably conditioned use of the place, since numerous much larger (but inferior) sources lie more conveniently along the margin of Undine Gorge.

Like quarry pits explored at other sites at USX-East (cf 26Ek3195 and 26Ek3197) the pit at 26Ek3200 accesses toolstone lying in subsurface contexts at the base of a low opalite outcrop. Presumably, aboriginal miners undertook such labor-intensive toolstone excavation in pursuit of the inherently superior knapability of unweathered material (cf. Elston, Chapter 1, this volume).

As described above, our testing operations collected an assemblage of limited abundance and diversity. However, in some respects, it is lack of diversity, as well as structural clarity (cf. below), that renders the site so highly informative about one aspect of toolstone procurement, i.e., quarry pitting.

Figure 70 depicts the plan structure of the principal quarry pit feature and the distribution of surface artifacts, as well as the disposition of the sample collection units and hand excavated trench along the sampling transect. Table 84 arrays the recovery of debitage from individual units.

Table 84. Debitage from Sample Feature 1, Site 26Ek3200.

SURFACE COLLECTIONS

OPALITE DEBITAGE

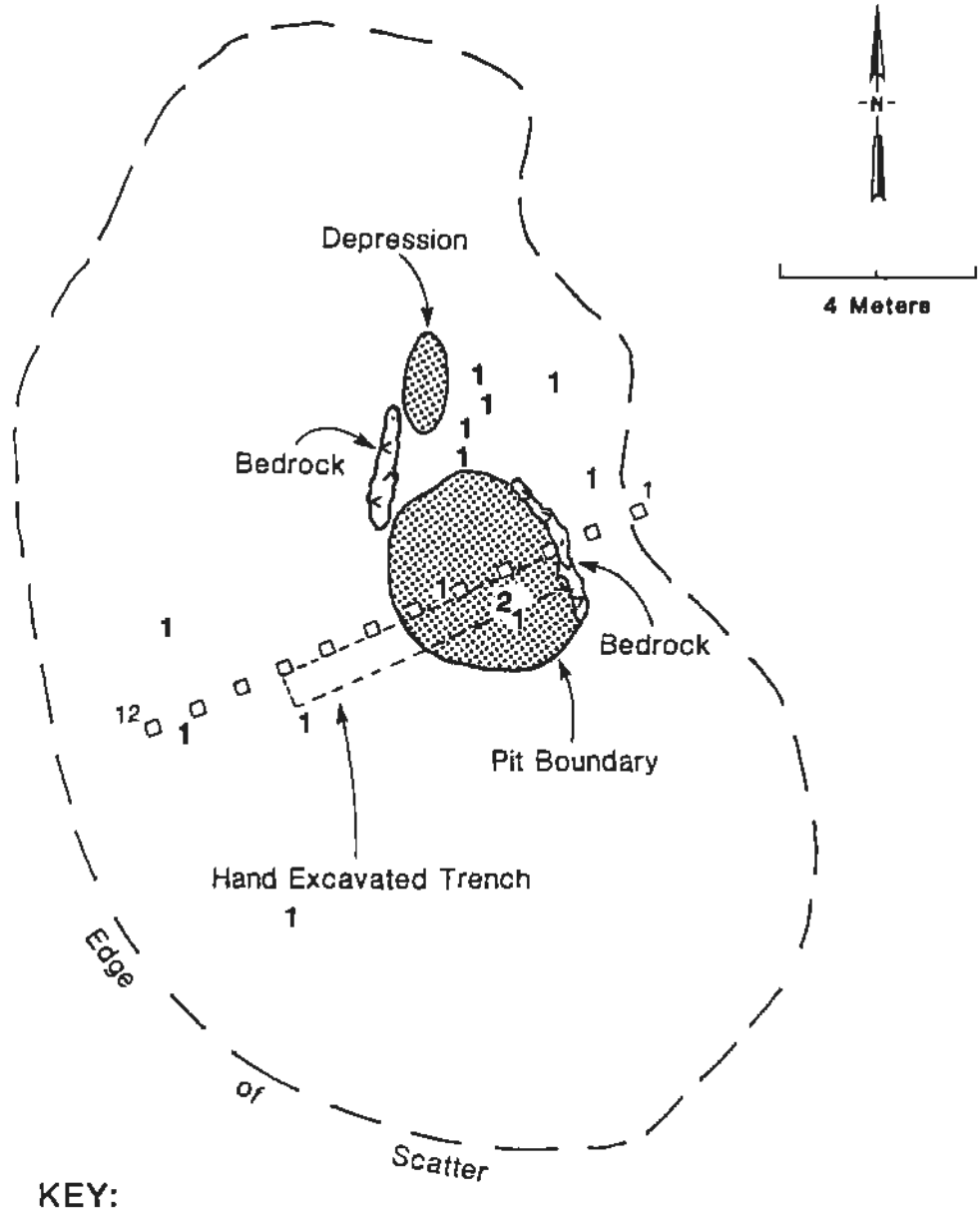
Unit	Flakes			Shatter			
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	Total
1	1	100.0	0.70	-	-	-	1
2	16	31.4	2.04	25	68.6	4.63	41
3	3	75.0	19.96	1	25.0	5.40	4
4	2	50.0	21.85	2	50.0	74.25	4
5	24	80.0	4.72	6	20.0	19.65	30
6	54	29.2	3.37	131	70.8	4.03	185
7	18	13.2	0.99	118	86.8	0.20	136
8	42	77.7	3.23	12	22.3	6.10	54
9	39	10.2	5.48	342	89.8	2.85	381
10	13	16.9	3.50	64	83.1	8.86	77
11	25	15.8	5.86	133	84.2	2.53	158
12	3	2.6	6.36	114	97.4	3.16	117
Total	240	20.0	4.21	958	-	80.00	1188

As shown in Figure 70, the surface occurrence of formed artifacts occurs primarily in contexts adjacent the confines of the pit, and downslope of its berm.

Comparison of Figure 70 to Table 84 suggests that the distribution of waste flakes by number and average individual weights clearly relates to both cultural and post-depositional processes. The small number and size of flakes above the

Figure 70. Plan of Feature 1, site 26Ek3200.

26Ek3200 Feature 1



KEY:

1 Quarry Biface

2 Scapula

□ Collection Unit (25cm)

opalite outcrop (Units 1 and 2) probably represent the remnants of attempts to obtain material from the upper margin of the ledge or perhaps where biface reduction took place. They contrast dramatically with the large flakes recovered immediately below the ledge in Units 3 and 4 that reflect primary quarrying directly against the downslope, pit-side of the rock face. Greater numbers of smaller flakes dominate the remainder of the pit, peaking at the crest of the berm (Unit 6) and then declining irregularly down the steep face of the talus slope. The increasingly large sizes of flakes down the talus, as well as the occurrence of numerous Quarry Bifaces there, suggest redeposition by colluvial action.

The high incidence of shatter to flakes (1.8 to 1) provides a comparison useful in inferring the nature of reduction tasks at other sites throughout USX-East. At 26Ek3200, obvious quarry use, coupled with the Quarry Biface assemblage and relatively abundant shatter, present in microcosm the full range of toolstone-specific activities displayed within the project area. Compared with test results obtained elsewhere from reduction features further removed from raw material sources, reduction stages expressed by Quarry Biface assemblages are similar, but the ratio of flakes to shatter contrasts markedly; at some of these sites (e.g., 26Ek3183), flakes outnumber pieces of shatter by ca 50 to 1.

Quarry Pit Stratigraphy

The pit apparently was excavated about 80 cm into tuff and silicified tuff bedrock, extracting both white and pink toolstone. The pit excavation apparently started along a tuff-filled fissure which allowed the prehistoric miners a place to get a "handle" on the bedrock. The pit was then worked upslope from the fissure. The texture of strata in the pit fill tends to alternate between fine and coarse, as observed in other quarry pit profiles. The sand to loamy sand fine sediments (Units 3, 5, 7, 10, 12, 15, and 17) probably represent slopewash and aeolian deposits accumulated in open pits between episodes of active quarrying. The coarser layers of angular rubble and/or cores and large flakes (Units 1, 2, 4, 6, 9, 11, 13, 14, 16, and 18) are colluvium and waste from quarrying and toolstone processing.

The highly organic Unit 3, thinly mantled with a layer of flakes and angular shatter, is the present A horizon. The upslope portion appears to have been buried by mostly colluvial Units 2 and 1 in the recent past.

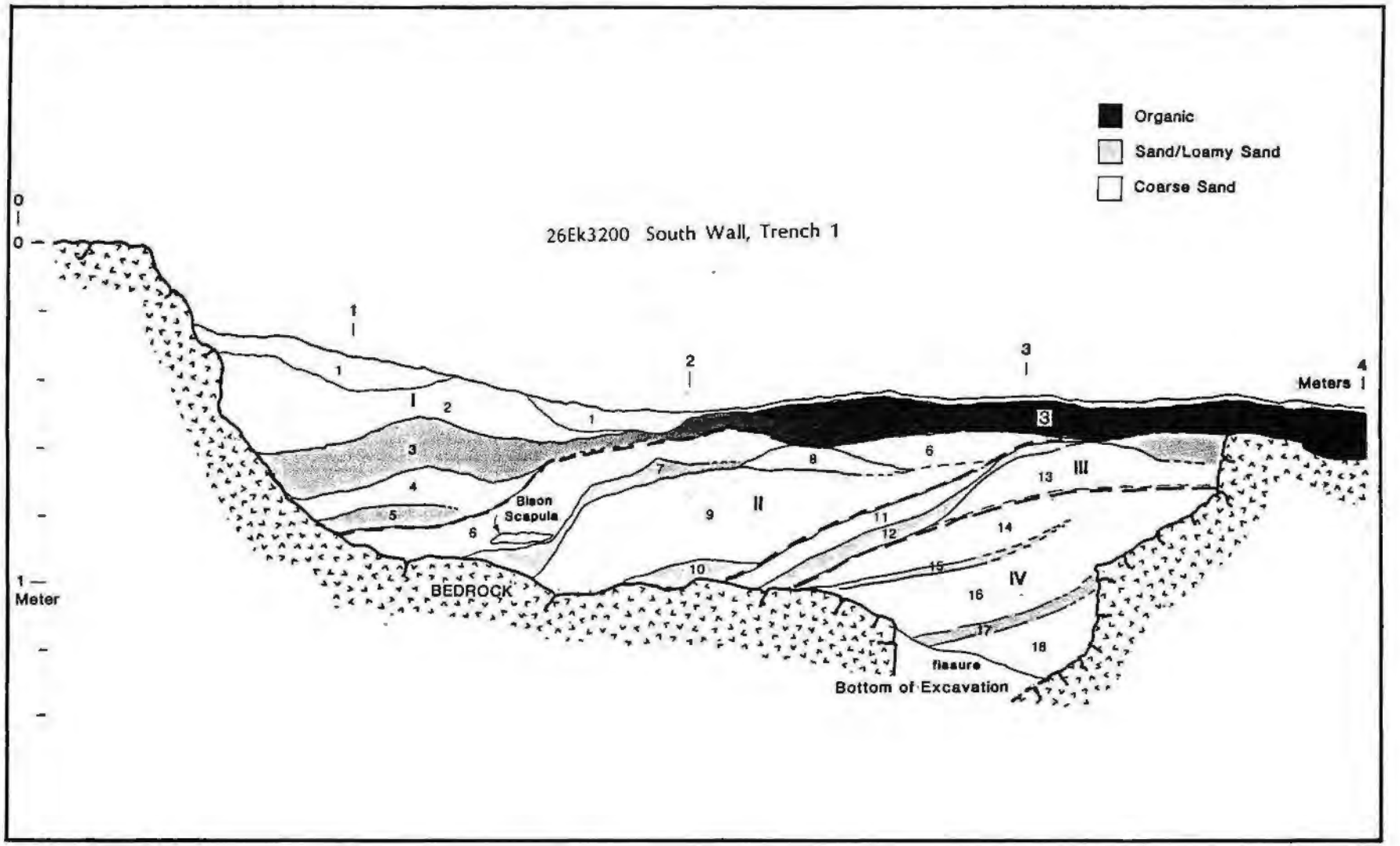
Working upslope and into the outcrop, prehistoric quarrymen backfilled their pits as they went along. Thus, the beds are progressively younger upslope and toward the face. The pit may have been started on the fissure still present in the bottom of the oldest part of the pit.

At least 18 distinct strata are apparent in the profile of the trench wall (Figure 71). Numbered consecutively from the surface, strata are grouped into four time-stratigraphic horizons. Horizon IV (Units 28 through 15), constitutes the oldest group. Truncated by units of Horizon II, they are short and concave upward. The outcrop face was probably nearly 1.4 m west of its present position. Horizon III (Units 11, 12, and 13) marks an interval when the outcrop face probably lay about 1.0 m west of its present position. These units are convex upward, preserving a portion of the pit berm. Horizon II (Units 9 through 6) marks the last intensive episode of quarrying visible in the profile. The profiles of these units are S-shaped, preserving both the pit floor and the berm. The outcrop face assumed its present position during Horizon II. The Bison sp. scapula was found in Unit 6. Finally, Horizon I includes the more horizontal layers subsequent to Unit 6, and suggests passive accumulations in the open pit rather than culturally generated deposits.

Summary

In sum, 26Ek3200 appears to have functioned exclusively as a source of high quality opalite toolstone. Positioned as it is, relatively high in the landscape, far from water or base camps, and remote from other toolstone sources, we surmise that the small opalite exposure was attractive chiefly for the extremely fine-grained and uniform quality of its lithic resources. Lacking evidence for activities ancillary to toolstone procurement, i.e., maintenance/subsistence tools (save for the single flake scraper), 26Ek3200 provides not only an informative venue for examination of quarry processes themselves, but offers as well, in its debitage assemblage, potentially useful indices by which the nature of reduction activities at other sites may be evaluated.

Figure 71. 26Ek3200, Trench 1, south wall profile.


Organic
Sand/Loamy Sand
Coarse Sand
26Ek3200 South Wall, Trench 1
0
0
1
Meter
1
2
3
4
Meters
I
II
III
IV
Bison Scapula
BEDROCK
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Bottom of Excavation

Chapter 16. UNDINE GORGE

by Steven G. Botkin

The Undine Gorge subarea encompasses a topographically diverse landscape subsuming the northernmost tier of sites in USX-East. It is named for the seasonal drainage whose sinuous course transits from east to west to debouche Little Antelope Creek at Big Meadow, just beyond the northwest corner of the study area (Figure 72). Down-cutting of this channel has exposed opalite bedrock which, in concert with the availability of intermittent water, undoubtedly attracted aboriginal use of the area. Undine quarry sites are more numerous, and as a rule, were exploited more intensively than those of the Ramadan and Corral areas. Circumstantial evidence (proximity) hints that opalite originating from Undine sources may have provided a sizeable portion of the raw material processed at source-poor Holeplug Ridge sites.

Topography in the western half of the subarea is dominated by the prominent rim of brecciated and silicified tuff capping the southern terminus of Italian Mesa. Slopes are steep (precipitous, in places) rising from a base of 5600 feet amsl at the bottom of Undine Gorge to crest the brink of Italian Mesa at 5700 feet amsl in only about 200 horizontal feet. Vertical bedrock faces interspaced with narrow rocky ledges and steep talus cones punctuate the escarpment; various points along the rim served prehistorically as sources of toolstone, and several of the crags and overhangs form rockshelters.

Owing to the prevalence of exposed bedrock, vegetation of the western zone is generally more sparse than elsewhere in the project area. The lower slopes of Italian Mesa exhibit the most extensive local coverage, where thin, colluvially transported sandy soils support a patchy growth of mixed low and tall sagebrush and rabbitbrush. Above this, amid increasing exposures of tuff, coverage diminishes. Bunch grasses and phlox occur sporadically in soil-filled cracks and pockets along the otherwise bare rock ledges. Harlequin colonies of lichen face much of the exposed stone.

By contrast, the eastern half of the subarea is characterized by open, more gently rolling terrain. It occupies the lowest slopes of Corral Fan, mildly dissected into a system of broad, relatively flat knolls and projections bounding the southern flanks of Undine Gorge along its upper reach. Opalite exposures are extensive along the footslopes overlooking the Gorge discontinuously occurring as outcrops and overhanging ledges. In many instances these evidence aboriginal toolstone extraction and in at least one location were exploited for shelter. Higher on the slopes, well-developed quarry pits sound near-surface sources and undermine low outcrops, while on the

Figure 72. Topographic setting, Undine Gorge.

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

knoll tops, toolstone supplies were obtained from bedrock weathered into dense cobble fields. Soils are generally shallow, consisting of a veneer of sandy, very gravelly, colluvium overlain in places by an extensive anthropic talus derived from prehistoric quarrying. In the southwestern quarter of the area (cf. 26Ek3195), colluvial soils are blanketed by thin, very fine-grained, loess-like deposits, similar to those encountered in neighboring portions of Holeplug Ridge (cf. 26Ek3192).

An edaphically determined mosaic of low sagebrush and tall sagebrush typifies the local plant community, the former species dominating the shallow soils of the rocky knoll tops, the latter supported in denser growths by deeper colluvium on the slopes. Abundant bitterbrush complements this assemblage at the highest elevations.

Descriptive Site Summary

Twelve sites were recorded in the Undine Gorge subarea. As summarized in Table 85, two are Quarry Pit/Reduction complexes, four are Outcrop Quarry/Reduction complexes, five are Rockshelters, and one, smallest of the open sites in the vicinity, is a Reduction Station. All save the reduction station and some rockshelters contain exploited opalite sources within their precincts. Ten of the Undine sites were tested; two small rockshelters (26Ek3205 and 26Ek3206) apparently retaining sparse data went untested.

Table 85. Descriptive Summary, Undine Gorge Sites.

Site Number	Type	Features (number)	Maximum Site Area (sq m)
26Ek3177	Rockshelter/Reduction Station	1	70
26Ek3178	Reduction Station	4	910
26Ek3195	Quarry Pit/Reduction Complex	8	8,800
26Ek3196	Outcrop Quarry/Reduction Complex	7	11,800
26Ek3197	Quarry Pit/Reduction Complex	11	4,420
26Ek3198	Outcrop Quarry/Reduction Complex	24	14,700
26Ek3201	Outcrop Quarry/Reduction Complex	4	2,100
26Ek3202	Rockshelter/Reduction Station	1	8
26Ek3203	Outcrop Quarry/Reduction Complex	-	8,230
26Ek3204	Rockshelter/Reduction Station	1	60
26Ek3205	Rockshelter/Reduction Station [NOT TESTED]	-	25
26Ek3206	Rockshelter/Reduction Station [NOT TESTED]	-	28

Testing Strategies

Testing the Undine sites was dictated in part by their functional type as assigned during survey. The discussion which follows is organized along these lines, and is offered in summary form by Table 86. Field methods were comparable to those used elsewhere within the project area; following feature inventories, features selected judgmentally were designated Sample Features. Procedures directed at Sample Features were intensive and invasive, with the result that the bulk of the data underpinning discussions which follow are derived from these sources.

Quarry Pit/Reduction Complexes

At 26Ek3195, two Sample Features were selected. Feature 1 consists of an outcrop quarry and associated reduction area where 5 25 by 25 cm units, spaced at 3 m intervals, were shovel skimmed and screened along a baseline transect parallel to the slope. Feature 2, a 4 m wide quarry pit lies beneath an exposed opalite outcrop that constituted the principal toolstone source within the feature. Surface content was tested by shovel skimming and screening a discontinuous series of 13 25 by 25 cm units spaced at 1 m intervals, from the bedrock outcrop, across the pit and its berm, to the base of the talus slope below. To test the internal structure of the feature, a 50 cm wide trench subsequently was excavated by hand along the same baseline for a distance of 5.5 m. Initiated at the outcrop, it dissected both the center of the pit and the most prominent portion of the berm. Deposits removed from the trench were not screened, the goal of the exercise lying instead in the exposure of stratigraphy and collection of stratigraphic samples directly from the sidewall.

At 26Ek3197, Feature 1, the larger of the two quarry pits was sampled. Slightly elliptical in plan (3.5 m by 2 m) and 50 cm deep, it occupies a relatively steep slope and exhibits a well developed berm along its downhill rim. A moderate to heavy scatter of reduction debris surrounds the pit and reveals greatest densities throughout the area of the berm. To sample this scatter a series of 20 25 cm by 25 cm units were shovel skimmed and screened at 1 m intervals along a discontinuous baseline bisecting the pit, its berms, and extending to an exposure of bedrock well downslope. The baseline was oriented parallel to the primary slope. Two additional features were tested; 1 m by 1 m excavation unit centered on a biface cache of Feature 5 was dug to 20 cm, and a 1 m by 50 cm unit was excavated to a depth of 60 cm into the floor of Feature 10, a small rockshelter.

Table 86. Summary of Testing Procedures, Undine Gorge Sites.

Site Number	FEATURES RECORDED: Total (n)	Sampled (n)	FEATURE CONTEXT: Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	Trench Cross Section (n)	Stratigraphic Profile (n)	Column Samples (n)	NON-FEATURE CONTEXT: Surface Skim Area (sq m)	Subsurface Excavation Volume (cu m)	RECOVERED COLLECTIONS: Debitage (n)	Artifacts (n)
26Ek3177	1	1	0.250	0.10	-	-	-	-	-	6285	4
26Ek3178	4	1	5.000	-	-	-	-	-	-	4048	12
26Ek3195	8	1	1.125	-	1	1	6	-	-	1149	63
26Ek3196	7	2	-	5.85	-	-	-	-	-	7407	55
26Ek3197	11	1	1.250	0.50	-	-	-	7.00	-	1794	45
26Ek3198	24	4	37.750	0.15	-	-	-	-	-	6373	99
26Ek3201	4	3	10.500	0.10	-	-	-	-	-	4237	44
26Ek3202	1	1	0.500	0.25	-	-	-	-	-	5868	5
26Ek3203					-	-	-	3.75	-	586	13
26Ek3204	1	1	1.000	0.70	1	1	-	-	-	6160	110

Outcrop Quarry/Reduction Complexes

Two Sample Features were selected at 26Ek3196, both outcrop quarries with associated opalite debris scatters. At Feature 1 surface contexts were tested by means of 11 units, each shovel skimmed and screened. Unit 1, a 1 m by 1 m collection unit, was positioned to test a possible adit, marked by a battered, apparently fire spalled and blackened opalite rim on the edge of a low exposure of bedrock. Units 2 through 11 were 50 cm by 50 cm in size, arrayed along a discontinuous transect at 2 m intervals across the lithic scatter occupying the bedrock exposure in the center of the feature. After shovel skimming, a 1 m by 1 m excavation unit was superimposed on surface collection Unit 1 and dug to a depth of 30 cm to sound subsurface contexts of the possible adit. Feature 2 is an extensive moderate density lithic scatter centered along the top of a low opalite cliff which served as a source of raw material. Tests focused on sampling two high density lithic concentrations within the feature, each of which was shovel skimmed and screened along a discontinuous baseline of 50 cm by 50 cm units placed at 2 meter intervals. The northernmost concentration was sampled by four units; the southern one by nine units.

Four features were treated as Sample Features at 26Ek3198. Feature 1, a relatively diffuse lithic scatter, was selected for 100% surface collection owing to its large number of projectile points and preforms, as well as to its abundant obsidian debitage. A 5 m by 6 m rectangular area was collected by shovel skimming and screening a contiguous block of 30 1 m by 1 m units. Following this, a 1 m by 50 cm excavation unit was centered on the area where the incidence of projectile points and debitage was highest; the unit was dug to a depth of 20 cm. Feature 2 appeared as a small (1.5 m by 0.75 m) but extremely dense concentration of reduction debris. It was tested by a line of three contiguous 1 m by 1 m shovel skimmed and screened units; two were positioned within the concentration, while the third explored just beyond its discernible surface boundary. A much larger lithic concentration, Feature 9, was also tested, owing to three ceramic sherds on its surface. A block of 2 1 m by 1 m units was shovel skimmed and screened at the location of the surface sherds to recover additional fragments and to determine whether greater functional variability in artifact classes would require reclassification of the feature.

The only outcrop quarry at 26Ek3198 lies at the northeastern periphery, where a small bedrock exposure drops to an abrupt rim. Much of the outcrop consists of toolstone quality opalite that, together with nearby boulders and cobbles, was quarried prehistorically. Because primary debitage was difficult to isolate from the background shatter and naturally weathered opalite, we shovel skimmed and screened 10 50 cm by 50 cm units arrayed at 2 m intervals along a baseline transecting the feature from its highest to lowest elevations. Additionally,

we collected all surface material (both cultural and non-cultural) from a single 50 cm by 50 cm unit, in order to characterize the size and quality of unmodified toolstone available and the relative proportion of cultural material with which it co-occurs.

All four of the features defining 26Ek3201 were addressed as Sample Features. Feature 1, a lithic scatter containing three dense concentrations of opalite debitage, was sampled by 2 shovel skimmed and screened 1 m by 1 m units. One was placed in the southernmost concentration, where numerous obsidian flakes occurred on the surface; the other was located in the moderate density scatter between two scatters further to the northeast. Feature 2 consists of two dense lithic concentrations surrounded by a moderate density scatter. A block of seven contiguous 1 m by 1 m units was shovel skimmed and screened in the southern portion of the feature where a mano was observed amid the greatest incidence of Quarry Biface fragments visible on the surface. Feature 3 is a small concentration of opalite debitage. Test efforts focused on a cluster of eleven fragments of a single metate which littered the northern edge of the concentration. A 1 m by 50 cm excavation unit explored subsurface contexts beneath the groundstone to a depth of 20 cm. Feature 4 is an outcrop quarry with associated reduction debris perched on a shelf immediately south of and overlying the rockshelter at 26Ek3177. The feature's lithic scatter was sampled by a discontinuous baseline composed of 5 50 cm by 50 cm units shovel skimmed and screened at 2 m intervals. A sixth such unit tested debitage accumulations at the base of one of the battered opalite outcrops in the southern extreme of the feature.

Lacking discernible concentrations of cultural debris identifiable as features, tests at 26Ek3203 sought to sample the artifactual content of the light to moderate density lithic scatter which litters its surface in order to bring to light any spatial patterning in the distribution of these remains that might be obscured by the abundant naturally weathered debris there. To this end 15 50 cm by 50 cm units were arrayed along a baseline parallel to the site slope transecting the scatter and manipulated bedrock outcrops. Each unit was shovel skimmed and screened.

Reduction Station

At 26Ek3178, the dense concentration of opalite reduction debris defining Feature 1 was selected as our Sample Feature. To sample its contents, the scatter was bisected by a collection transect consisting of 5 contiguous 1 m by 1 m units. Arrayed along a baseline parallel to the site slope, each unit was shovel skimmed and screened. The three central units fell entirely within the concentration as revealed on the surface;

these were bracketed by units on either end of the transect which sampled areas immediately outside observed margins of the concentration.

Rockshelters

Test actions at the three rockshelters examined were less areally extensive than those at open sites. Instead, they focused on sounding interior subsurface deposits in order to determine their content and structure, and to ascertain the degree to which the shelters offer protected contexts conducive to the preservation of perishable remains. All excavation measured were 1 m by 50 cm. Digging each commenced with by shovel skimming and screening the upper 2 cm of deposits. Below this, deposits removed from 10 cm arbitrary vertical levels were passed through nested screens of 1/4 in. and 1/8 in. mesh. Owing to the copious quantity of material held by the smaller mesh, contents of these screens were bagged en masse for later sorting in the laboratory.

At the two smaller rockshelters (26Ek3177 and 26Ek3202) one excavation unit was placed in the center of each floor, well inside the dripline. Deposits reached depths of 20 cm and 50 cm, respectively. Digging halted in both units where they bottomed on opalite bedrock or large slabs of roof-fall.

Site 26Ek3204, the largest of the rockshelters, was probed in two locations by units positioned at either end of a common baseline. Excavation Unit 1 was dug in the interior of the shelter to a depth of 60 cm. Excavation Unit 2 was placed on the upper portion of the apron outside the dripline and excavated to a depth of 40 cm. Both units terminated where bedrock or roof-fall was encountered. In order to characterize stratigraphic relationships more clearly, as well as to expose a complete cross-section of the interior deposits and explore for hearths, a trench was dug by hand from the apron to the rear wall, placed to join and extend the formal excavation units. Material from the trench was not screened, although artifacts encountered in situ were retained. The exposed profile was drawn, and samples collected directly from the trench wall.

Chronology

Our current assessment of the aboriginal antiquity of Undine Gorge relies heavily upon relative dates provided by temporally diagnostic artifacts. At present, only one radiocarbon assay has been obtained. However, testing reveals that several sites promise to yield datable remains. Also of potential chronological utility, extant collections include numerous obsidian pieces amenable to source characterization and hydration rim value determinations.

A total of 12 projectile points referable to Thomas's (1981) typological key were recovered from the Undine sites (Table 87). Nine are from site 26Ek3198 (six were found within Feature 1). Temporal affiliation of point styles from all Undine sites generally implies relatively late use of the area, a pattern mirrored by other portions of USX-East.

At Undine Gorge, the only evidence to suggest visitation as early as 3000 B.C. is the occurrence of one specimen each of Gatecliff Split Stem and Humboldt Series projectiles. Aboriginal presence appears to have been more intensive at times post-dating A.D. 1300. Fully 75% of the specimens recovered are attributable to Desert Series types, i.e. Desert Side-notched (n=5) and Cottonwood Series (n=4). Somewhat earlier occupation ca A.D. 700 - A.D. 1300 is hinted by the Rosegate Series point recovered from Level 1 (0-10 cm) in the 26Ek3204 rockshelter. Likewise, four sherds of Snake Valley Grayware ceramics encountered in Feature 9 at 26Ek3198 lend support to a slightly pre-A.D. 1300 occupation (Madsen 1977).

Table 87. Projectile Point Types from Undine Gorge Sites.

Site Number	Classifiable					Unclassifiable	
	GSS	HBS	RSG	CTN	DSN	OOK	Total
Outcrop Quarry/ Reduction Complex							
26Ek3198	1	1	-	4	3	-	24
Reduction Station							
26Ek3178	-	-	-	-	2	-	2
Rockshelter/ Reduction Station							
26Ek3177	-	-	-	-	-	2	2
26Ek3204	-	-	1	-	-	-	1

Type Designations (after Thomas 1981)

GSS = Gatecliff Split Stem
HBS = Humboldt Series
RSG = Rosegate Series
CTN = Cottonwood Series
DSN = Desert Side-notched

Other

OOK = Points out of Thomas' key

The radiocarbon assay was derived from a composite charcoal sample recovered from the 20-30 cm level of Excavation Unit 1 located inside 26Ek3204. It obtained a date of 40 $\pm$ 50 B.P. (Beta 26828) which, given ambiguities in curves for very young samples, could indicate an age for the sample of between 272 GP (A.D. 1678) and 0 B.P. on the two sigma bases. This recent

sample, juxtaposed with a Rosegate Series point recovered two levels above from the same unit, likely reflects turbation of site deposits. The composite nature of the sample, consisting of numerous minute fragments of charred sagebrush and other unidentified wood, introduces ambiguities as well. The abundance of carbon in the deposits at the rockshelter suggest the potential for discovery of hearths which would be especially useful in overcoming problems associated with composite samples, since charcoal from such sources could be attributable to a single cultural event.

Assemblage Composition

The most salient attribute of the assemblages from all Undine sites is, not surprisingly, the phenomenal quantities of opalite flakes and shatter they contain. The obvious emphasis on the manipulation of toolstone is reflected directly by the relative proportions of formed artifact types which comprise the collections (Table 88).

Reduction artifacts (e.g., cores, quarry bifaces) and the processing tools employed for their manufacture (e.g., hammerstones, other percussion implements) comprise the majority of all assemblages. Maintenance tools (scrapers, knives, and other flake tools), as well as subsistence oriented artifacts (projectile points, groundstone) comprise smaller assemblage components. These latter, we assume, are indices of multiple site functions beyond those which strictly address toolstone procurement. The relative proportions of these two sets of artifact classes (lithic processing and reduction vs. maintenance and subsistence) vary in a pattern concordant with functional site types assigned at the time of their original recording. With one notable exception, artifacts related to lithic processing average about 90% of assemblages at quarry sites of both pit and outcrop source varieties. The complements of maintenance and subsistence related items are responsible for roughly 10% of the collections at these sites. The exception to this trend is evident at 26Ek3198, where the ratio of lithic processing to maintenance/subsistence/tools appears less divergent, i.e. 64.2% to 35.5%, respectively. Recall from summary site descriptions that Feature 1 there consists of a rather anomalous lithic scatter made up of an abundance of tools not strictly related to toolstone production. Collection of this Sample Feature biased artifact counts, contributing over 80% of all projectile points and maintenance tools encountered at the site. If, for comparative purposes, Feature 1 artifacts are excluded momentarily from counts, the relative proportion of lithic processing specimens to maintenance/ subsistence artifacts achieves a ratio comparable to the rest of the quarry sites (85% to 15%, respectively).

Table 88. Intersite Artifact Class Frequency Comparisons, Undine Gorge Sites.

ARTIFACT CLASS	ARTIFACT FREQUENCY PER SITE																			
	Quarry Pit/ Reduction Complexes				Outcrop Quarry/Reduction Complexes								Rockshelter/Reduction Stations						Reduction Station	
	26Ek3195		26Ek3197		26Ek3196		26Ek3198		26Ek3201		26Ek3203		26Ek3177		26Ek3202		26Ek3204		26Ek3178	
Lithic Processing/ Reduction Tools																				
Hammerstones	6		6		8		2		4		-		1		-		4		-	
Scratched Stones	-		-		-		-		1		-		-		-		1		-	
Subtotal (%)	6	(9.2)	6	(14.6)	8	(13.8)	2	(1.6)	5	(10.4)	0	(0)	1	(14)	0	(0)	5	(8.7)	0	(0)
Reduction Artifacts																				
Assayed Pieces	-		-		1		3		1		-		-		1		1		-	
Cores	8		1		24		5		1		5		1		2		17		1	
Quarry Bifaces	42		32		17		51		33		4		2		2		15		12	
Preform Bifaces	-		-		-		12		-		-		-		-		-		-	
Small Bifaces	1		1		1		8		4		2		-		-		4		1	
Indeter. Bifaces	-		-		-		-		1		-		-		-		2		1	
Subtotal (%)	51	(78.5)	34	(83)	43	(74.1)	79	(62.6)	40	(83.3)	11	(100)	3	(43)	5	(71.4)	39	(68.4)	15	(80)
Projectile Points																				
Classifiable	-		-		-		9		-		-		-		-		1		2	
Unclassifiable	-		-		-		11		-		-		3		-		-		1	
Subtotal (%)	0	(0)	0	(0)	0	(0)	20	(15.8)	0	(0)	0	(0)	3	(43)	0	(0)	1	(1.8)	3	(15.8)
Maintenance and/or Processing Tools																				
Abraders	-		-		-		1		-		-		-		-		-		-	
Scrapers/Spokeshaves	6		1		3		8		-		-		-		1		6		1	
Knives	1		-		1		3		-		-		-		-		-		-	
Perforators/Gravers	-		-		-		2		1		-		-		-		1		-	
Multipurpose Flakes	1		-		1		6		-		-		-		-		1		-	
Indeter. Flake Tools	-		-		1		1		-		-		-		1		3		-	
Subtotal (%)	8	(12.3)	1	(2.4)	6	(10.3)	21	(16.6)	1	(2)	0	(0)	0	(0)	2	(28.5)	11	(19.3)	1	(5.2)
Plant Processing																				
Manos	-		-		-		-		1		-		-		-		1		-	
Metates	-		-		-		-		1		-		-		-		-		-	
Indeter. Groundstone	-		-		1		-		-		-		-		-		-		-	
Subtotal (%)	0	(0)	0	(0)	1	(1.7)	0	(0)	2	(4)	0	(0)	0	(0)	0	(0)	1	(1.8)	0	(0)
Other																				
Ceramic Sherds	-		-		-		4		-		-		-		-		-		-	
Subtotal (%)	0	(0)	0	(0)	0	(0)	4	(3.1)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Site Total	65		41		58		126		48		11		7		7		56		19	

At rockshelters, opalite reduction artifacts dominate, but they are augmented by much higher proportions of maintenance tools. Lithic processing tools and their products comprise from 57% (26Ek3177) to 77.2% (26Ek3204) of collections at these sites (x=68.5%), while 22.8% (26Ek3204) to 43% (26Ek3177) are maintenance related tools (x=31%). We assume that these ratios reflect the use of shelters for both toolstone reduction and other ancillary tasks. This is especially likely at the largest shelter, 26Ek3204. There, the comparatively large number of formed artifacts recovered (n=57) and the relatively high incidence of maintenance tools, coupled with a subsurface abundance of non-artifactual constituents (charcoal, faunal remains) imply some measure of residential use of the site.

The relative proportions of formed artifact classes from the one isolated Reduction Station in Undine, 26Ek3178, reveals a situation somewhat intermediate between those expressed at rockshelters and quarry sites. Maintenance tools account for 21% of the assemblage and lithic processing reduction artifacts for the remaining 79%.

Consideration of individual classes of formed artifacts also reflects the emphasis on toolstone processing at the Undine sites. As elsewhere in USX-East, the most common (n=210, 48%) formed artifacts in the Undine collection are opalite quarry bifaces. As well, they constitute the largest number of items within individual site assemblages, save at 26Ek3196, 26Ek3203, and 26Ek3204, where they are outnumbered slightly by opalite cores. Quarry bifaces resulting from early stage reduction predominate; none has progressed beyond secondary thinning (Stage IV; cf. Table 89). Stage II Quarry Bifaces dominate most assemblages. At 26Ek3198 and 26Ek3178, somewhat more reduced Stage III forms are most frequent. These sites appear to emphasize the reduction, rather than primary procurement, of toolstone. In spite of the preponderance of evidence for early biface reduction tasks, quarry biface blanks (Stage I) are rare.

Although comprising differing proportions of total assemblages, maintenance/processing tools occur at all sites save 26Ek3177, a site depauperate in all but debitage. Most of these implements are simple flake tools in a variety of forms augmented occasionally by perforators, gravers, and/or knives. Implements most clearly associated with subsistence tasks are less widely distributed. Fully 82% of hunting oriented tools (projectile points and preforms) occur at 26Ek3198, the majority from Feature 1. This feature contains too, the only shaft abrader encountered in the project area. Ground stone artifacts are rare, a mano at 26Ek3204 lends slight support to our proposition that the rockshelter served at least minimally as a camp site. Contrary to expectations of assemblage composition predicated by functional site type, the small outcrop Quarry/Reduction Complex at 26Ek3201 contains 18 fragments of groundstone, 17 of which represent one metate. Finally, a little-used mano was found on the surface of Feature 3.

Table 89. Quarry Biface Reduction Stage, Undine Gorge Sites.

Reduction Stage	Quarry Pit/ Reduction Complexes 26Ek3195 n	%	26Ek3197 n	%	Outcrop Quarry/ Reduction Complexes 26Ek3196 n	%	26Ek3198 n	%	26Ek3201 n	%	26Ek3203 n	%	Rockshelters 26Ek3177 n	%	26Ek3202 n	%	26Ek3204 n	%	Reduction Station 26Ek3178 n	%	Total n	%
1 Blank	-	-	-	-	-	-	2	2.0									1	6.7			2	0.95
2 Edge Preparation	27	64.0	27	84.0	14	82.4	12	23.0	18	55.0	4	100.0	1	50.0	1	50.0	7	46.7	3	27.0	114	54.30
3 1 Thinning	11	25.0	4	13.0	1	5.9	26	51.0	14	42.0							4	26.7	9	73.0	69	32.80
4 2 Thinning	-	-	1	3.0	-	-	10	19.6	-	-	-	-	-	-	1	50.0	1	6.7	-	-	13	6.20
5 Shaping	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 Stage Indeterminate	4	10.0	-	-	2	11.8	2	3.9	1	3.0	-	-	1	50.0	-	-	2	13.3	-	-	12	5.70
TOTAL	42		32		17		51		33		4		2		2		15		12		210	

Quarry Pit/Reduction Complexes: Context and Function

This and the following discussions describe the Undine sites on a site-specific basis, organized according to functional site types.

26Ek3195

Site 26Ek3195, the larger of the Quarry Pit/Reduction Complexes, occupies the crest and western and northern slopes of a broad, rocky knoll top intruding the footslopes of Corral Fan at the southern extreme of the subarea (Figure 73). Two shallow drainage channels topographically isolate the site from others nearby.

Central to the site, the knoll crest and bedrock exposures are paved with primary and secondary debitage, large volumes of opalite shatter, and a few cores and quarry bifaces. Six of the eight cultural features detected are: two shallow quarry pits (Features 3 and 4), three outcrop quarries (Features 1, 6, and 8), and a reduction station (Feature 5). Near the base of the slope at the northwestern periphery occur two additional quarry pits (Features 2 and 7), both deeper and littered with quarrying refuse more dense than those on the knoll above. Most of the knoll outside of feature boundaries appears to have served as a cobble quarry of variable quality opalite. Hundreds of assayed cobbles and scattered primary flakes and shatter lie across the knoll crest and down its slopes.

Despite its large size, 26Ek3195 yielded only 1146 cultural items, of which 65 are formed artifacts. Formed artifacts recovered from features and non-feature contexts are summarized in Table 90.

The assemblage reflects a strong focus on toolstone extraction and only the earliest stages of opalite reduction. The majority of quarry bifaces have been subjected only to incipient edge preparation of the blanks; other items have not been reduced beyond primary thinning (Table 89). Toolstone extraction/early stage reduction is reflected by the relatively large average sizes of individual waste flakes and pieces of shatter (cf. below). Sample Features disclosed two different approaches to toolstone procurement at the site.

Feature 1

Centered on a prominent opalite exposure on the knoll top, Feature 1 is a bedrock outcrop quarry and associated reduction area. Procurement focused on both the outcrop and on material from the ground surface adjacent. Opalite that remains in situ appears to be inferior as toolstone; perhaps better material has been exhausted.

Figure 73. Site map, 26Ek3195.

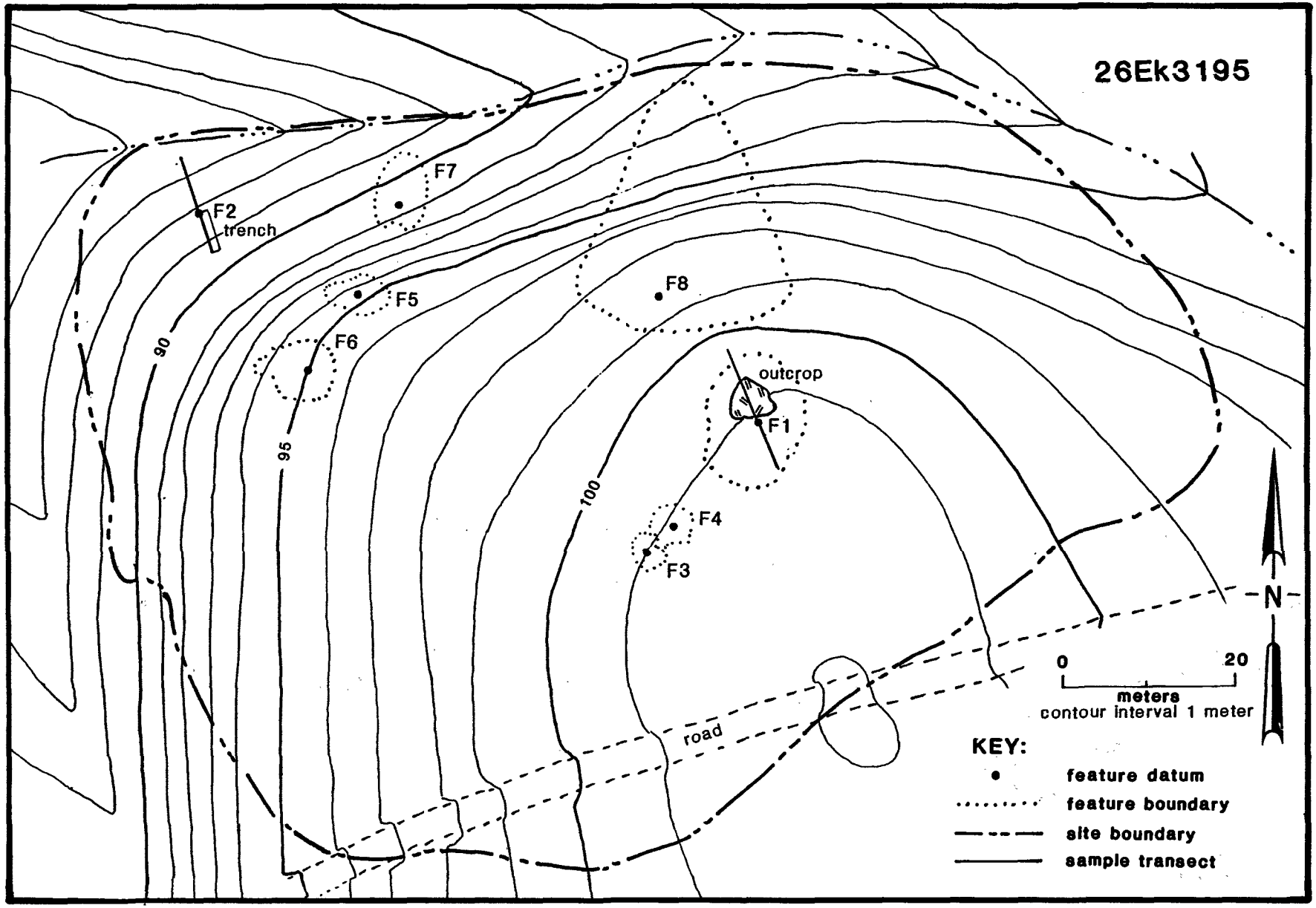

26Ek3195
F2
trench
F7
F5
F8
F6
90
95
100
outcrop
F1
F4
F3
road
N
0
20
meters
contour interval 1 meter
KEY:
feature datum
feature boundary
site boundary
sample transect

Table 90. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Quarry Pit/Reduction Complexes, Undine Gorge.

Site Number	Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction HM	CR	QB	SB	Processing SC	KN	PG	MP	OT	Total
26Ek3195	1*	Outcrop Quarry/Reduction	245	-	1	2	-	2	1	-	1	-	71
	2*	Quarry Pit/Reduction	143	2	6	10	-	3	-	-	-	-	21
	3	Quarry Pit/Reduction	86	1	-	3	-	-	-	-	-	-	4
	4	Quarry Pit/Reduction	49	-	-	1	-	-	-	-	-	-	1
	5	Biface and Core Reduction	50	-	-	4	-	-	-	-	-	-	4
	6	Outcrop Quarry/Reduction	132	-	-	3	-	-	-	-	-	-	3
	7	Quarry Pit/Outcrop Quarry/ Cobble Quarry/Reduction	132	3	1	3	-	-	-	-	-	-	7
	8	Outcrop-Nodule Quarry/ Reduction	795	-	-	2	-	-	-	-	-	-	2
	Extra-Feature Context		N/A	-	-	14	1	1	-	-	-	-	16
26Ek3197	1*	Quarry Pit/Reduction	71	-	-	4	-	-	-	-	-	-	4
	2	Quarry Pit/Reduction	48	-	-	-	-	-	-	-	-	-	0
	3	Core and Biface Reduction	33	-	-	3	-	-	-	-	-	-	3
	4	Outcrop Quarry/Reduction	236	2	-	1	-	-	-	-	-	-	3
	5*	Biface Cache	49	-	-	17	-	1	-	-	-	-	18
	6	Biface Reduction	88	2	-	-	-	-	-	-	-	-	2
	7	Outcrop-Cobble Quarry/ Reduction	17	1	-	1	-	-	-	-	-	-	2
	8	Core Reduction	154	1	1	1	1	-	-	-	-	-	4
	10*	Rockshelter	20	-	-	-	-	-	-	-	-	-	0
	11	Possible Adit		-	-	-	-	-	-	-	-	-	0
	Extra-Feature Context		N/A	-	-	6	-	-	-	-	-	-	6

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces

Maintenance/Processing
SC = Scrapers and Spokeshaves
KN = Knives
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tool

A line of five sampling units which spanned the feature revealed that the cultural content of the moderate density scatter of opalite debris blanketing the vicinity is quite low; debitage recovery rates in the sample units ranged from only 6 to 61 flakes per unit. Average individual flake size (4.9 gm) is quite high, commensurate with the quarrying and initial reduction inferred for the feature (Table 91).

Table 91. Debitage from Sample Feature Collections, Quarry Pit/Reduction Complexes, Undine Gorge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	Total
26Ek3195	1	245	.31	672.0	170	80.0	4.90	40	20.0	4.79	210
	2	143	.81	1072.0	449	51.5	5.64	422	48.4	8.38	871
26Ek3197	1	71	1.25	503.2	499	79.5	6.00	130	20.6	11.32	629

SUBSURFACE COLLECTIONS

Site Number	Fea. No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	Total
26Ek3197	5	1 / E	20	0.20	144	70.5	11.76	60	29.4	14.91	204
	10	1 / F	60	0.30	261	43.0	2.80	345	57.0	3.3	606

Key to Excavation Unit Type

A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen
E = 1 by 1 m, 1/4 in. screen
F = 50 cm by 1 m, 1/4 in. screen

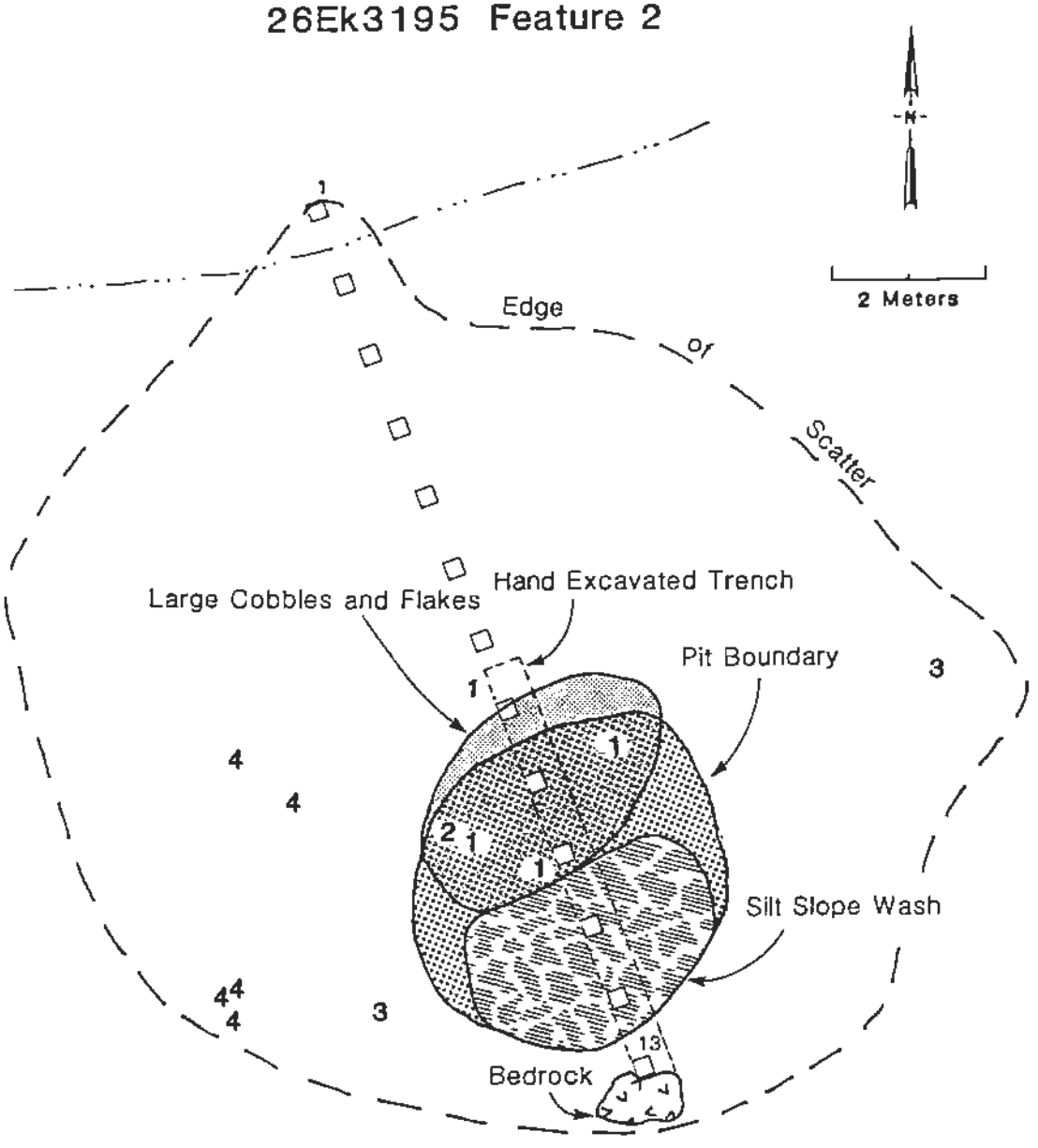
Feature 2

Feature 2, a 4 m diameter quarry pit and affiliated opalite debris, displays a suite of attributes (bedrock exposure, associated pit, surrounding berm, downslope talus of nodules and debris) that characterize numerous quarry features of the Tosawihi vicinity (Figure 74). A transect of 13 sample units tested all of these components, characterizing one dimension of its surface structure. Recovery rates by unit are presented in Table 92.

Comparison of Figure 74 to Table 92 discloses an extreme heterogeneity in the surface distribution of flakes related to the principal morphological components of the feature. The lower extent (Units 1 to 4) of the talus is composed of flakes far larger (mean average individual weight 4.6 gm) than the upper slope (Units 5-8, mean average individual weight 2.2 gm), attributable to colluvial redisposition. The interior of the pit achieves the greatest average flake weight (ca 14.5 gm at Unit 9) and the highest flake count (n=179, Unit 10) observed in the feature. Units 12 and 13, virtually devoid of cultural materials, occupy a zone in which the deepest portion of the pit has trapped more recent slopewash and obscured cultural surfaces.

Figure 74. Plan of Feature 2, site 26Ek3195.

26Ek3195 Feature 2



KEY:

1 Hammerstone

2 Core

3 Flake Tool

4 Quarry Biface

□ Collection Unit (25cm)

Table 92. Debitage from Sample Feature 2, site 26Ek3195.

SURFACE COLLECTIONS

Unit Number	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	Total
1	21	23.0	5.36	1	77.0	70.00	91
2	4	44.4	1.07	5	55.5	5.86	9
3	33		7.79	25		17.51	58
4	58	62.4	4.21	35	37.6	6.34	93
5	39	39.0	2.97	61	61.0	4.49	100
6	33	57.9	2.57	24	42.1	11.78	57
7	41	39.0	3.73	64	61.0	3.65	105
8	1	25.0	0.20	3	75.0	39.46	4
9	36	48.6	14.48	38	51.4	31.55	74
10	179	59.5	5.81	122	40.5	4.31	301
11	3	75.0	0.13	1	25.0	0.10	4
12	-	-	-	7	100.0	12.60	7
13	1	2.7	0.60	36	97.3	1.52	37
Total	449	51.5	5.64	422	48.5	8.38	871

To clarify details of internal pit structure, a trench was hand-excavated from the base of the opalite outcrop and the profile was recorded (Figure 75).

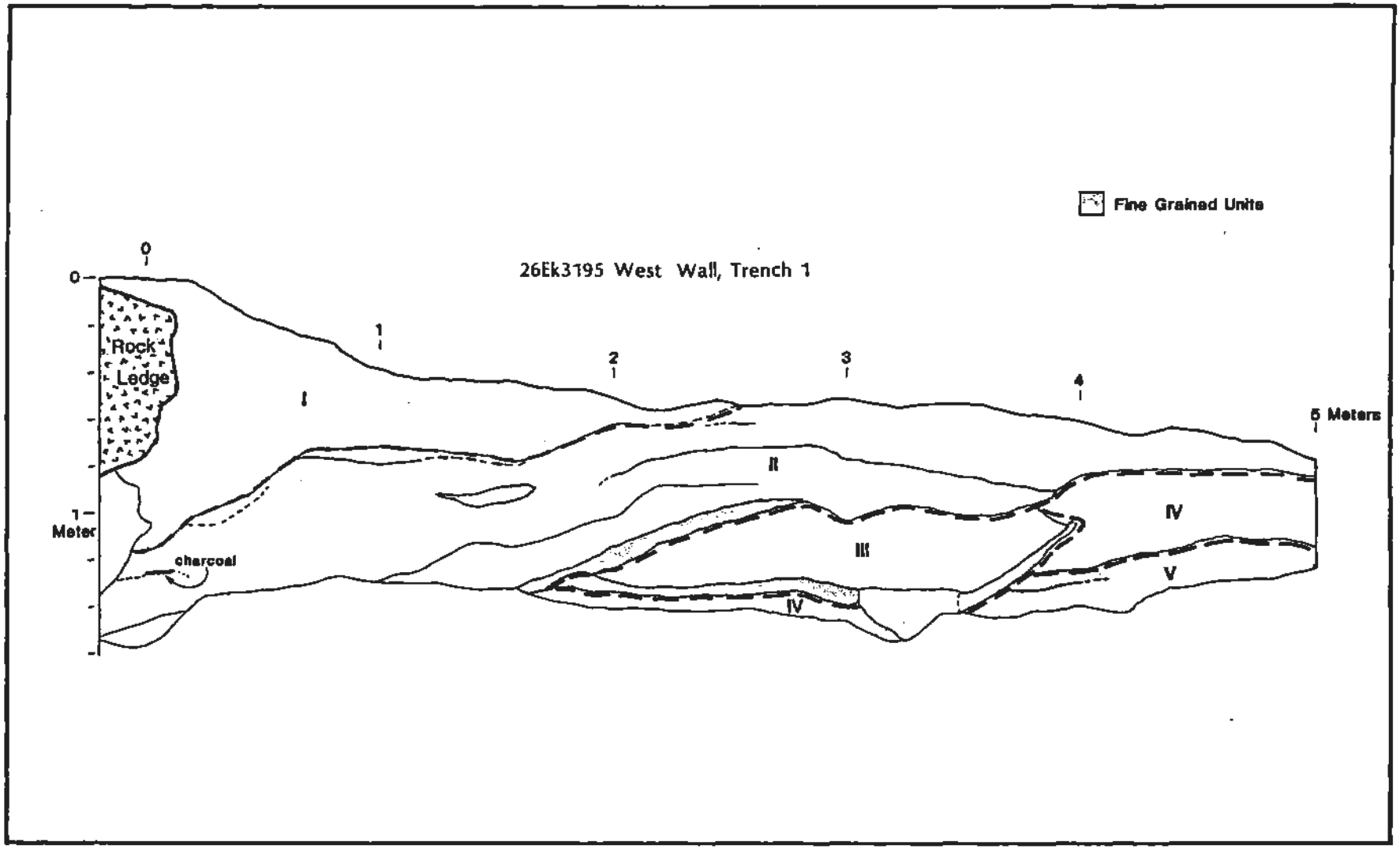
Bedrock was observed only at the outcrop, which is undercut at least 20 cm; we suspect the presence of an adit. The trench floor did not penetrate to bedrock.

Observed in the north end of the trench between 50 cm below the surface and the trench floor, Horizon IV is marked by a layer of rubble with few flakes in a matrix of gray brown soil. This is overlain by a layer of browner soil with few flakes that may represent slope wash accumulation. Both layers slope slightly down toward the outcrop. Horizon IV was also observed in the south end of the trench, extending 10 to 20 cm below the surface to the top of Horizon V, and is comprised of flakes and rubble in a matrix of gray brown soil.

Horizon III fills a pit that truncates Horizons V and VI. Extending 10 cm above the trench floor is a layer of clean, angular opalite, possibly representing quarry waste. This is overlain by a layer about 5 cm thick of dark gray silt and few flakes that probably is slopewash. Finally, the pit is filled with a thick layer of pink angular tuff and opalite rubble containing charcoal.

Horizon II is a thick pile of quarry waste extending from the surface at the berm to over 1 m in depth under the overhang

Figure 75. 26Ek3195, Trench 1, west wall profile.


Fine Grained Units
26Ek3195 West Wall, Trench 1
0
1
2
3
4
5 Meters
0
1 Meter
Rock Ledge
I
II
III
IV
V
IV
charcoal

in the outcrop. This material fills a pit that truncates Horizon III, and overlies Horizon IV. Horizon II probably can be divided into numerous stratigraphic units, several of which contain charcoal. Charcoal is concentrated in lenses beneath the outcrop, suggesting the possibility that firesetting was used to assist quarrying operations. Horizon I is a thick wedge comprised of gray brown gravelly silt with few, if any, flakes. It probably represents material that filled the pit through colluvial processes since the last time it was used.

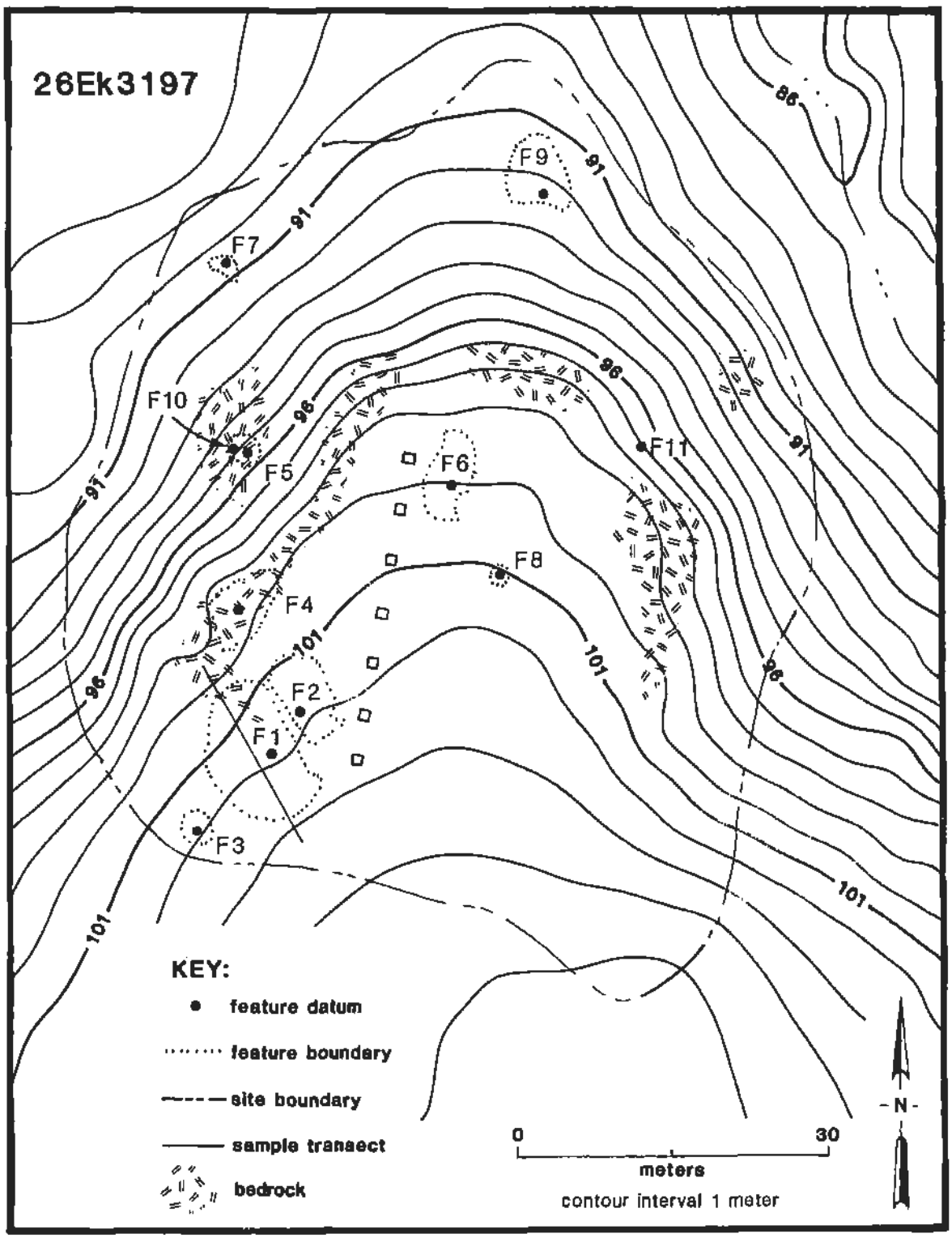
In summary, the feature represents an opalite quarry used during several episodes. The morphology and arrangement of stratigraphic layers suggest movement into the outcrop face; the bedrock overhang suggests the possibility of an adit. The deposits are stratified and have the potential for much greater depth than we actually observed. Charcoal is abundant, offering potential for dating episodes of use.

26Ek3197

The smaller Quarry Pit/Reduction Complex, 26Ek3197, occupies a broad peninsular shelf that juts northward from the foot of Corral Fan requiring a pronounced bend in the upper reach of Undine Gorge (Figure 76). The shelf is bounded on the west, north, and east by the drainage. Extensive exposures of white and grey brecciated opalite bedrock emerge over most of its surface, controlling its principal contours and undoubtedly conditioning its aboriginal use. Eleven cultural features, all directly attributable to primary opalite procurement and reduction, occur on the crest and along the rims of the shelf. These are concentrated in the northwestern quarter of the site, where toolstone extraction and processing efforts focused on surface and near-surface bedrock along the upper and mid-slopes of the landform. Two close-set quarry pits and their associated dense lithic scatters (Features 1 and 2) share the same contour on the upper slopes; below these, outcrop sources are exploited at Features 4 and 7. A bedrock overhang on the steep western mid-slope houses a small rockshelter (Feature 10), and a crag in the rimrock adjacent held a cache of quarry bifaces (Feature 5). Reduction stations (Features 6, 8, and 9) dot the more gentle northern slopes and one, Feature 3, accompanies the quarry pits perched somewhat higher up. On the eastern flank of the shelf, an adit-like excavation (Feature 11) extends about a meter into the base of a bedrock exposure. Examination of this feature failed to clarify its origins; whether it represents activities of historic or prehistoric vintage remains unknown, but its similarity to other recent explorations in the region suggests that it may be a consequence of historic mining.

The relatively flat, uppermost reach of the shelf lacks discernible cultural features. Instead, it is covered by an amorphous expanse of opalite debris in which a diffuse scatter

Figure 76. Site map, 26Ek3197.


26Ek3197
F9
F7
F10
F5
F6
F11
F8
F4
F2
F1
F3
86
91
96
101
KEY:
feature datum
feature boundary
site boundary
sample transect
bedrock
0
30
meters
contour interval 1 meter
N

of cultural debitage is intermingled with a dense blanket of naturally weathered materials.

The recovered assemblage suggests that prehistoric activities at 26Ek3197 focused on toolstone extraction and processing tasks even more narrowly than they did at 26Ek3195. In spite of its moderately large areal extent and numerous cultural features, 26Ek3197 yielded one of the smallest, least diverse collections of all Undine sites (Tables 88, 90). Reduction-related specimens comprise virtually the entire assemblage of 41 formed artifacts; only a single flake scraper suggests ancillary behavior. Quarry bifaces account for most (n=32), and 84% of these (n=27) are attributable to Stage II forms (Table 89). Correspondingly, hammerstones (n=6) comprise the only other sizeable artifact class. Except for debitage, numbers of artifacts in all features is quite low, save for the many bifaces comprising the cache.

Testing addressed a range of these toolstone-oriented activities by sampling the residues of quarry pit excavation (Feature 1) - opalite reduction at a rockshelter (Feature 10), and the stockpiling of partially processed material evidenced by the cache of quarry bifaces at Feature 5. A series of shovel skimmed units sampled the amorphous debris along the shelf.

Feature 1

The two quarry pits, Features 1 and 2, lie adjacent one another along a contour on the upper margin of the site. The dense accumulations of opalite debris surrounding them almost overlap; the abundance of surface debitage in the immediate vicinity is magnified further by the admixture of materials contributed by Feature 3, a reduction station, located just a few meters south. Feature 1, the larger and deeper of the pits (3.5 by 2 m in diameter, ca. 50 cm deep), was selected as our Sample Feature. It shares many attributes with the pit tested at 26Ek3195, including a well developed berm along its downslope edge and related dense lithic scatter around its perimeter. However, Feature 1 is strikingly depauperate of formed artifacts; only four quarry bifaces comprise the assemblage (Table 90).

A transect of 20 collection units sampled a longitudinal cross-section of the feature surface, along a baseline parallel to the site slope. Units 1-5 occur in the lithic scatter upslope of the quarry pit, Units 6-10 sample the pit itself, and Units 11 and 12 occupy the berm. The debris concentration below the berm was tested by Units 13-15 and Units 16-20 occur well downslope of the surface boundary of the feature. Table 93 summarizes debitage recoveries.

Table 93. Debitage from Sample Feature 1, Site 26Ek3197.

SURFACE COLLECTIONS

OPALITE DEBITAGE

Unit	Flakes			Shatter			
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	Total
1	9	75.0	1.44	3	25.0	1.60	12
2	6	85.7	1.81	1	14.3	11.80	7
3	23	95.8	1.35	1	4.2	1.30	24
4	26	96.3	4.43	1	3.7	144.70	27
5	80	86.9	4.71	12	13.1	5.25	92
6	37	52.1	10.35	34	47.9	5.45	71
7	43	71.6	5.54	17	28.3	2.25	60
8	10	83.3	3.05	2	16.7	3.05	12
9	37	80.4	2.39	9	19.6	1.55	46
10	29	85.3	1.97	5	14.7	26.50	34
11	42	67.7	1.07	20	32.3	9.65	62
12	18	100.0	0.68	-	-	-	18
13	14	73.7	21.74	5	26.3	14.60	19
14	28	90.3	14.58	3	9.7	34.36	31
15	22	88.0	4.10	3	12.0	16.56	25
16	17	80.9	4.23	4	19.1	94.82	21
17	30	85.7	3.98	5	14.3	10.00	35
18	8	80.0	6.61	2	20.0	4.15	10
19	7	70.0	76.92	3	30.0	3.20	10
20	13	100.0	3.08	-	-	-	13
Total	499	79.3	6.01	130	20.7	11.32	629

Results of the exercise disclose some fluctuations in the diversity and size of debris but, perhaps as a result of converging materials from adjoining features and the relatively steep slope, the levels of debris accumulation are less clearly partitioned than at 26Ek3195. The density of waste flakes tends to diminish downslope while individual average weights increase. Flakes appear to be somewhat more numerous within the pit and on its berm, and their incidence drops markedly beyond the visible limits of the concentration. While much of this density and size sorting may be attributable to colluvial action, the berm is composed of flakes smaller than those encountered in adjacent contexts. Possibly the berm was created by the aggregation of biface reduction debris, while the more robust pieces in areas surrounding the berm apparently are products of quarry pit excavation, toolstone assay, and the opalite blank preparation.

Feature 5

Feature 5 was manifested on the surface as a cluster of nine opalite quarry bifaces occurring within a 0.6 m^2 area on

the floor of a small, sheltered crag in the rimrock. A 1 m by 1 m excavation unit, centered on the cluster, revealed an additional 8 specimens just below surface at a depth of < 10 cm, all of them resting just above the bedrock substrate (ca. 15 cm B.S.). No stratigraphic evidence of intentional burial was observed in unit sidewalls.

The seventeen bifaces appear to represent a stockpile of items quarried and reduced elsewhere, then transported and secreted beneath the bedrock ledge, presumably in anticipation of further processing. All are of the same, bluish grey coarse-grained opalite. Material of this type does not occur in the bedrock surrounding the cache, nor is it represented in the debitage scatter that litters the immediate vicinity of the feature. Exclusively early reduction stages are represented by the bifaces; 82% (n=14) are Stage II forms, and the remainder are Stage III.

Feature 10

Lying some 20 m westward along the rimrock from the biface cache is Feature 10, a small rockshelter created by an overhang of brecciated opalite bedrock. Although 5 m wide, its aperture is presently only 90 cm high at the dripline and its ceiling slopes steeply downward to converge with the floor just 2 m inside the outer lip, a configuration offering little space accessible to human occupants. Perhaps reflecting its meagre shelter, cultural remains in the shelter are correspondingly sparse; it appears to have served as a repeatedly but never intensively used reduction station.

None of the local bedrock displays evidence of quarry use. The shelter floor is strewn with cobbles and small boulders apparently derived from roof-fall, and it is littered by a light, amorphous scatter of opalite debitage. Two denser accumulations of reduction debris occur on the rocky shelf just outside the overhang. All these scatters are composed exclusively of opalite waste flakes and shatter.

A 1 m by 50 cm excavation unit straddled the dripline on the shelter floor. Until bedrock was encountered at 60 cm, all vertical levels of the unit yielded similarly monothematic cultural materials consisting of opalite waste flakes and shatter (Table 91). These were distributed homogeneously, but diffusely, through the deposit. Their average weight, ca. 2.8 grams, is generally smaller than at quarry sources examined and is consistent with the toolstone reduction functions posited for the feature.

Soils within the unit consist of gravelly colluvial sand augmented by abundant slabs and cobbles of roof fall. Rodent turbation is extensive and pronounced. This, combined with

minimal human use of the shelter, has left little distinct stratigraphy. Minute flecks of charcoal are scattered diffusely throughout, and occur in slightly higher numbers only within a krotovina ca 10 cm below the surface; consequently, the feature offers little opportunity for the recovery of reliable samples for radiometric dating. Even those deposits located within the dripline are moist, making preservation of perishable materials unlikely. Bone fragments appear to be the remains of recently deceased rodents and contributions by carnivore scat.

The series of seven surface collection units arrayed across the amorphous scatter of opalite debris on the upper portions of the site illuminate the dispersed nature of its cultural component. The density of waste flakes ranges from 7 to 89 per m^2, and that of shatter, from 6 to 24 pieces per m^2. Average sizes of the remains are quite large (ca. 5 gm for flakes and 54 gm for shatter). Prehistoric use of the location appears to have been more sporadic and transitory than elsewhere on the site. The large average size of debitage suggests that toolstone was obtained in raw form from adjacent quarry features and transferred to the shelf for reduction, or that bedrock exposed on-site and weathered into cobbles was assayed and processed on the spot.

Summary

Site 26Ek3197 appears to have attracted prehistoric use principally for its toolstone quality opalite; evidence for behaviors other than toolstone procurement and processing is almost entirely lacking. The reduction of toolstone is testified primarily by the quantities of debitage left at the site. Quarry bifaces, presumably the focus of this task, are rare (if the cache is excluded) in comparison to most other sites, and those that do occur are predominantly early stage specimens. This suggests that much of the toolstone quarried and initially reduced at 26Ek3197 was transported elsewhere for further processing. The several Large Reduction Complexes on nearby Holeplug Ridge, which lack primary sources but evidence copious quantities of reduction debris, are plausible destinations for these minimally processed "toolstone packages."

Outcrop Quarry/Reduction Complexes: Context and Function

Cultural features of the four Outcrop Quarry/Reduction Complexes reflect aboriginal mining and processing of toolstone. Generally, they are differentiated from Quarry Pit/Reduction sites by the narrower range of toolstone extraction techniques employed; at none of them was toolstone accessed by excavation. Instead, raw material was liberated from opalite ledges and, to a lesser degree, from exposures of opalite cobbles. Too, site precincts of Outcrop Quarry/Reduction complexes typically

subsume larger numbers of distinct lithic debitage concentrations (i.e., reduction features) than do the Quarry Pit/Reduction sites (cf. Tables 90 and 95).

26Ek3196

Site 26Ek3196 occupies the western extreme of the principal knoll in the eastern half of the Undine Gorge area. It is topographically isolated from 26Ek3195 on the south by a shallow ephemeral drainage, and shares the knoll with most of the other open Undine sites that occur slightly upslope and further east on the landform (see Figure 72).

Seven cultural features define the site. Three of its four outcrop quarries (Features 1, 2, and 7) occur on the relatively steep western slopes of the knoll, and a smaller utilized bedrock exposure (Feature 4) occurs higher, on more level ground, where it is surrounded by three reduction stations, Features 3, 5, and 6. The two largest and apparently most intensively used of the quarries, Features 1 and 2, were selected as Sample Features. The manipulated bedrock outcrops at each of them are capped by extensive, dense pavements of natural and culturally derived opalite debris.

As at other quarry sites, recovered assemblages reflect toolstone extraction and early stage biface reduction (cf. Tables 88, 94). A relatively high incidence of cores and hammerstones highlights these activities, as does the prevalence (82%) of Stage 2 quarry biface (Table 89). A single groundstone fragment of unidentified function and several flake tools offer minimal evidence for ancillary maintenance tasks.

Feature 1

The battered facets of many opalite outcrops subsumed by Feature 1 testify to aboriginal toolstone exploitation; however, a possible prehistoric adit, representing a somewhat different approach to toolstone extraction, warranted special scrutiny.

The adit is a small declivity gouged into the bedrock at the base of a low opalite buttress on the southern flank of the knoll. Its aperture is 30 cm high and 1 m wide, and the excavation extends into the outcrop approximately 1 m. Its floor and the ground surface immediately outside are obscured by a dense accumulation of opalite debitage and non-cultural lithic debris. The ceiling of the recess appears fire-blackened and spalled. The bedrock is composed of high quality toolstone; apparently it had sufficient value to inspire a great expenditure of extraction effort. The bedrock exposed elsewhere on the outcrop is highly weathered, softer and grainier in texture, and of lower toolstone utility.

Table 94. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Quarry/Reduction Complexes, Undine Gorge.

Site Number	Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction								ARTIFACT CLASSES: Processing						
				HM	SS	CR	AS	QB	SB	PB	IB	SC	KN	PG	MP	OT	GS	Total
26Ek3196	1*	Adit/Outcrop Quarry/Reduction	905	3	-	14	1	5	1	-	-	2	-	-	1	1	-	28
	2*	Outcrop Quarry/Reduction	2592	4	-	5	-	8	-	-	-	1	1	-	-	-	1	20
	3	Core Reduction	35	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	4	Outcrop Quarry/Reduction	16	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
	5	Core and Biface Reduction	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	6	Core and Biface Reduction	31	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	7	Outcrop Quarry/Reduction	528	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
	Extra-Feature Context		N/A	1	-	4	-	-	-	-	-	-	-	-	-	-	-	5
26Ek3201	1*	Biface Reduction	102	-	1	-	-	9	3	-	1	-	-	1	-	-	-	15
	2*	Biface Reduction	151	1	-	-	-	21	1	-	-	-	-	-	-	-	1	23
	3*	Biface Reduction	38	1	-	-	-	3	-	-	-	-	-	-	-	-	1	5
	4*	Outcrop Quarry/Lithic Scatter	679	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2
	Extra-Feature Context		N/A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
26Ek3203	N O F E A T U R E S																	
	Extra-Feature Context		N/A	-	-	5	-	4	2	-	-	-	-	-	-	-	-	11

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts

HM = Hammerstones
SS = Scratched Stones
CR = Cores
AS = Assayed Stones
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces
IB = Indeterminate Biface Fragments

Maintenance/Processing

SC = Scrapers and Spokeshaves
KN = Knives
PG = Perforatores and Gravers
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tool
GS = Groundstone

Table 95 summarizes the results of our 1 m by 1 m shovel skim and coterminous excavation unit that sampled the area immediately outside the adit; our discontinuous baseline of collection units sampled the dense blanket of lithic debris upslope.

Table 95. Debitage from Sample Feature Collections, Outcrop Quarry/Reduction Complexes, Undine Gorge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3196	*1	N/A	1	691.0	394	57.0	3.21	297	43.0	9.60	-	-	691
	1	905	2	435.0	419	38.5	3.75	669	61.4	10.00	-	-	1088
	2	2592	3.25	540.9	1443	82.0	5.98	315	18.0	29.20	-	-	1758
26Ek3198	1	24	30	91.7	2442	88.7	1.07	279	10.0	4.40	31	1.3	2752
	+2	0.9	3	220.6	598	90.3	3.24	64	9.7	1.87	-	-	662
	9	239	2	62.5	107	85.6	2.30	18	14.4	2.72	-	-	125
	14	151	2.75	298.2	702	85.6	5.56	118	14.4	70.20	-	-	820
26Ek3201	1	102	2	656.0	1257	95.8	1.20	30	2.2	3.80	25	2.0	1312
	2	151	7	383.5	2616	97.4	1.05	69	2.6	2.40	-	-	2685
	4	679	1.50	128.0	164	85.4	10.70	28	14.5	42.16	-	-	192
26Ek3203	N/A		3.75	149.6	387	69.0	3.90	174	31.0	11.52	-	-	561

SUBSURFACE COLLECTIONS

Site Number	Fea. No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3196	*1	1 / E	30	0.3	2911	75.0	3.25	976	25.0	17.6	-	-	3887
26Ek3198	1	1 / AA**	20	0.2	154	57.8	0.75	35	13.1	2.3	77	28.9	266
26Ek3201	1	1 / F	20	0.1	24	100.0	1.80	-	-	-	-	-	24

Key to Excavation Unit Type

A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen
E = 1 by 1 m, 1/4 in. screen
F = 50 cm by 1 m, 1/4 in. screen

* Adit within Feature 1
** Level 2 reduced to Unit Type D
\+ 1/8 in. screen

Recovery rates reveal accumulations of formed artifacts and opalite debris fronting the adit that appear to support our assumptions of its prehistoric origin. Until bedrock was reached at ca 30 cm depth, each vertical provenience of the deposit yielded opalite debris in such high densities that it comprises almost the entire volume of the excavated sample; soils contribute a minor intervening matrix amid the lithic waste. As might be expected with primary extraction efforts, average individual size of debitage is quite large; waste flakes weigh on average 3.25 gm, and shatter a robust 17.6 gm per item. As a class, shatter comprises about one-third the total material recovered, but makes up some 67% of the weight of the assemblage. Formed artifacts reflect toolstone processing exclusively. Composition of the collection suggests that, upon liberation of toolstone from the adit walls, it was rendered into cores (n=12) and reduced as far as Stage 2 Quarry Bifaces (n=2) on the spot. Apparently, these were then transported elsewhere for later stages of reduction.

The dense cultural content of deposits associated with the adit is emphasized further when retrievals there are compared to the sample obtained by our discontinuous baseline of 10 1 m x 1 m collection units that spanned the lithic scatter immediately upslope of the feature (Table 95).

Although the area sampled is densely blanketed by opalite debris, its cultural component is rather diffuse, containing on average only 41 waste flakes and 67 pieces of shatter per m (cf. the adit shovel skim densities of 394 flakes and 297 shatter). The average flake size (3.7 gm) is comparable to those at the adit, that of shatter, somewhat lower. Two cores, a pair of hammerstones, and one Stage 2 and one Stage 3 quarry biface suggest that here, as well, reduction focused on early processing of opalite raw materials; these most likely derived from cobbles within the scatter and from the battered outcrops that flank it.

Feature 2

Feature 2 encompasses a prominent bedrock ledge that has been battered in several locations for the liberation of opalite toolstone. Processing of this material appears to have occurred primarily upon the relatively flat bench immediately above the ledge, as evidenced by two dense scatters of reduction debris. Presumably by means of colluvial action, bedrock-free gaps in the ledge have allowed quantities of debris to be transported downward onto the steep slopes below; this in large part appears to account for the feature's extreme size (>2500 m^2).

Our discontinuous series of 50 by 50 cm collection units sampled both of the dense patches of lithic debris as well as contexts within the more diffuse scatters upslope. Units 1-9

examined the southern component, with Units 6-9 falling within the concentrated portion of it; Units 10-13 were each located within the concentrated portion of the northern scatter. Recoveries are summarized in Table 95.

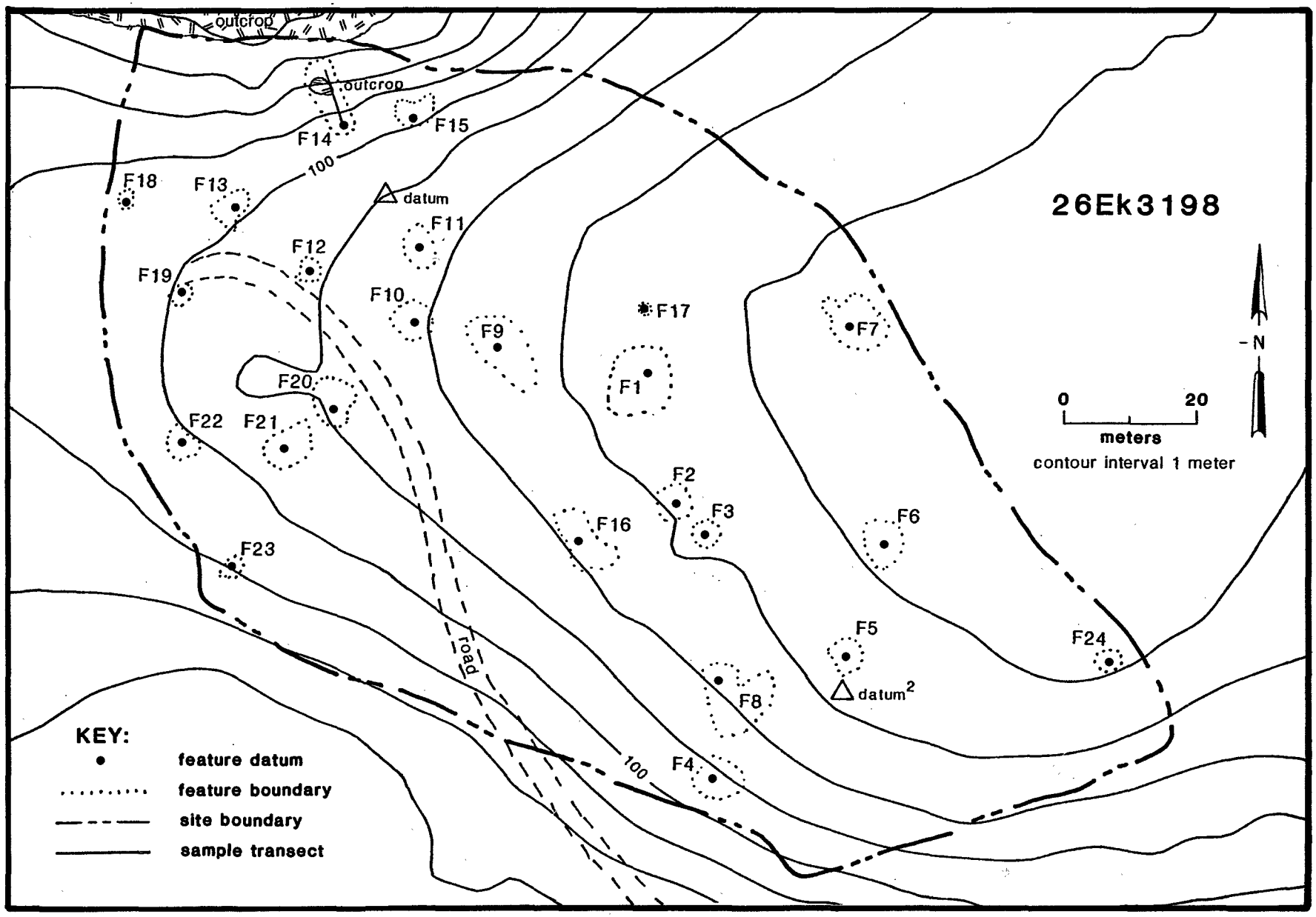
Debitage yielded by samples of both concentrations appear quite similar in character. The densities and average sizes of waste flakes recovered from the two concentrations are roughly identical (ca. 180 flakes per unit and 7.6 gm per flake in the southern concentration, 171 flakes per unit and 7.8 gm per item in the northern). As well, each concentration is augmented by very large specimens of opalite shatter weighing on average ca 49 gm and 33 gm respectively. Formed artifacts are less evenly distributed in the sample. The northern concentration yielded 4 cores, a hammerstone, and 2 Stage 2 quarry bifaces; the southern concentration contained a single core. Those units falling beyond the visible surface concentration of the southern scatter manifest markedly reduced flake densities (ca. 7 flakes per unit), and these are of somewhat smaller size (5.3 gm) than those encountered in either of the concentrations. Like the scatter defining the upper portions of Feature 1, Feature 2 also appears to reflect quarrying and initial biface preparation; the distribution of cultural materials at Feature 2, however, suggests that toolstone extraction and processing were more spatially focused there.

26Ek3198

26Ek3198 occupies the crest of the principal knoll overlooking the eastern reach of Undine Gorge (Figure 72). In our original survey report (Raven 1988), this site was designated a "large reduction complex." Closer scrutiny during testing, though, revealed several toolstone sources within its precincts, leading us to reclassify the site. Still, however, aboriginal use of the locality appears to relate primarily to the reduction, rather than the extraction, of lithic raw material.

Of the 24 cultural features comprising the site (twice the number detected originally), 19 consist of single reduction stations. Varying in size and composition, they are strewn over the central, nearly flat portion of the knoll top (Figure 77). Quarrying, by contrast, occurs in only four locations; most seem to represent minor extraction efforts. Feature 14 resulted from use of a low outcrop at the site's northwestern extreme, and several small exposures of opalite cobbles were exploited in widely scattered places throughout the site (Features 8, 15, and 24). Only the outcrop quarry Feature 14 contains evidence of substantial toolstone procurement.

Figure 77. Site map, 26Ek3198.


outcrop
outcrop
F14
F15
100
F18
F13
datum
F11
F12
F19
F10
F17
F9
F7
F1
F20
F22
F21
F2
F3
F16
F6
F23
F5
F24
road
datum2
F8
F4
100
KEY:
feature datum
feature boundary
site boundary
sample transect
26Ek3198
N
0
20
meters
contour interval 1 meter

Feature 1 reflects activities ancillary to, but supportive of, toolstone manipulation. Here, an abundance of projectile points and maintenance tools appears to represent a hunting stand, temporary camp, or a special activity area.

Inventory and sampling operations at 26Ek3198 resulted in the collection of 5571 cultural items, including the largest (n=126) assemblage of formed artifacts recovered from the Undine sites (Tables 88, 96); predictably, the vast majority of the collection is composed of opalite debitage.

The collection is notable in several respects. First, quarry bifaces appear to have been more fully reduced at 26Ek3198 than they were elsewhere (cf. Table 89); more than half of the specimens from 26Ek3198 are Stage 3 forms and almost 20% have been processed to Stage 4, suggesting an emphasis on intermediate stages of reduction. The relatively high frequency of cores and assayed pieces in the assemblage would seem to contradict this suggestion, save that all of the cores and assayed pieces collected at the site were recovered from Feature 14, the small outcrop quarry. We suspect that most of the material reduced at 26Ek3198 was imported to the site in the form of Stage 2 bifaces obtained from neighboring quarry sites that flank it on three sides.

Feature 1

Already distinctive for the large numbers of projectile points and obsidian flakes visible before testing, shovel-skimming the entire surface of the feature, followed by the excavation of a 1 m by 1 m unit centered on its zone of greatest concentration, served to amplify the abundance and diversity of its contents. The assemblage looks much like the accumulation predictable for a small hunter's temporary camp or tool maintenance station; the 6 quarry bifaces recovered comprise a miniscule portion of the formed artifact collection. The assemblage includes over 80% (n=6) of the projectile points and all, save one, of the projectile point preforms recovered from the site. As well, 14 of the 17 flake tools and all of the knives (n=3) found at the site are contributed by the feature. A shaft abrader, unique among USX-East collections, was also encountered there. Our subsurface probe suggests that the feature is confined largely to the upper 10 cm of the deposit; below this level artifact yields are markedly reduced. Debitage retrievals are summarized for both surface and subsurface samples in Table 96.

Feature 2

Feature 2, appearing on the basis of very limited surface exposure to consist of a buried core-reduction station, was

Table 96. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3198.

Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction						Points		Processing						Other	Total
			HM	CR	AS	QB	SB	PB	PT	FG	SC	KN	PG	MP	OT	AB	CE	
1*	Lithic Scatter/Hunting Camp	24	-	-	-	6	2	11	6	11	7	7	1	5	1	1	-	54
2*	Core Reduction	0.9	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	3
3	Biface Reduction	22	-	-	-	3	2	1	1	-	-	-	-	-	-	-	-	7
4	Core and Biface Reduction	86	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
5	Biface Reduction	50	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5
6	Biface Reduction	26	-	-	-	5	-	-	-	-	-	-	-	1	-	-	-	6
7	Core Reduction	123	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
8	Cobble Quarry/Reduction	297	-	-	-	3	-	-	1	-	-	-	-	-	-	-	-	4
9*	Core Reduction	239	-	-	-	2	-	-	-	-	-	-	-	-	-	-	4	6
10	Core Reduction	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
11	Core and Biface Reduction	19	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
12	Biface Reduction	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
13	Core and Biface Reduction	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
14*	Outcrop Quarry/Reduction	151	2	5	3	8	-	-	-	-	-	-	-	-	-	-	-	18
15	Cobble Quarry/Reduction	33	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
16	Biface Reduction	170	-	-	-	5	1	-	-	-	-	-	1	-	-	-	-	7
17	Biface Reduction	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
18	Biface Reduction	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
19	Core and Biface Reduction	14	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
20	Biface Reduction	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
21	Biface Reduction	24	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5
22	Core and Biface Reduction	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
23	Biface Reduction	5	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
24	Cobble Quarry/Reduction	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Extra-Feature Context		N/A	-	-	-	2	2	-	1	-	-	-	-	-	-	-	-	5

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
CR = Cores
AS = Assayed Stones
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Other
CE = Ceramic Sherds

Maintenance/Processing
SC = Scrapers and Spokeshaves
KN = Knives
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tool
AB = Abraders

found upon testing to be composed of a dense cluster of fairly small opalite flakes and shatter, a scraper, and a single Stage 2 quarry biface. The surface distribution was found, in fact, to map rather accurately the distribution of artifacts immediately below the surface (i.e., 0-2 cm), although the latter were considerably more abundant. The "off-feature" 1 m by 1 m collection units placed just beyond the apparent limit of the surface scatter produced dramatically less debitage (6 flakes, and no shatter) than the units centered on the visible scatter. Large average individual sizes of flakes (ca 3.2 gm) appears to substantiate our original identification of the feature as a core-reduction locale (Table 96).

Feature 9

Testing of Feature 9 was predicated on the surface occurrence of three ceramic sherds and the implied possibility that the feature might contain greater diversity than suggested by the surface scatter of opalite debitage. Our 1 m by 2 m sample produced one additional sherd, a pair of Stage 2 quarry bifaces, 107 opalite flakes, and 18 pieces of opalite shatter. We suspect that the ceramic vessel may have been broken in transit and may bear no intrinsic functional relationship to the feature. The average individual size of flakes (2.3 gm) is commensurate with the reduction stages displayed by the small collection of quarry bifaces, and suggests early stage toolstone processing functions for the feature.

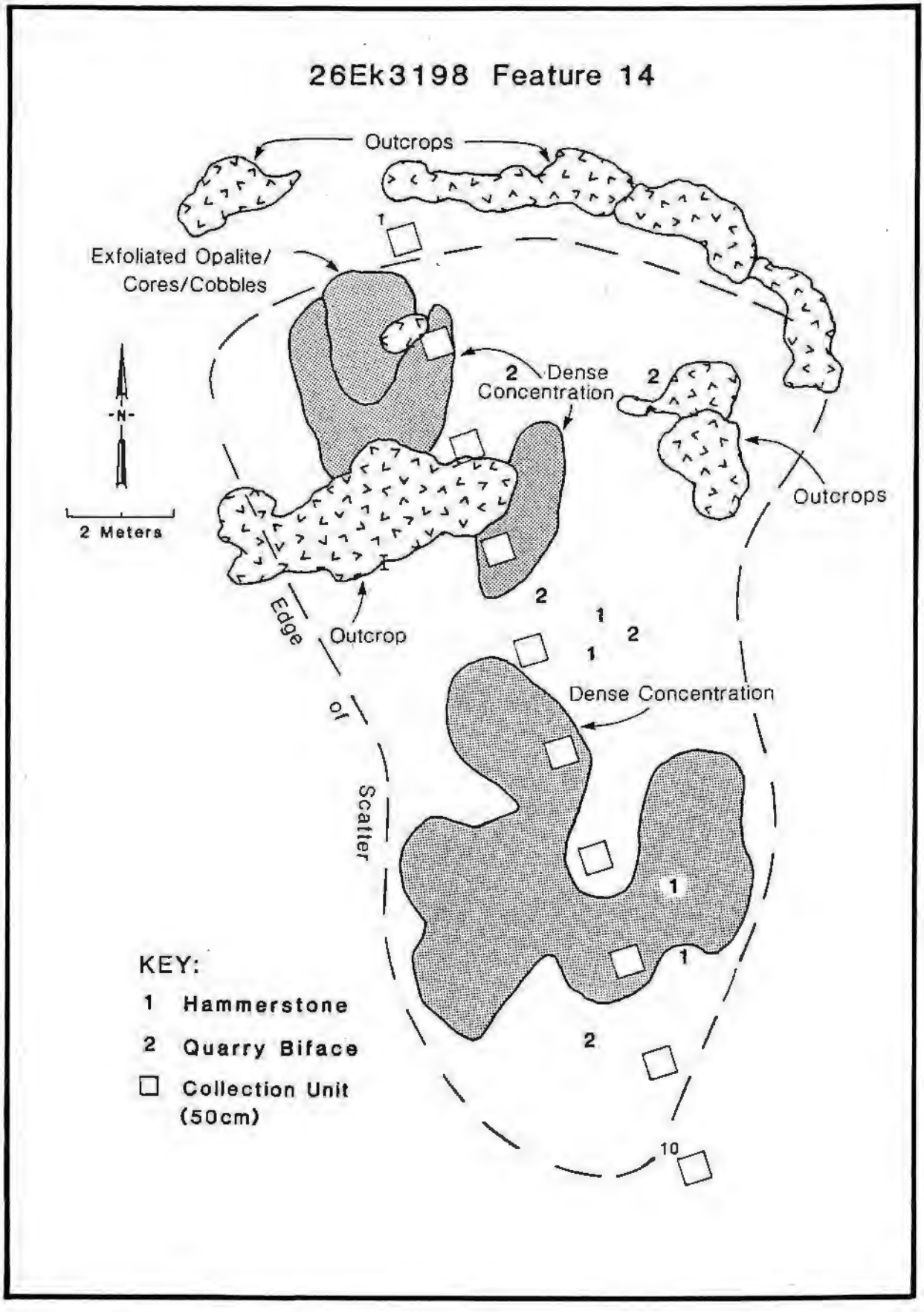
Feature 14

Feature 14 is the only major quarry located within 26Ek3198. It occurs at an opalite outcrop on the northern brink of the knoll (Figure 78). Toolstone exploitation is reflected in several concentrations of debris, and our discontinuous transect of sampling units was placed to test the artifact content both within and between recognizable concentrations. Table 97 presents recovery rates by unit.

The densest concentrations occur just downslope of the principal outcrop (Unit 2) and about an equal distance upslope from it (Unit 5); average flake weights (4.4 gm and 5.7 gm, respectively) are fairly robust in both cases.

Noting an apparent concentration of cores and large shatter just off our sample line, we imposed an additional sampling unit (Unit 11) to increment the range of variability tested. This unit produced all 5 of the cores recovered from the site, as well as its only Stage 1 quarry biface. Average weights for the 11 opalite flakes (ca 34 gm) and 56 pieces of shatter (ca 118 gm) obtained from Unit 11 are very high. Clearly, this portion of the feature reflects some of the earliest stages in

Figure 78. Plan of Feature 14, 26Ek3198.


26Ek3198 Feature 14
Outcrops
Exfoliated Opalite/
Cores/Cobbles
1
2
Dense
Concentration
2
Outcrops
-N-
2 Meters
2
Edge
of
Scatter
Outcrop
1
2
1
Dense Concentration
1
1
2
10
KEY:
1 Hammerstone
2 Quarry Biface
Collection Unit
(50cm)

extraction and reduction. The large fragments utterly blanketing the surface suggest they may continue to significant depth. Alternately, since no pit has been developed, yet the topographic relationship of the outcrop and the surrounding landform reflects that of quarry pits elsewhere in the project area (cf. 26Ek3170, -3171, -3196, and 3200), it may be that Feature 14 represents an earlier point in the sequence of site formation that eventually results in quarry pits. On the other hand, earlier episodes of quarrying may be buried beneath the overburden of primary debitage and shatter.

Table 97. Debitage from Sample Feature 14, Site 26Ek3198.

SURFACE COLLECTIONS

OPALITE DEBITAGE

Unit	Flakes			Shatter			
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	Total
1	24	92.3	3.57	2	7.7	168.65	26
2	231	95.1	4.41	12	4.9	32.89	243
3	13	100.0	1.86	-	-	-	13
4	50	96.1	4.44	2	3.9	19.35	52
5	115	100.0	5.74	-	-	-	115
6	80	87.0	3.56	12	13.0	6.45	92
7	81	93.1	5.51	6	6.9	42.48	87
8	43	75.4	8.75	14	24.6	26.59	57
9	50	78.1	8.24	14	21.9	13.65	64
10	4	100.0	0.60	-	-	-	4
11	11	16.4	33.9	56	83.6	118.29	67
Total	702	85.6	5.56	118	14.4	70.25	820

In sum, the composition of the majority of cultural features at 26Ek3198 relate overwhelmingly to intermediate stages of opalite toolstone reduction. Although opalite sources occur in sufficient numbers to classify the site an "Outcrop Quarry/Reduction Complex," these are apparently little used save at Feature 14. The seeming low intensity of quarrying evidenced by the on-site sources leads us to assume that most of the toolstone processed at the site originated at other nearby sources. In addition to its temporally diagnostic artifacts, the informative but anomalous lithic scatter of Feature 1 contributes the majority of non-quarry artifacts to the assemblage. These tools are concentrated in a single, spatially discrete feature, which may inform us about prehistoric activities coincident with more narrowly focused aboriginal mining tasks.

26Ek3201

Site 26Ek3201 overlooks the upper reach of Undine Gorge from the northern flank of the principal knoll in the eastern half of the study area (see Figure 72). It encompasses only three Reduction Stations and an Outcrop Quarry (Figure 79). Like 26Ek3198, sharing the knoll top just to the west, the opalite source at 26Ek3201 appears little used; aboriginal occupants seem instead to have employed the site primarily as a base for toolstone reduction convenient to other nearby sources. As at 26Ek3198, a relatively high proportion of quarry bifaces processed at 26Ek3201 appears to have been reduced further than those at other Undine sites (cf. Table 89). Although more quarry bifaces in the collection are early reduction products (Stage 2 forms n=18, 55%), the relative proportion of specimens advanced to intermediate reduction stages (Stage 3 n=14, 42%) is larger than that at any other site in the area save 26Ek3178 and 26Ek3177.

Opalite debitage makes up the bulk of the 4162 cultural items recovered. The formed artifact assemblage (n=48) is dominated by implements directly related to toolstone processing (93.7%, n=45); maintenance/subsistence oriented items comprise the scant remainder. The distribution of formed artifacts is restricted almost exclusively to the confines of features; only a single hammerstone was encountered in a non-feature context (Table 94).

Feature 1

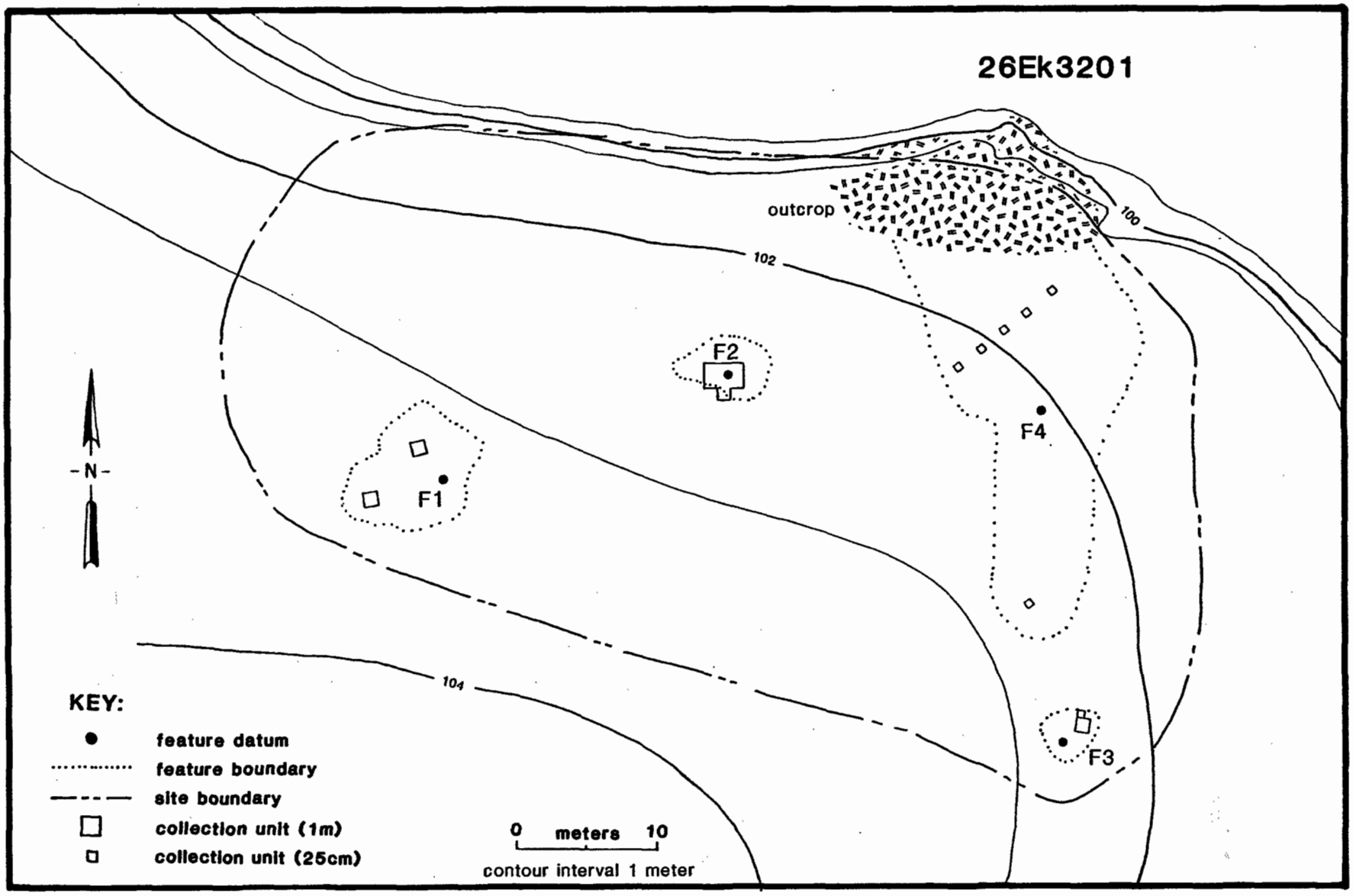
Three dense, close-set concentrations of opalite reduction debris, interspaced by a moderate density lithic scatter, define Feature 1. One of these concentrations, which displayed several pieces of obsidian debitage on its surface, was sampled by our 1 m by 1 m collection Unit 1. Unit 2 was placed in the moderate density scatter between concentrations. Recovery rates are offered in Table 95 and 98.

Table 98. Debitage from Sample Feature 1, Site 26Ek3201.

SURFACE COLLECTIONS

Unit	OPALITE DEBITAGE						OTHER		
	Flakes			Shatter			DEBITAGE		
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
1	900	94.4	1.37	28	2.9	4.07	25	2.7	953
2	357	99.4	0.78	2	0.6	1.25	-	-	359

Figure 79. Site map, 26Ek3201.


26Ek3201
outcrop
100
102
104
F1
F2
F3
F4
N
KEY:
feature datum
feature boundary
site boundary
collection unit (1m)
collection unit (25cm)
0 meters 10
contour interval 1 meter

The resulting collection is informative two ways. First, the strikingly different yields of the units imply that the concentrations visible on the surface are spatially very discrete; densities observable by surface inspection alone predict those immediately below the surface (i.e. < 2 cm). Second, the relatively low average weight of individual flakes (ca 1 gm per item), coupled with the comparatively low incidence of shatter, appears to be consistent with the types of quarry bifaces recovered. Of the 9 quarry bifaces most (n=5, 56%) display attributes of intermediate reduction (Stage 3), while Stage 2 forms comprise one-third (n=3) of the set (one specimen is of indeterminate stage). We take the lack of cores, as well as its paucity of large waste flakes and shatter, to suggest that opalite arrived at Feature 1 in the form of either flake blanks or, more likely, Stage 2 quarry bifaces.

Feature 2

Except for the absence of obsidian debitage, the artifact content of the reduction station at Feature 2 appears similar to that at Feature 1. Surface manifestations, however, are not reliable indicators of the distribution of remains lying immediately out of view (< 2 cm depth). Our collection grid of 7 1 m by 1 m units centered on and exceeded the visible horizontal limits of the largest of two dense lithic concentrations which define the feature (Table 95). Some units external to the feature yielded higher debitage returns than some units within it. Mechanisms accounting for these discrepant distributions probably have to do with post-deposition processes; this is one of the issues to be addressed by further data recovery.

Amounts of debitage appear to be concordant with the types of Quarry Bifaces recovered. The occurrence of 12 Stage 2 specimens (57%) and 9 Stage 3 specimens (43%) is consistent with the relatively small flake sizes and minor quantities of shatter encountered.

Feature 3

A small, moderate density scatter composed largely of opalite reduction debris, Feature 3 was sampled by a 1 m by 0.5 m excavation unit because a dozen metate fragments were observed on its surface. Their presence hinted that activities additional to toolstone processing occurred there, but results of our probe were equivocal.

The two excavation levels, both heavily turbated, yielded a very few (n=24) opalite waste flakes, and five additional metate fragments. In addition, they exposed an amorphous charcoal stain of ambiguous vintage. The charcoal stain appeared similar

to ones observed on the ground surface elsewhere which were clearly attributable to recent burning of sagebrush roots. The stain in Unit 1 is somewhat more diffuse, a result, perhaps, of ostensible rodent churning. All seventeen fragments pertain to the same metate; some of the pieces are heavily fire affected while others, refitted adjacent to burned ones, appear pristine. The contrasting condition of the fragments may reflect re-use of some of them as cooking stones. However, given the recent and certainly long history of range fires in the region, natural causes fragments' condition as well as for the shallow zone of charred soils cannot be ruled out.

Feature 4

Feature 4 is an extensive but apparently little-used outcrop quarry located on a broad expanse of rimrock that immediately overlies the 26Ek3177 rockshelter. Two bedrock outcrops evidence minor battering; elsewhere, the feature is defined by a diffuse scatter of debitage intermixed with denser accumulations of natural opalite debris (Table 99).

Table 99. Debitage from Sample Feature 4, Site 26Ek3198.

SURFACE COLLECTIONS

OPALITE DEBITAGE

Unit	Flakes			Shatter			
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	Total
1	100	100.0	14.80	-	-	-	1
2	119	87.5	10.58	17	12.5	4.46	136
3	4	100.0	30.20	-	-	-	4
4	1	100.0	13.90	-	-	-	1
5	1	100.0	2.80	-	-	-	1
6	38	100.0	9.04	-	-	-	38
Total	164	90.6	10.7	17	9.4	4.46	181

Units 1-5 spanned the diffuse lithic scatter. Their meager cultural content, save in Unit 2, suggests minimal use of the area. The large average size of the flakes recovered (14.5 gm) echoes its principal function as a quarry source where apparently only the earliest stages of opalite processing (core and/or possibly blank preparation) took place. Unit 6 sampled a more concentrated scatter of debitage surrounding one of the battered opalite outcrops. Here waste flakes are more numerous, and their large average size and the concomitant abundance of large shatter are commensurate with those anticipated for quarrying debris.

Formed artifacts are exceedingly scarce; A core and a hammerstone make up the entire assemblage.

26Ek3203

Site 26Ek3203 occupies a narrow shelf of rimrock at the brink of Italian Mesa on the north side of Undine Gorge, affording a good view of the confluence of Undine Gorge and Little Antelope Creek to the southwest. The site appears to have been utilized only minimally in comparison to most other nearby quarry sources. Few formed artifacts occur there, all of them (n=13) related directly to toolstone procurement and early stages of opalite processing. The distribution of artifacts is diffuse; they occur in a moderately dense scatter of naturally liberated opalite fragments strewn over the entire site area. Nowhere are they sufficiently concentrated to form discernible cultural features.

Our discontinuous transect of 15 50 cm by 50 cm collection units sampled the cultural content of the scatter across the entire downslope axis of the site. The uppermost units (Units 1-5) span a relatively flat area, and those below (Units 6-15) cross a steeper (ca. 4-5%) grade. Unit-specific debitage retrievals are summarized by Table 100.

The relatively large size of individual debitage items and the abundance of shatter reflect quarrying and early stage lithic reduction. Units yielded an average of only 26 flakes and 12 pieces of shatter; and these items are relatively large, flakes averaging ca. 4 gm and shatter, 12 gm. Due either to colluvial processes or the more commodious working contexts offered by the relatively flat upper portion of the site, units there contain a somewhat greater abundance of smaller debitage than occurs downslope. Upslope units (1-5) returned on average 34 waste flakes and 18 pieces of shatter, weighing 3 gm and 5 gm, respectively. Downslope, Units 6-15 yielded on average of 21 flakes and 7 pieces of shatter per unit, flakes weighing an average of 5 gm, shatter, 13 gm.

The formed artifact assemblages reflect emphasis on early stages of toolstone processing and the dispersed rather than spatially focused nature of the remains. Five cores were encountered in surface collection units suggesting relatively high incidence throughout the site. Conversely, only one of four quarry bifaces (all Stage 2 forms) was recovered in a collection unit; the remainder were recovered from widely scattered locations.

Table 100. Debitage from Discretionary Surface Collection Units, Site 26Ek3202.

SURFACE COLLECTIONS

Unit Number	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	Total
1	62	56.8	4.26	47	43.2	9.90	109
2	19	100.0	0.57	-	-	-	19
3	46	51.1	1.80	44	48.9	9.90	90
4	21	67.7	4.96	10	32.3	3.20	31
5	21	77.7	3.50	6	22.2	2.46	27
6	37	69.8	3.59	16	30.2	16.70	53
7	5	55.5	4.78	4	44.4	1.85	9
8	58	61.0	1.60	37	38.9	16.48	95
9	3	100.0	0.46	-	-	-	3
10	19	86.4	2.73	3	13.6	21.26	22
11	31	88.6	4.07	4	11.4	19.90	35
12	25	100.0	6.27	-	-	-	25
13	23	92.0	10.43	2	8.0	12.70	25
14	8	100.0	14.16	-	-	-	8
15	9	99.0	4.90	1	1.0	1.70	10
Total	387	68.9	3.90	174	31.1	11.50	561

Rockshelters: Context and Function

Of the three rockshelters tested at USX-East, two, 26Ek3177 and -3202, appear to be comparatively little used, as testified by their depauparate and functionally limited artifact assemblages. Each assemblage is dominated by items indicative of toolstone processing, but less so than elsewhere in the project area. Although collections from all of the rockshelters are augmented by maintenance and/or subsistence related tools, only the largest rockshelter, 26Ek3204, offers these implements in quantities and varieties suggestive of at least some degree of residentiality (cf. Tables 88 and 101).

26Ek3177

The smallest of the rockshelters, 26Ek3177, occurs in the rimrock just below the outcrop quarry at 26Ek3201. An overhang of opalite bedrock provides limited protection over an area of ca. 5 m^2 within its 1 m high dripline. Several places on the shelter's opalite walls and bedrock exposures just outside it are battered, suggesting at least minor toolstone extraction. A moderate density lithic scatter floors the shelter and occupies

the apron immediately outside. For the most part, our meager collection of formed artifacts was encountered in these surface contexts. Two quarry bifaces were collected from the floor of the shelter, and a core and hammerstone occurred on the rocky shelf just outside the dripline.

Table 101. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Rockshelter Reduction Stations, Undine Gorge.

				ARTIFACT CLASSES														
				Reduction							Points		Processing					
Site Number	Fea. No.	Type	Total Area (sq m)	HM	SS	CR	AS	QB	SB	IB	PT	FG	SC	PG	MP	OT	GS	Total
26Ek3177	1*	Rockshelter/Reduction	71	1	-	1	-	2	-	-	-	2	-	-	-	-	-	6
		Extra-Feature Context		-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
26Ek3202	1*	Rockshelter/Reduction	8	-	-	2	1	2	-	-	-	-	1	-	-	1	-	7
26Ek3204	1*	Rockshelter/Reduction	16	-	-	2	-	15	4	2	1	-	5	1	1	3	-	34
		Extra-Feature Context		4	1	15	1	-	-	-	-	-	1	-	-	-	1	23

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
SS = Scratched Stones
CR = Cores
AS = Assayed Stones
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
IB = Indeterminate Biface Fragments

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tools
GS = Groundstone

Our 1 m by 0.5 m excavation unit and coterminous shovel skim revealed deposits in the interior of the shelter that are shallow and whose artifactual content is made up almost exclusively of opalite debitage. Bottomed by bedrock between 15 and 20 cm, the overlying gravelly colluvium produced only two formed artifacts, both unclassifiable projectile points: one in the 0-2 cm shovel skim; and another from the 2 to 10 cm level. The deposit lacks discernible stratigraphy, and rodent turbation is extensive. Small particles of charcoal are scattered diffusely throughout the unit. Soils were moist at all depths, suggesting little likelihood for the preservation of organic remains. Debitage recovered by the exercise is summarized by Table 102.

After taking into account the differential volumes sampled by the surface scrape and the excavation levels, Table 102 reveals that the overwhelming majority of cultural material

retained in the 1/4" mesh resides in the upper 2 cm of the deposit. Moderate average flake sizes and abundant shatter mirror both the early stage of reduction reflected by the single classifiable quarry biface (a Stage 2 form), as well as the minor toolstone extraction suggested by the battered opalite exposures at the site.

Table 102. Debitage from Sample Feature Collections, Rockshelters, Undine Gorge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
26Ek3184	1	71	0.5	1502	115	15.4	1.89	636	84.6	2.25	-	-	751
26Ek3202	1	8	0.5	530	228	86.0	0.61	37	14.0	10.55	-	-	265
26Ek3204	1	16	1.0	1736	1548	89.1	3.02	188	10.8	8.50	-	-	1736
				3345	[2759]	[82.5]	[0.06]	[580]	[17.3]	[68.3]	[6]	[0.2]	[3345]
				(5081)	(4307)	(84.8)	(1.12)	(760)	(15.1)	(2.2)	(6)	(0.1)	(5081)

SUBSURFACE COLLECTIONS

Site Number	Fea. No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
26Ek3177	1	1 / G	20	0.10	255	72.4	1.38	97	27.6	5.05	-	-	352
					[356]	[96.7]	[0.04]	[12]	[3.3]	[0.13]	-	-	[368]
					(611)	(84.7)	(0.60)	(109)	(15.3)	(4.51)	-	-	(720)
26Ek3202	1	1 / G	50	0.25	830	85.0	1.62	146	15.0	4.05	-	-	976
					[2,051]	[78.5]	[0.05]	[561]	[21.5]	[0.10]	-	-	[2,612]
					(2,881)	(80.3)	(0.50)	(707)	(19.7)	(0.92)	-	-	(3,588)
26Ek3204	1	1 / G	60	0.30	14,680	89.6	1.67	1651	10.1	5.46	41	0.3	16,372
					[52,616]	[91.8]	[0.05]	[4632]	[8.1]	[0.09]	[33]	[0.1]	[57,281]
					(67,296)	(91.4)	(0.40)	(6283)	(8.5)	(1.50)	(74)	(0.1)	(73,653)
		2 / G	40	0.20	1,765	86.1	3.30	284	13.9	11.86	1	0.05	2,050
					[252]	[83.4]	[0.10]	[50]	[16.6]	[0.13]	-	-	[302]
					(2,017)	(85.8)	(2.92)	(334)	(14.2)	(10.13)	-	-	(2,351)

Key to Excavation Unit Type
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen
G = 50 cm by 1 m, 1/4 in. and 1/8 in. screen

Key to Mesh Size Retrievals
n = 1/4 in. fraction
[n] = 1/8 in. fraction
(n) = 1/4 in. + 1/8 in. combined

26Ek3202

Encompassing a slightly larger and somewhat more protected area within its dripline (ca 8 m^2), the rockshelter at 26Ek3202 encloses deposits that are deeper but otherwise comparable to those sounded at 26Ek3177. Also like the smaller shelter, 26Ek3202 is manifest on the surface by a moderate density opalite scatter within and immediately outside its dripline, but it lacks evidence of on-site toolstone procurement. A pair of cores and an assayed fragment of opalite found on the apron just outside the shelter comprise the surface assemblage of formed artifacts. Table 102 presents debitage retrievals from our 1 m by 0.5 m shovel skim and coterminous excavation unit.

Again, after imposing controls for the differential volumes and screen mesh sizes employed for shovel skims and excavated levels, the shallowest contexts of our sample (i.e., <2 cm deep) are seen to contain the densest accumulations of cultural materials. The presence of both a Stage 4 quarry biface in Level 2 and a Stage 2 biface in Level 4 hint weakly that a wider range of reduction tasks were hosted by the site than was the case at 26Ek3177. Given the lack of evidence for toolstone extraction from opalite outcrops at 26Ek3202, however, the abundance and relatively large size of shatter encountered there suggest that reduction was initiated on relatively early-stage raw materials (i.e., cores or unmodified opalite nodules). The close proximity of Outcrop Quarry 26Ek3202, located several meters upslope, is the probable source of opalite reduced at the rockshelter.

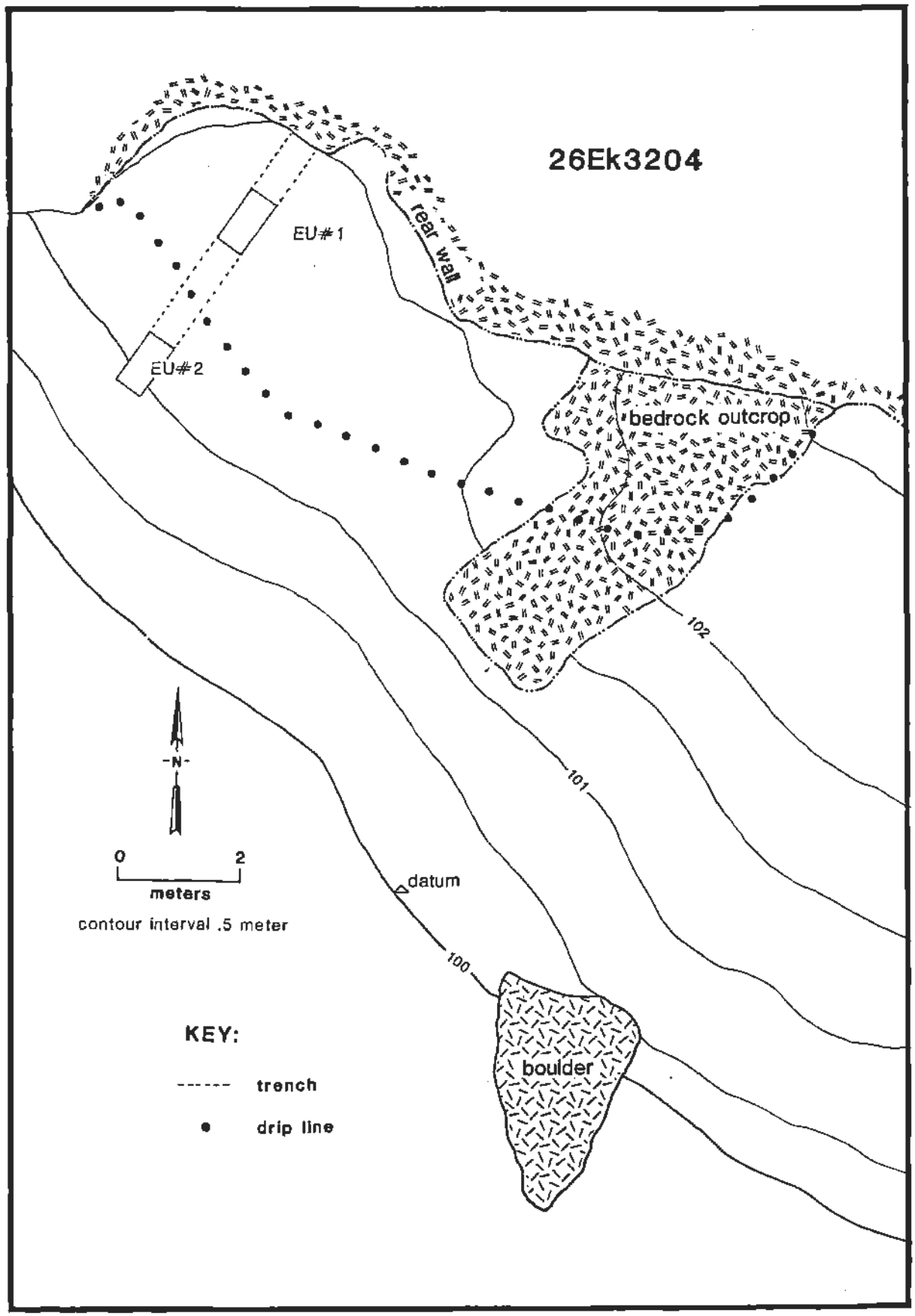
In sum, the two smallest rockshelters appear to have functioned primarily as minimally sheltered reduction stations. Although both assemblages include tool classes suggestive of additional functions, only a very few of these implements occur in our sample, and this, combined with the wet soil encountered in subsurface probes at each site, dampens hope that they contain perishable materials.

26Ek3204

26Ek3204, the largest of the Undine shelters, exhibits the greatest intensity of prehistoric use, expressed both in the abundance and diversity of surface cultural material and in apparent accumulation of vertical deposit (Figure 80, Table 101 and 102).

Back of the dripline, ca 18 m^2 of flat surface are covered with a virtually unbroken pavement of opalite debitage and lesser frequencies of obsidian waste flakes, quarry bifaces, cores, hammerstones, and flake tools. The opalite walls of the shelter appear to have served as a source of toolstone. Outside the dripline, the apron is littered with a similar, though less

Figure 80. Site map, 26Ek3204.


26Ek3204
EU#1
EU#2
rear wall
bedrock outcrop
102
101
100
datum
-N-
0
2
meters
contour interval .5 meter
KEY:
trench
drip line
boulder

dense, assemblage; quarry bifaces and cores are especially abundant. The surface scatter of cultural materials extends ca 12 m beyond the mouth of the shelter, growing more diffuse in contexts furthest downslope.

Deposits at both the interior and exterior of the shelter appeared upon initial reconnaissance to hold considerable potential for buried cultural remains. Moreover, the deposits appeared to be largely dry, although two small patches of Great Basin wildrye grow near the rear wall, indicating some localized collection of moisture. We noted also that subsequent to the snows in June 1988, fissure seepage from the roof of the shelter dampened these areas, but the preponderance of the surface is unvegetated and seems seldom to receive moisture. The exterior deposits, appear to be greater than a meter deep. They are, however, exposed to weathering and are unlikely to retain organic components.

Our inventory and limited testing resulted in the recovery of some 110,345 cultural items, the highest number yielded by any site in the USX-East project area. Within this collection, only 57 formed artifacts occur; the remainder is composed of lithic debitage, chiefly opalite waste flakes and shatter. The assemblage of formed artifacts is summarized by Table 101, and Table 102 provides average recovery rates for our two 1 m x 0.5 m excavation units.

Considering both the formed artifact and debitage assemblages, it would appear that the full opalite reduction scenario was played out at the shelter. Toolstone procurement, evidenced by the battered state of the rear wall of the shelter, where opalite nodules appear to have been liberated from the brecciated matrix, is asserted as well by the great abundance of shatter encountered. Early reduction stages are witnessed both by the high incidence of cores as well as by the quarry biface collection which, although encompassing forms representative of reduction through Stage 4, is dominated by Stage 2 and Stage 3 specimens (Table 89). Later toolstone reduction is reflected principally by the debitage assemblage alone. Within the shelter, the high numbers of debitage pieces recovered by the 0.3 m^3 of excavation Unit 1 are the consequence of a dense packing of very small items. Over 78% (n=52,616) of the flakes and 74% (n=5198) of the shatter recovered by Unit 1 were retained in the 1/8" mesh fraction; the average weight of these flakes is 0.05 gm and that of pieces of shatter is 0.09 gm. Such miniscule debitage implies a finishing workshop not evident in the recovered assemblage of formed tools. It may be, however, that repeated occupation of the shelter and trampling of its surface have resulted in the fragmentation of larger secondary flakes, but this seems unlikely in light of the number of pieces involved. Detailed debitage analysis will be required to resolve the issue.

Comparison of debitage yielded by the 1/4" samples from within the shelter (Unit 1) to that recovered outside it (Unit 2) suggests some differences in the prehistoric use of these locations. Accumulations inside the shelter are probably denser than those tested on the apron, and average sizes of flakes and shatter from the interior (1.6 gm and 5.5 gm, respectively) are substantially smaller than those of items encountered outside (3.1 gm and 8.9 gm, respectively). While it is possible that these differences represent some spatial separation of tasks, (i.e., relatively early reduction tasks on the apron, and later reduction undertaken within the shelter) they could also be due to size sorting occurring as a consequence of site maintenance. Both units disclose a general reduction in the number of cultural items per level as depth increases, but no clear trend in the distribution of average flake weights.

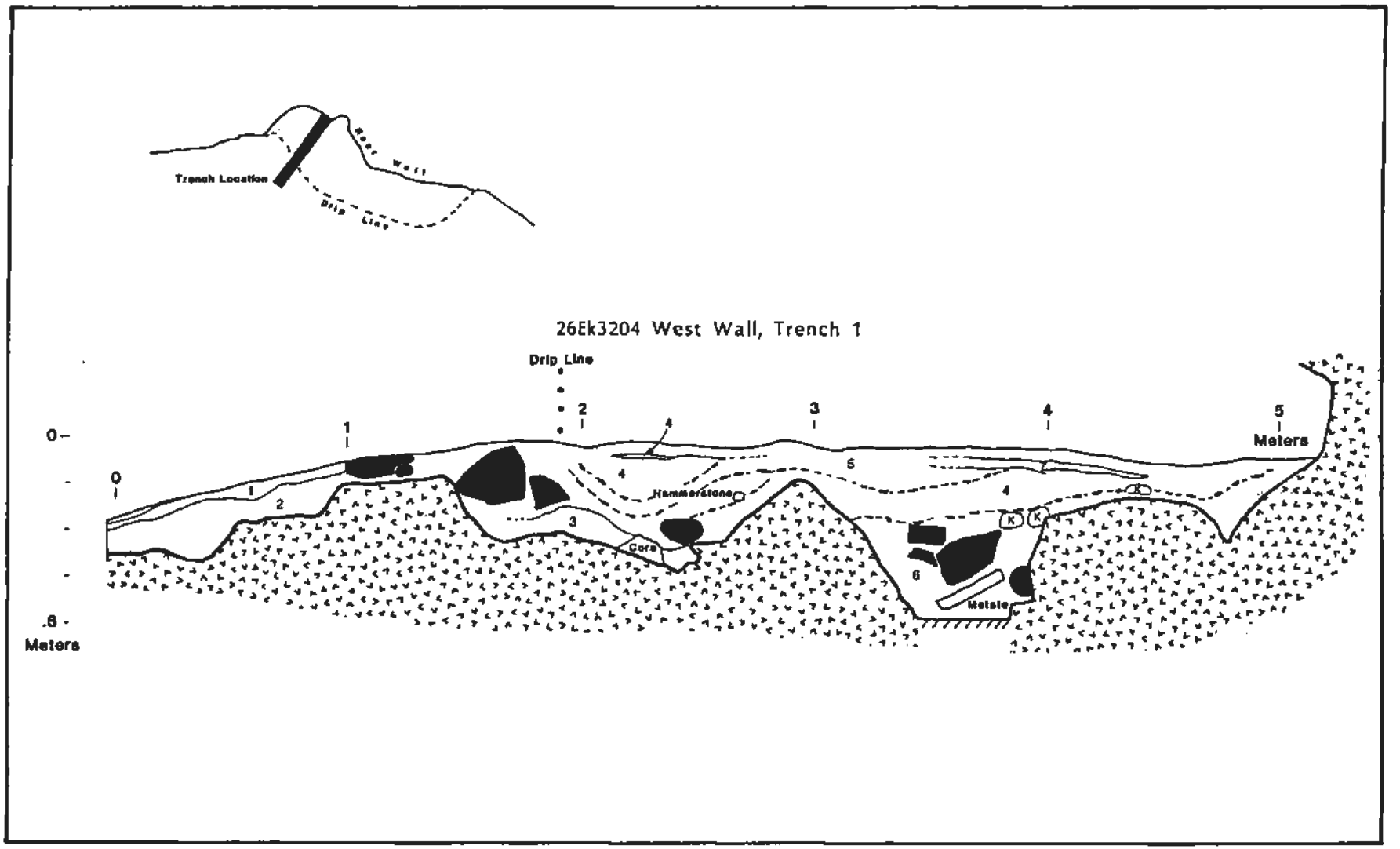
Other components of the assemblage, particularly the wide variety and comparatively large numbers of maintenance/ subsistence tools encountered on the interior surface suggest that the site served occasionally as shelter for small, temporary camp groups. This speculation inspired our digging of two excavation units in hopes of defining hearths and other subsurface cultural features as well as recovering a sample of perishable materials. These goals were only partially accomplished by unit excavation.

No hearths were discerned in unit excavations. Although charcoal is abundant, it occurs as very small particles distributed diffusely throughout the deposits. Of the ca. 500 bones recovered, there is little evidence for cultural origins. The assemblage consists chiefly of rodents, with a few artiodactyls, miscellaneous reptiles, and 2 fish. Only 4% of the bones are burned, while 40% of them exhibit diagnostic traits (e.g., pitting, rounding of fractured surfaces) marking them as carnivore scat bones (Schmitt and Juell 1989). Most of the others appear to be recent inclusions, probably representing rodent burrow deaths.

The hand excavated stratigraphic trench extended through the two 1.0 by 5 m test units, from the rear wall of the shelter to the apron and colluvial slope below. The excavation units and the trench all revealed a shallow cultural deposit overlying an irregular floor comprised of bedrock and large blocks that have fallen from the ceiling (Figure 81). It is difficult to distinguish bedrock from roof-fall in limited excavations, and we cannot estimate how much cultural deposit remains beneath the collapsed material.

On present knowledge, cultural deposits in the shelter occur over a narrow range of depths from 10 cm to over 80 cm. Due to the presence of charcoal and other organics, all deposits are black (10Yr 2/1). Most are sandy loams or loamy sands.

Figure 81. 26Ek3204, Trench 1, west wall profile.


Trench Location
Rear Wall
Drip Line
26Ek3204 West Wall, Trench 1
Drip Line
0
1
2
3
4
5
Meters
Hammerstone
Core
Metate
K
.6 -
Meters

In the discussion that follows, stratigraphic unit numbers do not reflect their relative position in the profile (Figure 81). However, the discussion is organized from outside to inside and from top to bottom of the profile. No attempt is made to group units into horizons.

Unit 1 is a layer of black sand loam about 5 cm thick mantling the colluvial slope outside the dripline. Unit 1 is overlain in places by a thin layer of sagebrush duff. Unit 2 is a layer of black loam with a maximum thickness of 25 cm laying on bedrock below Unit 1 outside the dripline.

Unit 5 is the uppermost layer inside the dripline of the shelter. It is black sand about 5 cm thick. Unit 7 is a discontinuous layer of compact, brown dung between 2 and 4 cm thick, found only in the shelter interior, just below Unit 5. This material was deposited during use of the shelter by some large ungulate, most likely mountain sheep (Ovis canadensis). Unit 4 is black loamy sand overlain by Unit 7 and/or Unit 5. About 40 cm of Unit 4 fills a crevice or pocket between 2.2 and 3.4 m out from the rear wall, as well as a larger pocket between 1.2 and 2.3 meters from the rear wall. Flake lines suggest the presence of basin-shaped features in both pockets, filled in several discrete episodes. In the outermost pocket, a hammerstone can be seen in the profile resting on the lowest flake line. The trench excavators noticed an abundance of bifaces and hammerstones when they went through this section, suggesting the possibility of a cache.

Unit 3 is a layer of black clay loam about 10 cm thick, appearing to rest on bedrock. If so, this unit may represent residual clay from weathered bedrock we have observed elsewhere in the study area. Although flakes were not observed in Unit 3, a large opalite core is embedded in it.

Unit 6 is black loamy sand filling the lower portion of the rear-most pocket, below about 30 cm BS. The bottom of this feature was not penetrated, and it may be considerably deeper. Unit 6 contains several large blocks of stone, including a flat, tabular piece of basalt that appears to be a metate. A cache seems possible in this location as well.

In sum, 26Ek3204 is unique in constituting the densest concentration of cultural material encountered in the project area. The low incidence of formed artifacts within the deposits limits the kinds of inferences that can be made regarding the suite of activities carried out there, but the surface assemblage suggests that some (recent?) episodes of use may have been residential. Despite the failure of our excavations to locate hearths or informative collections of faunal remains, it seems likely that they may be present in other quadrants of the shelter.

Reduction Station: Context and Function

The single site of its kind in the Undine area, 26Ek3178, is noteworthy primarily for its similarity to, but isolation from, sites that typify the archaeological record at Holeplug Ridge. Each of its four cultural features is composed of dense concentrations of opalite reduction debris; evidence of toolstone procurement is absent. It is, however, on the eastern flank of the knoll dominating the upper reach of Undine Gorge, adjacent several nearby opalite sources (i.e., 26Ek3198, -3197, and -3178). On the basis of proximity, we suspect that toolstone processed at 26Ek3178 was derived from these neighboring sources (Figure 72).

Feature 1, our Sample Feature, inspired closer scrutiny for the relative abundance of formed artifacts on its surface and its apparent spatial integrity. Surface inspection of Feature 1 revealed five Stage 3 quarry bifaces, a flake scraper, one Desert Side-notched projectile point, and a projectile point fragment within the debris concentration. The remainder of the features are defined by concentrations of opalite debitage only, save for an additional Desert Side-notched projectile point recovered from the surface of Feature 1 (Table 103).

Table 103. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3178.

Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction CR	QB	SB	IB	Points PT	FG	Processing SC	Total
1*	Core and Biface Reduction	44	1	11	1	1	1	1	1	17
2	Unspecified Reduction	64	-	-	-	-	1	-	-	1
3	Biface Reduction	10	-	-	-	-	-	-	-	0
4	Biface Reduction	8	-	-	-	-	-	-	-	0
Extra-Feature Context		N/A	-	1	-	-	-	-	-	1

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
IB = Indeterminate Biface Fragments

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves

Our set of 5 contiguous 1 m by 1 m collection units bisected the scatter of Feature 1; 3 central units (2, 3, and 4) were positioned wholly within the concentration, and Units 1 and 5 fell just outside the concentration at its upslope and downslope extremes. Unit-specific debitage recovery rates are summarized by Table 104.

Table 104. Debitage from Sample Feature 1, Site 26Ek3178.

SURFACE COLLECTIONS

Unit	OPALITE DEBITAGE						OTHER DEBITAGE		
	Flakes			Shatter					
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
1	90	91.8	2.10	8	8.2	2.28	-	-	98
2	1523	98.1	1.59	28	1.8	22.21	1	0.10	1552
3	1538	86.9	1.84	230	13.1	2.79	-	-	1768
4	481	92.9	1.62	37	7.1	4.11	-	-	518
5	104	88.1	1.96	14	11.1	1.70	-	-	118
Total	3736	92.2	1.80	317	7.8	4.62	1	0.02	4054

The distribution of cultural materials revealed by this exercise suggests that the observed surface limits of the feature are echoed by the relative densities of remains immediately below the ground surface. The units within the visible concentration are clearly more densely packed with debris than those outside. This implies that the present configuration of the feature approximates its original state and suggests that it represents the results of spatially focused opalite reduction events rather than accumulation by post-depositional processes. In addition, the apparent integrity of the feature, at least circumstantially, supports the contemporaneity of the reduction episode with Desert Series projectile points.

The Quarry Biface assemblage, coupled with attributes of the debitage, suggests that the feature served primarily as a station for early and intermediate stages of opalite reduction. In addition to the five Stage 3 Quarry Bifaces retrieved during inventory, 3 more of these specimens, as well as 3 Stage 2 forms, and a Stage 3 small biface were recovered by shovel skims within the concentrations. The average size of waste flakes (ca 1.8 gm) and the comparatively small quantity of opalite shatter is consistent with the types of debris anticipated to have been created during the manufacture of Stage 2 and 3 quarry bifaces.

In sum, based on our detailed scrutiny of one of its features and a general perusal of its others, 26Ek3178 appears to have served largely as a station for the reduction of toolstone. The raw materials for this were likely obtained and initially processed into cores and/or flake blanks at quarry sites nearby. As observed at similar sites elsewhere in the project area, the presence of maintenance/subsistence tools (the scraper and projectile points) suggest that reduction activities were supplemented by additional tasks not directly addressing toolstone processing.

Summary

Of the twelve sites in the Undine Gorge subarea all, save the single Reduction Station 26Ek3178 and some of the smaller rockshelters, contain exploited opalite sources within their precincts; these are accompanied by numerous reduction features, many of which evidence early stages of toolstone processing. Opalite procurement methods employed at the Undine sites duplicate the full range of techniques in evidence at the Tosawihi Quarries proper. These include the excavation of quarry pits, exploration of exposed outcrops, utilization of surface accumulations of cobbles and, in at least one instance perhaps, the creation adit-like excavations in the rimrock. While the archaeological record of the subarea is dominated by the remains of opalite extraction and processing, maintenance and subsistence artifacts suggestive of activities ancillary to and supportive of prehistoric mining occur within most site assemblages and are particularly salient components of 26Ek3204 and Feature 1 at 26Ek3198.

Three of the Undine sites proved to be particularly informative and promise to contribute significantly to the address of Research Domains developed by Elston (1988; Chapter 1, this volume) for the Tosawihi Quarries and its immediate surrounds. At 26Ek3195, trenching to the basal levels of various of the quarry pits would provide necessary horizontal as well as vertical controls to isolate units for volumetric analyses of the quantities of toolstone processed and the levels of effort expended. Tests of Feature 2 there suggest that it is eminently suited to the investigation of the relation between extraction techniques and site formation processes. Such data might be achieved via exposure of the original source material outcrop, identification of the techniques used to reduce it (firing, direct percussion, etc.), close examination of the relative lithology of the outcrop in terms of toolstone quality, and attempted correlation with the stratigraphic units composing the pit and berm. The presence of charcoal in the stratigraphic units of Feature 2 also promises the opportunity to provide an absolute chronological framework for identifying temporal variation in quarry use and knapping techniques.

At 26Ek3198, the place of the quarries in the regional economy might be addressed by further investigation of the hunting camp represented by Feature 1. Closer examination of the spatial configurations of the feature, together with a better characterization of assemblage diversity and sourcing of a large sample of obsidian debitage would allow observations on group size, activity focus, and site function.

The rockshelter 26Ek3204 proved to be unique, constituting the densest concentration of debitage encountered in the project area, however it remains unknown whether the bulk of this reduction debris originated from the processing of opalite from

its surrounding walls or from other off-site sources. The distinction is important to the question of the quantity of toolstone processed, the level of effort expended, and ultimately the function of the site. Resolution of the issue could be approached through further exploration for hearths, fuller characterization of assemblage variability, and comparison of debitage with known toolstone sources. Despite the failure of our excavations to locate hearths, it seems possible that they may be present in other quadrants of the shelter; their utility as sources of both directly datable materials as well as dietary remains is obvious. The preservation of bone, although largely non-cultural, suggests that the site may yield paleo-environmental data as well.

Chapter 17. HOLEPLUG RIDGE

by Steven G. Botkin

The Holeplug Ridge testing arena occupies the central portion of the project area (Figure 82). Mildly rolling and ascending gradually to the south between elevations of 5600 and 5750 ft. amsl, the subarea incorporates elements of three locally prominent landforms. Its southwestern quadrant includes the relatively flat uppermost bench on the crest of Ramadan Ridge. Holeplug Ridge, a broad, gently sloping appendage originating from the eastern flank of these highlands, arcs northeastward and then northwestward through the midsection of the area. Near its base, the ridge coalesces with the westernmost foot slopes of Corral Fan and terminates in a series of low knolls at the southern margin of Undine Gorge.

Soils over most of the area are shallow (where tested, ca 30 cm deep) sandy colluvial silts. They vary chiefly in the quantities of cobbles and gravels of rhyolite tuff they contain. These inclusions are most abundant on the lower ridgecrests and slopes at the extreme northern edge of the area. Somewhat higher, on the knolls along the southern margin of Undine Gorge, this colluvium is overlain by aeolian silt or loess-like deposits that appear to have buried some cultural features in the vicinity (cf 26Ek3192).

Vegetation of Holeplug Ridge is essentially identical to that found elsewhere in the project area, an edaphic mosaic of low sage and big sage communities, with smaller components of phlox, rabbitbrush, and perennial grasses.

Factors attracting aboriginal use of the Holeplug area remain unclear. The composition and distribution of sites suggest that people located there more in response to the proximity of natural resources just outside than to distinctive attributes of the subarea itself. This appears to be the case, particularly, when the nature of the Holeplug sites is compared to the distribution of toolstone and sources of potable water.

Cultural features comprising the nineteen Holeplug sites are almost entirely the consequence of opalite toolstone reduction. However, primary sources of this material are virtually absent from the area. Although several small outcrops do occur sporadically within the precincts of Holeplug sites located on the slopes immediately above Undine Gorge, for the most part they evidence apparently episodic, expedient use, rather than the more intensive exploitation observed elsewhere in the project area. Apparently none of these sources was of sufficient quality, or their toolstone contents in high enough demand, to have inspired the excavation of quarry pits or other intensive extraction efforts.

Figure 82. Topographic setting, Holeplug Ridge Sites.

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

In spite of the paucity of lithic raw material, the incidence and density of reduction features is greatest along this northern fringe of the Holeplug area. Here, sites defined by large numbers of well defined concentrations of reduction debris and functionally diverse artifact assemblages occur in an almost continuous band coincident with the relatively flat knoll tops overlooking Undine Gorge. From these locations high quality toolstone is available in abundance and is easily accessible at nearby quarries within the Ramadan and Undine subareas. This northern tier of Holeplug sites also lies within easy reach of at least seasonally available water. Pools remained in the drainage of Undine Gorge for several days following summer storms in 1988.

Upslope and southward from Undine Gorge, the archaeological record changes (see Figure 82). Comparatively far removed from opalite sources and water, sites there consist of progressively fewer and less densely clustered reduction features. These upland sites are all quite small, and they occur at widely spaced intervals on relatively steeper slopes. Their artifact assemblages are somewhat less functionally diverse than those at the margin of Undine Gorge.

The Holeplug area seems to have attracted most use primarily to its northern margin, where low knolls provide relatively flat workshop zones proximal to water and conveniently positioned for the reduction of toolstone from elsewhere. Its elevated southern portion forms a less intensively used, apparently less frequently visited, hinterland.

Descriptive Site Summary

The nineteen sites within the area sort into four site types. These include Outcrop Quarry/Reduction Complexes (n=2), Large Reduction Complexes (n=3), Small Reduction Complexes (n=5), and Reduction Stations (n=9). Almost all are defined by concentrations of opalite processing debris. They are differentiated chiefly by the presence or absence of manipulated toolstone outcrops and by the number of reduction features they contain (Table 105). All save one was tested. The exception, Reduction Station 26Ek3182, was excluded from our sample after close inspection revealed that its shallow depositional context and sparse artifactual contents offered little useful data not obtainable from other sites close by.

Located in the northeast corner of the Holeplug area, the two Outcrop Quarry/Reduction Complexes (26Ek3191 and 26Ek3193) are confined to the knolls of the westernmost spur of Corral Fan overlooking Undine Gorge. Both sites include small bedrock exposures that evidence only minimal exploitation. At 26Ek3193, a battered opalite rim surrounded by a litter of angular shatter

and primary flakes (Feature 1) offers the only clear indication of toolstone extraction at the site. The six additional features are concentrations of reduction debris. Quarrying efforts are even less pronounced at 26Ek3191. There, owing perhaps to the diminutive size and weathered state of its solitary opalite outcrop, toolstone acquisition appears to have been directed instead toward a diffuse field of exposed cobbles. Many of the cobbles evidence assay and the presence of later stage debitage suggests that some were reduced further on the spot. However, nowhere has the resulting debris accumulated in sufficient densities to be identifiable as reduction features; overall, the site displays one of the sparsest lithic scatters observed within USX-East. Moreover, the single feature recorded at the site is not clearly associated with opalite processing. It consists of a small cluster of obsidian flake tools and debitage isolated at the margin of the cobble field.

Table 105. Descriptive Summary, Holeplug Ridge Sites.

Site Number	Type	Features (n)	Maximum Site Area (sq m)
26Ek3172	Small Reduction Complex	6	2,420
26Ek3173	Small Reduction Complex	4	530
26Ek3174	Reduction Station	2	590
26Ek3175	Reduction Station	1	90
26Ek3179	Reduction Station	2	110
26Ek3180	Reduction Station	1	12
26Ek3181	Reduction Station	1	235
26Ek3182	Reduction Station [NOT TESTED]	1	--
26Ek3183	Reduction Station	1	90
26Ek3184	Large Reduction Station	24	12,680
26Ek3185	Small Reduction Station	7	910
26Ek3186	Reduction Station	2	185
26Ek3187	Reduction Station	1	40
26Ek3188	Small Reduction Complex	1	95
26Ek3189	Small Reduction Complex	4	1,320
26Ek3190	Large Reduction complex	11	7,450
26Ek3191	Outcrop Quarry/Reduction Complex	1	6,600
26Ek3192	Large Reduction Complex	5	3,190
26Ek3193	Outcrop Quarry/Reduction Complex	7	3,610

The three Large Reduction Complexes adjoin the Outcrop Quarries and likewise occupy the flat knoll tops and shelves that verge on the southern bank of Undine Gorge. Site 26Ek3192 lies between the two Outcrop Quarries at the base of Corral Fan; 26Ek3184 and -3190 are positioned immediately to the west, along the lowest extensions of Holeplug Ridge. Each site covers an area in excess of 2000 m^2 and is punctuated by from 6 to 24

cultural features. With two notable exceptions, these features are composed of concentrations of opalite reduction debris; many include a variety of processing and maintenance tools as well. The noteworthy examples occur at 26Ek3184 and 26Ek3192, where reduction stations are augmented by single features consisting of discrete piles or cache-like clusters of opalite quarry bifaces. Boundaries of all three sites are lines enclosing clusters of these features and conform closely to the principal contours of the landforms, encircling the flattest, uppermost portions of the knolls above Undine Gorge.

The five Small Reduction Complexes appear to have functional similarity to Large Reduction Complexes, but, owing perhaps to topographic constraints imposed by relatively steeper slopes and/or greater distance from material sources, they include fewer, sparser concentrations of opalite debitage. They are defined by from 1 to 7 reduction features and cover total areas <700 m^2. Three of them (26Ek3185, -3186, and -3189) occupy microtopographic flats on the slopes surrounding a gully that separates lower Holeplug Ridge from Corral Fan. Two, 26Ek3172 and -3173, occur on the almost level, highest bench, of Ramadan Ridge.

Smaller still are the nine Reduction Stations. All but 26Ek3174 are located on the midslopes of Holeplug Ridge; the exception is perched on the crest of Ramadan Ridge at the southwestern corner of the study area. Relatively far from opalite sources and water, they are composed only of concentrations of reduction debris surrounded by lower density scatters, encompassing generally less than 300 m^2. Their internal composition appears equivalent to that of individual features within the Larger Reduction Complexes, from which they are distinguished chiefly by their isolation.

Testing Strategies

The Holeplug sites were tested by methods identical to those employed elsewhere in the project area. Table 106 summarizes actions applied to the Holeplug Ridge sites; these are described in more detail basis below.

Outcrop Quarry/Reduction Complexes

At 26Ek3191, the single cultural feature, a small obsidian scatter, was collected in its entirety by shovel-skimming and screening a square grid of four contiguous 1 m^2 units. Two of the seven features at 26Ek3193 were sampled. The lithic scatter upslope of the battered opalite ledge of Feature 1 was sampled by shovel skimming and screening a series of four 50 cm by 50 cm units placed at three meter intervals along a baseline bisecting the scatter and oriented parallel to the ground slope. The

entire northern half of Feature 4 was shovel skimmed in six 1 m by 1 m collection units. The southern half of the feature was occupied by a large harvester ant mound. Its occupants, aroused somewhat by our initial efforts on the north, and of sufficient size and/or tenacity to be retained in 1/4" screen mesh, inspired alteration of our original strategy which had called for 100% collection of the feature. The southern half of Feature 4 remains in situ, available for additional study in the future, by others.

Table 106. Summary of Testing Procedures, Holeplug Ridge Sites.

Site Number	Features Recorded Total (n)	Features Recorded Sampled (n)	FEATURE CONTEXT Surface Skim Area (sq m)	FEATURE CONTEXT Subsurface Excavation Volume (cu m)	RECOVERED COLLECTIONS Debitage (n)	RECOVERED COLLECTIONS Formed Artifacts (n)
26Ek3172	6	1	8	-	1252	5
26Ek3173	4	1	40	.075	4346	14
26Ek3174	2	0	-	-	-	2
26Ek3175	1	0	-	-	-	1
26Ek3179	2	1	13	-	1295	6
26Ek3180	1	0	-	-	-	1
26Ek3181	1	1	24	.050	3822	18
26Ek3183	1	1	15	-	2316	4
26Ek3184	26	4	9	.200	5557	131
26Ek3185	7	1	20	.050	2118	36
26Ek3186	2	0	-	-	-	1
26Ek3187	1	0	-	-	0	0
26Ek3188	1	0	-	-	0	0
26Ek3189	4	0	-	-	1	5
26Ek3190	11	2	40	.100	11617	93
26Ek3191	1	1	4	-	35	34
26Ek3192	5	2	29.5	-	24872	271
26Ek3193	7	2	7	-	3700	24

Large Reduction Complex

Owing in part to their large size, but as well to the variety and composition of the features they subsume, Large Reduction Complexes dominated the testing program at USX-East.

At 26Ek3184, Feature 1, a biface cache, consisted on the surface of a small, tightly clustered assemblage of six opalite quarry biface fragments and an obsidian biface. A block of two 1 m by 1 m units was shovel skimmed and screened to test the composition of the assemblage, and a 1 m by 50 cm excavation unit was opened to a depth of 10 cm in the zone of greatest artifact density. Selected as a typical reduction station,

Feature 2 was collected totally by shovel skimming and screening four contiguous 1 m by 1 m units. Feature 3, a larger reduction station with seven discernible concentrations of reduction debris, was tested by a discontinuous transect of eight 50 cm by 50 cm collection units spaced at 2 m intervals; each unit was shovel skimmed and screened. Feature 8, also a reduction station, but distinguished from most by a small cluster of early stage opalite quarry bifaces and cores, was shovel skimmed over a 1 m^2 area and subsequently excavated to a depth of 20 cm.

Two features at 26Ek3190 were sampled. Feature 1, a moderately large concentration of reduction debris, was selected for closer scrutiny because of the abundance of quarry biface fragments observed on its surface as well as for its dense accumulation. Arrayed to cover the entire surface of the feature, a grid of 28 contiguous 1 m by 1 m collection units was shovel skimmed and screened. Following this, a 1 m by 50 cm excavation unit sounded its depths to 20 cm in an area of high artifact density. A smaller reduction station, Feature 2, was collected completely by shovel skimming a block of 12 1 m x 1 m units.

Tests at 26Ek3192 focused most intensive field efforts at two features. Feature 1 was marked on the surface by a scatter of opalite debitage and a cluster of 6 early stage quarry bifaces that we took to represent a biface cache. A rectangular area 4 m by 6 m in extent centered on the biface cluster was shovel skimmed and screened in 24 1 m x 1 m units. Subsequently, an initial 1 m by 50 cm excavation unit was dug to 20 cm in order to expose the cache more completely. Expanding from this, additional excavation units were added, to expose a hearth-like stain and an underlying layer of large debitage and chunks of opalite. By the close of the testing phase, 12 m^2 had been dug within the feature to depths of between 20 and 40 cm.

Feature 2 comprised an opalite reduction station dotted by two dense lithic concentrations that displayed a diversity of material types and artifacts. The feature was first sampled by a discontinuous transect of 20 50 cm by 50 cm units arrayed at 1 m intervals. Each unit was shovel skimmed and screened; 7 of them fell within the larger of the feature's lithic concentrations. Additionally, a 1 m by 50 cm excavation unit was placed near the baseline and excavated to a depth of 20 cm. Results of augering probes in the vicinity prompted the excavation of another unit, 1 m by 1 m in size, to a depth of 80 cm.

Small Reduction Complexes

At 26Ek3172, the entire surface content of Feature 1, a reduction station, was collected by shovel skimming and screening a block of 8 1 m by 1 m units. Feature 1 at 26Ek3173 was selected for complete surface collection due to the observation of two (unclassifiable) projectile points within the

scatter of opalite reduction debris. This was accomplished by superimposing a grid of 40 1 m by 1 m shovel skim units over the feature's visible horizontal extent. A 1 m by 0.5 m excavation unit, its contents screened through 1/8" mesh, sounded subsurface contexts to a depth of 20 cm. Likewise at 26Ek3185, Feature 1 was chosen as Sample Feature for its abundance of formed artifacts (Quarry Bifaces, projectile points, and flake tools). A block of 20 contiguous 1 m by 1 m collection units was shovel skimmed and screened, covering the entire feature. Following this a 1 m by 0.5 m unit was excavated to a depth of 10 cm where surface artifacts appeared to be most densely concentrated. Subsurface soils were passed through 1/8" mesh. The remaining two Small Reduction Complexes, 26Ek3188 and -3189, were tested via inventory procedures alone.

Reduction Stations

Only three of the eight Reduction Stations tested were scrutinized by Sample Feature methods. A cluster of debitage concentrations at 26Ek3179 (Feature 1) was sampled by a grid composed of 13 1 m by 1 m shovel skimmed units. These subsumed the feature's entire area. At 26Ek3181, the site's single feature - a dense accumulation of reduction debris accompanied by a pair of ceramic sherds and several flake tools was collected by means of shovel skimming a rectangular area composed of 24 1 m by 1 m units. Where this exercise revealed flake densities to be the highest, a 1 m by 0.5 m excavation unit was dug to a depth of 10 cm, the deposits screen through 1/8" mesh. The single feature at 26Ek3183, a scatter of reduction debris, was collected in its entirety by a block of 15 1 m by 1 m units. Each square was shovel skimmed and screened.

The remaining Reduction Stations tested (26Ek3174, -3175, -3180, -3186, and -3187) were subjected only to inventory level examination of their features.

Chronology

Given the nature of data presently at hand, we can address the chronology of aboriginal use of the Holeplug sites only with reference to projectile points and ceramic sherds. Table 107 summarizes projectile point recoveries on a site by site basis.

Most specimens (n=27) were unclassifiable, in terms of Thomas' (1981) due to fragmentation (n=16), unfinished state (n=10), or deviant morphology (n=1).

The 13 classifiable projectile points suggest a relatively late prehistoric use of Holeplug Ridge. More than three-quarters of the specimens are of Desert Series styles (Desert Side-notched n=4, Cottonwood n=3) dating from post-A.D. 1300. Several points from 26Ek3192 hint at earlier occupation; a Great Basin Stemmed projectile recovered from the surface of Feature 2

and a Humboldt Series piece from excavation Level 2 of Feature 1 imply visitation as early as 9000 B.C. and from 3000 B.C. - A.D. 700, respectively. Further, although less reliable, evidence of early site use is implied by the recovery of three fragments of a single, rather robust, edge ground basalt biface from the surface of Feature 2. These, we speculate, may represent an additional Stemmed Series specimen but they are highly weathered and fragmentary. An episode of pre-A.D. 1300 site use is suggested as well at 26Ek3184 by the Large Side-notched point recovered from Feature 24.

Table 107. Summary of Projectile Point Types from Holeplug Ridge.

Site Number	Classifiable					Other		
	STM	HBS	LSN	CTN	DSN	PPT	FRG	Total
Outcrop Quarry/ Reduction Complex								
26Ek3193	-	-	-	-	-	-	-	0
Cobble Quarry								
26Ek3191	-	-	-	-	-	-	-	0
Large Reduction Complex								
26Ek3184	-	-	1	1	-	-	1	3
26Ek3190	-	-	-	-	2	1	3	6
26Ek3192	1	1	-	1	3	-	8	14
Small Reduction Complex								
26Ek3172	-	-	-	-	-	-	-	0
26Ek3173	-	-	-	-	-	-	2	2
26Ek3185	-	-	-	1	2	-	2	5
26Ek3188	-	-	-	-	-	-	-	0
26Ek3189	-	-	-	-	-	-	-	0
Reduction Station								
26Ek3174	-	-	-	-	-	-	-	0
26Ek3175	-	-	-	-	-	-	-	0
26Ek3179	-	-	-	-	-	-	-	0
26Ek3180	-	-	-	-	-	-	-	0
26Ek3181	-	-	-	-	-	-	-	0
26Ek3182	-	-	-	-	-	-	-	0
26Ek3183	-	-	-	-	-	-	-	0
26Ek3186	-	-	-	-	-	-	-	0
26Ek3187	-	-	-	-	-	-	-	0
Totals	1	1	1	3	7	1	16	30

Type Designations (after Thomas 1981)

STM = Great Basin Stemmed
HBS = Humboldt Series
LSN = Large Side-notched
CTN = Cottonwood Series
DSN = Desert Side-notched
Other
PPT = Points out of Thomas' key

The assemblage of pottery sherds is comprised exclusively of Shoshone Brownware. Most of the 43 specimens were recovered from 26Ek3192 (Feature 2, n=39; Feature 1, n=1). Two sherds occur at 26Ek3181 (Feature 1), and a single specimen was encountered at 26Ek3174. Their presence at the Holeplug sites corroborates the post-A.D. 1300 occupation of the area implied by the majority of the projectile points (Madsen 1986).

The open aspect and shallow soils of most of the Holeplug sites offers little likelihood for the recovery of remains directly datable by radiocarbon assay. Tests at 26Ek3192, however, suggest that it may contain a buried living surface; exploration of this area may result in the exposure of hearths and charcoal. Obsidian artifacts and debitage occur in several sites but have not yet been submitted for sourcing and hydration rim evaluations.

Assemblage Composition

The overwhelming bulk of the assemblages along Holeplug Ridge consists of the waste products of toolstone processing. Of the approximately 59,000 cultural items recovered during testing, only 705 are formed artifacts; the remainder consists of waste flakes (principally opalite) and pieces of shatter. Table 108 summarizes the formed artifact assemblages of each of the Holeplug Sites.

The relative proportions of formed artifact classes mirror the prominent role played by toolstone production in the formation of the local archaeological record. Formed artifacts directly related to the manipulation of toolstone - cores, quarry bifaces, and other reduced forms of opalite raw material - combined with the implements presumably employed to produce them (hammerstones, etc.) make up the largest proportion of all assemblages except at 26Ek3181 and 26Ek3174, where they occur in numbers equal to other implements.

Most sites subsume features whose assemblages reveal multiple uses additional to toolstone procurement. These activities are indicated by the occurrence of maintenance tools (scrapers, knives, and other flake tools) and subsistence related artifacts (projectile points, groundstone, and ceramics). Although the contemporaneity of these activities and toolstone production itself has not yet been established, we infer that tasks such as hunting and food and materials processing were supplementary to and supportive of opalite procurement.

Sites containing features whose assemblages display sizeable relative proportions of maintenance/subsistence tools are geographically widespread; they occur throughout the Holeplug area and occupy virtually all topographic contexts there. They are most numerous, however, and most densely clustered within the Large Reduction Complexes that rim the southern flank of Undine Gorge.

Table 108. Intersite Artifact Class Frequency Comparisons, Holeplug Ridge Sites.

	ARTIFACT FREQUENCY PER SITE																	
	Quarry Pit/ Reduction Complexes		Large Reduction Complexes			Small Reduction Complexes						Reduction Stations						
ARTIFACT CLASS	26Ek 3191	26Ek 3193	26Ek 3184	26Ek 3190	26Ek 3192	26Ek 3172	26Ek 3173	26Ek 3185	26Ek 3188	26Ek 3189	26Ek 3174	26Ek 3175	26Ek 3179	26Ek 3180	26Ek 3181	26Ek 3183	26Ek 3186	26Ek 3187
Lithic Processing/ Reduction Tools																		
Hammerstones	-	-	1	-	3	-	-	2	-	-	-	-	-	-	-	-	-	-
Scratched Stones	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Other Percussion	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal (%)	0(0)	0(0)	2(1.4)	0(0)	3(0.9)	0(0)	0(0)	3(6.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Reduction Artifacts																		
Assayed Pieces	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cores	2	2	5	4	15	-	-	2	-	1	-	-	1	-	-	-	-	-
Quarry Bifaces	4	17	87	48	123	4	7	18	-	2	1	1	1	1	9	4	1	-
Preform Bifaces	-	-	2	1	2	-	-	4	-	1	-	-	-	-	-	-	-	-
Small Bifaces	3	3	11	11	13	2	3	4	-	-	-	-	2	-	-	-	-	-
Indeterminate Bifaces	-	-	2	6	17	-	1	-	-	-	-	-	1	-	1	-	-	-
Subtotal (%)	9(53)	22(92)	107(77)	70(68)	172(55.8)	6(100)	11(61)	28(58.3)	0(0)	4(80)	1(50)	1(100)	5(62.5)	1(100)	10(50)	4(100)	1(100)	0(0)
Projectile Points																		
Classifiable	-	-	2	2	6	-	-	3	-	-	-	-	-	-	-	-	-	-
Unclassifiable	1	-	1	4	8	-	2	2	-	-	-	-	-	-	-	-	-	-
Subtotal (%)	1(6)	0(0)	3(2.2)	6(5.8)	14(4.5)	0(0)	2(18.2)	5(10.4)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Maintenance and/or Processing Tools																		
Scrapers/Spokeshaves	5	2	18	19	61	-	5	9	-	-	-	-	3	-	6	-	-	-
Knives	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perforators/Gravers	-	-	3	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Multipurpose Flakes	2	-	3	1	8	-	-	2	-	-	-	-	-	-	1	-	-	-
Indeterminate Flakes	-	-	1	-	3	-	-	-	-	1	-	-	-	-	-	-	-	-
Abraders	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal (%)	7(41)	2(8)	26(18.7)	26(25.2)	76(24.7)	0(0)	5(27.8)	11(22.0)	0(0)	1(20)	0(0)	0(0)	3(37.5)	0(0)	7(35)	0(0)	0(0)	0(0)
Plant Processing																		
Manos	-	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-
Metates	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal (%)	0(0)	0(0)	0(0)	1(1)	2(0.6)	0(0)	0(0)	1(2)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(5)	0(0)	0(0)	0(0)
Other																		
Stone Pipes	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceramic Sherds	-	-	-	-	40	-	-	-	-	-	1	-	-	-	2	-	-	-
Subtotal (%)	0(0)	0(0)	1(0.7)	0(0)	41(13.3)	0(0)	0(0)	0(0)	0(0)	0(0)	1(50)	0(0)	0(0)	0(0)	2(10)	0(0)	0(0)	0(0)
Site Total	17	24	139	103	308	6	18	48	0	5	2	1	8	1	20	4	1	0

Relative proportions of individual artifact types also reflect an emphasis on toolstone processing. As elsewhere in USX-East, the most common formed artifacts occurring in the Holeplug assemblages are quarry bifaces, accounting for nearly half (n=328; 47%) of the 705 specimens recovered by tests there. At all sites save two, quarry bifaces also are the most numerous items in individual site collections. At 26Ek3191 and -3179 they are outnumbered slightly by scrapers, a product perhaps of the intentional sampling of atypical features at these sites. Two sites, 26Ek3184 and -3192, are noteworthy for the unusually high numbers of quarry bifaces they contain; yielding 87 and 123 specimens respectively, they account for ca 64% of the total Holeplug quarry biface assemblage. A majority of these pieces were encountered in clustered concentrations, presumably representing caches.

The range and relative proportions of reduction stages represented by the quarry bifaces from Holeplug sites are similar to those expressed at other areas within USX-East; as elsewhere, Stage 2 (37%) and Stage 3 (41%) forms dominate. Relatively few specimens reveal Stage 4 attributes (6.7%), and none are more fully reduced. Absent as well are Stage 1 forms.

Among other classes of reduction artifacts, small bifaces occur at virtually all sites sampled. Preform bifaces, (incipient projectile points) are likewise widespread and tend to occur in greatest numbers at sites which yielded finished points.

Of the maintenance and processing tools in the collection, scrapers (n=128; 78%) are the most widely distributed and, where encountered, are the most numerous of the tools of this class in site assemblages. A number of end scrapers occur at several of the close-set sites along the northern edge of Holeplug Ridge (26Ek3184, -3185, -3190, and -3192). These are robust, steep-edged, carefully executed pieces that, in appearance, are identical to end scrapers thought to be diagnostic of pre-Archaic assemblages throughout the Desert West. Perforators and gravers occur exclusively within the collections from Large Reduction Complexes.

Subsistence-related artifacts (projectile points, groundstone, and ceramics) tend to co-occur at sites that contain the most abundant remains of other tasks ancillary to toolstone processing activities. These sites include the three Large Reduction Complexes and the neighboring Small Reduction Complex, 26Ek3185. Unexpectedly, given its isolated location, the maintenance/processing tools at Reduction Station 26ek3181 are augmented by both ceramic sherds and a mano.

The only esoteric piece from Holeplug Ridge is a stone (schist) pipe fragment recovered from Feature 8 at 26Ek3184.

The following section describes the nature of the Holeplug Ridge sites as revealed by the results of testing. Organized by

functional site type, it presents findings on a site specific basis. Note that discussions focus on data garnered from our judgmentally selected "Sample Features" which may not provide a representative sample.

Quarry/Reduction Complexes

Overlooking Undine Gorge from the relatively flat knoll-top formed by the western terminus of Corral Fan, both 26Ek3191 and 26Ek3193 appear to represent two of the most minimally exploited opalite sources at USX-East. All sites lie within easy access from localities throughout the project area; their location did not inhibit their use. Instead, light use appears to be a function of low toolstone quality. Bedrock surfaces and cobbles presently exposed are coarse-grained, highly weathered opalite suggesting that better-quality materials have been exhausted or never existed there. A related possible explanation for the minimal use of the sites derives from the completion of alternate higher quality opalite sources available within easy reach at several Undine quarries to the east and north. Table 109 summarizes formed artifact retrievals from both of the Outcrop Quarry/Reduction Complexes; Table 110 presents debitage recoveries from all their cultural features.

Table 109. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Outcrop Quarry/Reduction Complexes, Holeplug Ridge.

				ARTIFACT CLASSES						
				Reduction			Points	Processing		
Site Number	Feature Number	Type	Total Area (sq m)	CR	QB	SB	FG	SC	MP	Total
26Ek3191	1*	Obsidian Scatter	16	-	-	3	1	5	2	11
	Extra-Feature		N/A	2	4	-	-	-	-	6
26Ek3193	1*	Outcrop Quarry/ Reduction Station	226	1	3	-	-	-	-	4
	2	Biface Reduction	112	-	4	-	-	-	-	4
	3	Biface Reduction	14	-	2	-	-	-	-	2
	4*	Core and Biface Reduction	9	1	3	-	-	1	-	5
	5	Biface Reduction	43	-	1	1	-	-	-	2
	6	Core and Biface Reduction	44	-	-	-	-	-	-	0
	7	Biface Reduction	9	-	-	-	-	-	-	0
	Extra-Feature		N/A	-	4	2	-	1	-	7

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces

Projectile Points
FG = Unclassifiable Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
MP = Multipurpose Flake Tools

Table 110. Debitage from Sample Feature Collections, Outcrop Quarry/Reduction Complexes, Holeplug Ridge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
26Ek3191	1	16	4	10	21	51.2	3.40	18	43.9	22.60	2	4.9	41
26Ek3193	1	226	1	340	289	85.0	4.89	51	15.0	14.37	-	-	340
	4	9	6	576	3006	87.0	3.45	452	13.0	6.62	-	-	3458

26Ek3191

Close order reconnaissance of 26Ek3191 failed to disclose accumulations of opalite debitage sufficiently dense or discrete to be identified as cultural features. A low exposure of bedrock covers an area of ca 50 m^2 on the northwestern midslope of the site knoll that displays a battered appearance characteristic of quarrying; it is surrounded by a diffuse scatter of waste flakes and shatter that nowhere exceeds 5 items/m^2. Additional source material occurs as small opalite clasts included in the colluvial deposits throughout the site surface; some of these appear to have been assayed and rejected from further consideration on the spot. Evidence of somewhat further reduction of local opalite is offered by the pair of cores and 4 quarry biface fragments recovered from wide spread locations throughout the site. Three of the quarry bifaces are Stage 3 forms; 1 is a Stage 2.

Feature 1, the site's only cultural feature, is not clearly associated with toolstone processing, but was marked by a score of obsidian flakes and several obsidian tools and bifaces. After retrieving the obsidian visible on the ground, our 4 1 m by 1 m shovel skim collected the entire feature, returning one additional obsidian waste flake and the feature's single opalite tool (a scraper). Formed tool recoveries are presented in Table 109. Opalite debitage yields from shovel skimming were low (ca. 5/m^2), similar to those of the site as a whole (Table 110). As might be expected, flakes and shatter are robust (3.4 gm and 22.6 gm, respectively).

Feature 1 appears to represent a single episode, perhaps by hunters or others engaged in maintenance and/or subsistence chores, employing obsidian tools and cores brought to the site. The opalite scraper, a minimally used specimen, likely selected for some expedient task from amid the general debris scatter, offers the only evidence of their interest in the toolstone supply available at the site. This suggests that this

particular group was at the site in pursuit of non-toolstone resources and perhaps, their time in the area was limited.

26Ek3193

The moderate density lithic scatter dotted by 6 reduction stations, and the single exploited outcrop at 26Ek3193, suggest its somewhat more intense aboriginal use. Opalite reduction, rather than extraction, appears to have engrossed most visitors. The battered outcrop located on the northeastern slope of site 26Ek3195 is not heavily used, but cultural debris is sufficiently concentrated on its uphill side to allow its delineation as Feature 1. Our discontinuous transect of 4 50 cm by 50 cm collection units that spanned the feature revealed it to be relatively dense, homogeneous and composed exclusively of opalite debitage (Table 110). The large average size of flakes and shatter (ca. 4.9 gm and 14 gm, respectively) is predictable for quarrying debris. The scant formed artifact assemblage of the feature (3 quarry bifaces and a core) was recovered from general surface contexts surrounding the outcrop. These, combined with the character of the debitage, suggest that activities centered on the quarry included both toolstone extraction and processing The relatively high density of debitage (ca. 289 m^2 for flakes and 51 m^2 for shatter) is probably due to cultural deposition alone. Given the location of the feature on the midslope and the potential dam-like effect of the outcrop below the concentration, we suspect colluvial redisposition was in part responsible for Feature 1.

Sample Feature 4 was manifest on the surface as a very dense concentration of large opalite debitage with a single core on its surface. Our initial inspection suggested its use as a core and early stage biface reduction station. Subsequent collection of the entire northern half of the feature via 6 1 m by 1 m shovel skims appears to confirm our original identification.

Debitage accumulations were found to be quite dense but heterogeneous. Unit yields of flakes range from ca. $1600/m^2$ to ca. $70/m^2$ ($x=501/m^2$) and for shatter from ca. $235/m^2$ to ca. $8/m^2$ ($x=75.3/m^2$). The density of flakes and shatter reflected that visible on the surface. Moderate mean size of flakes and shatter (ca. 3.5 gm and 6.6 gm) and three Stage 2 quarry bifaces recovered during testing suggest the processing of cores into early reduction stage bifaces (Table 109).

Large Reduction Complexes

The three Large Reduction Complexes, and 26Ek3184 and -3192 in particular, are noteworthy for the abundance and variety of their cultural features and for abundant artifacts these

contain. One half of all of the reduction station features encountered at Holeplug Ridge occur within the precincts of these three sites. In addition, sites 26Ek3184 and -3192 contain caches of quarry bifaces. The high incidence of features and their close-set distribution along the flat knolltops bounding the southern rim of Undine Gorge attest to the intensive aboriginal use of this segment of the project area. For the most part, the structure and content of the individual reduction features comprising the Large Reduction Complexes are comparable to those that occur at other Holeplug sites.

26Ek3184

The 26 cultural features and intervening moderate density lithic scatter that defines 26ek3184 is confined primarily to the relatively flat knoll top at the northernmost extension of Holeplug Ridge. Occupying some 12,680 m^2, it is the second largest site at USX-East and is exceeded in size only by 26Ek3170, which lies on lower Ramadan Ridge immediately adjacent to the west, across a shallow drainage channel (Figure 83). Like most locations in the area, site soils are generally shallow sandy, gravelly colluvial deposits with abundant tuff clasts. However, on the somewhat higher portions of the eastern quarter of the site, these deposits are overlain by shallow accumulations of loess. Bedrock daylights sporadically along the slopes bordering Undine Gorge, but none evidences use.

Features all appear to be consequences of toolstone reduction. Quarry biface reduction stages suggest that over the site as a whole, intermediate (Stage 3 and 4) reduction tasks dominate.

The surface of Feature 1 consisted of seven opalite quarry biface fragments and an obsidian small biface (Table 111). The virtual absence of opalite reduction flakes from the immediate vicinity of the bifaces suggested that the feature might represent a biface cache or discard pile. Shovel skimming recovered seven additional opalite quarry biface fragments and a paltry debitage collection: seven opalite waste flakes, and two of obsidian (Table 112). The 1 m by 50 cm excavation unit dug immediately below the biface cluster yielded only 2 additional flakes by a depth of 10 cm below the surface.

Of the fourteen total quarry bifaces contained by Feature 1, 10 are Stage 3 forms, 3 are Stage 2 forms, and 1 is of indeterminate reduction stage. All of the specimens are fragmentary; most are about 50% complete and all are about the same size and shape. We surmise that the feature may represent a discard pile rather than a cache. Biface caches elsewhere in the project area (i.e. at 26Ek3192 and -3197) and at USX-West (26Ek3095) consist almost exclusively of whole specimens. Given, however, that the biface cluster is confined essentially

Figure 83. Site map, 26Ek3184.

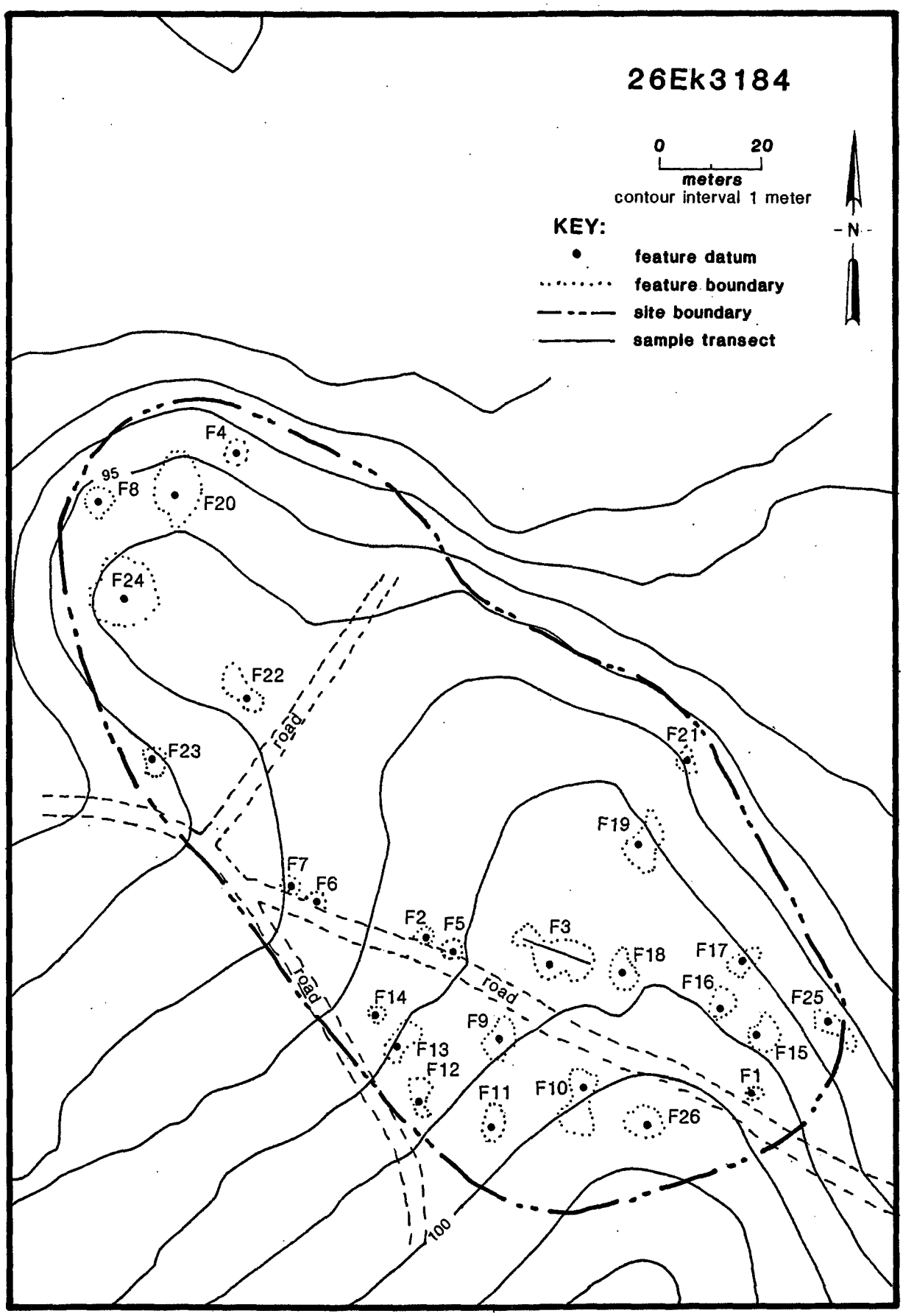

26Ek3184
0
20
meters
contour interval 1 meter
KEY:
feature datum
feature boundary
site boundary
sample transect
N
F4
95
F8
F20
F24
F22
road
F23
F21
F19
F7
F6
F2
F5
F3
F18
F17
road
road
F16
F25
F14
F9
F15
F13
F12
F1
F11
F10
F26
100

Table 111. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Site 26Ek3184.

Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES																
			Reduction							Points		Processing					Other	
			HM	OP	CR	QB	SB	PB	IB	PT	FG	SC	PG	MP	OT	AB	SP	Total
1*	Biface Cluster/Cache	0.4	-	-	-	14	2	-	-	-	-	-	-	-	-	-	-	16
2*	Core and Biface Reduction	2	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-	4
3*	Biface Reduction	160	-	1	-	9	-	1	-	1	1	7	-	-	-	1	-	21
4	Biface Reduction	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
5	Biface Reduction	15	-	-	-	4	-	-	-	-	-	2	-	-	-	-	-	6
6	Biface Reduction	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
7	Biface Reduction	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
8*	Biface Reduction	64	1	-	4	29	1	1	1	-	-	2	1	2	-	-	1	43
9	Biface Reduction	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
10	Biface Reduction	148	-	-	-	8	2	-	-	-	-	-	1	-	-	-	-	11
11	Core and Biface Reduction	16	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
12	Biface Reduction	22	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
13	Biface Reduction	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
14	Biface Reduction	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
15	Core and Biface Reduction	86	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
16	Biface Reduction	23	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	4
17	Biface Reduction	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
18	Biface Reduction	50	-	-	-	1	1	-	1	-	-	1	-	-	1	-	-	5
19	Core and Biface Reduction	39	-	-	-	3	1	-	-	-	-	1	-	-	-	-	-	5
20	Core and Biface Reduction	156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
21	Biface Reduction	22	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	3
22	Biface Reduction	57	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-	5
23	Biface Reduction	63	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
24	Core and Biface Reduction	177	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	2
Extra-Feature Context		N/A	-	-	1	4	2	-	-	-	-	1	1	-	-	-	-	9

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
HM = Hammerstones
OP = Other Percussion Tools
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces
IB = Indeterminate Biface Fragments

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tool
AB = Abraders
SP =

to the site surface (<2 cm deep) and the feature lies immediately adjacent to the main dirt road through the project area, we remain somewhat skeptical about the origin of the feature. The concentration may indeed represent a discard pile, but its anomalous composition and context suggest that while it may represent a stockpile of rejects destined for redirection into smaller biface forms, it could as well be the discarded spoils of a pothunter.

Table 112. Debitage from Sample Feature Collections, Large Reduction Complexes, Holeplug Ridge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3184	1	0.4	2	4.5	7	77.7	2.30	-	-	-	2	22.3	9
	2	2	4	577.8	1988	86.0	4.42	322	13.9	4.40	1	0.1	2311
	3	160	2	559.0	1096	98.0	1.92	16	1.4	6.10	6	0.5	1118
	8	64	1	408.0	374	91.7	3.13	34	8.3	2.48	-	-	408
				[664.0]	[656]	[98.8]	[0.05]	[7]	[1.0]	[0.90]	[1]	[0.2]	[664]
				(1072.0)	(1030)	(96.1)	(1.17)	(41)	(3.8)	(2.00)	(1)	(0.1)	(1072)
26Ek3190	1	31	28	236.0	4690	71.0	1.34	1851	28.0	2.32	68	1.0	6609
	2	9	12	269.0	2997	92.9	1.48	218	6.7	3.61	9	0.3	3224
26Ek3192	1	19	24	306.0	7068	96.2	1.39	255	3.5	2.46	24	0.3	7347
	2	400	5	671.0	3171	94.5	1.16	162	4.8	2.24	21	0.6	3354

SUBSURFACE COLLECTIONS

Site Number	Fea. No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3184	1	1 / D	10	0.10	2	100.0	0.35	-	-	-	-	-	2
	8	1 / A	20	0.15	918	95.3	1.00	45	4.7	10.10	-	-	963
26Ek3190	1	1 / D	20	0.10	1125	89.9	0.36	120	9.5	1.10	6	0.5	1251
26Ek3192	1	*	40	3.40	9021	98.5	1.63	12	0.1	0.40	130	1.4	9163
	2	1 / D	20	0.10	458	95.0	0.48	24	5.0	0.69	-	-	482
	2	2 / A	80	0.80	3792	98.9	1.49	24	0.6	4.05	17	0.5	3833

Key to Excavation Unit Type
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen

Key to Mesh Size Retrievals
n = 1/4 in.
[n] = 1/8 in.
(n) = 1/8 in. + 1/4 in. combined

* Excavation Unit No. 1 = Type D
Nos. 5, 6, 7, 8, 9, 11, 12, 13 = Type A

Feature 2 was selected for sampling as a typical reduction station. Its surface boundaries were extremely discrete and our 4 m^2 shovel scrape apparently removed all material lying in primary deposition, since no flakes were found below the scraped surface save in a zone of apparent rodent disturbance. The debitage assemblage consists of 1988 opalite waste flakes and 322 pieces of shatter (Table 112).

Debitage density is relatively high and uniform throughout the concentration, averaging 497/m^2 for flakes and ca. 81/m^2 for shatter. Average size of both are the same (4.4 gm). While the small size and discrete clustering of the debris suggested a single reduction event, the debitage exhibits several color varieties indicating reduction of multiple blanks (although not necessarily material from multiple sources). The feature lacks formed reduction artifacts, although the moderately large debitage and relatively low incidence of shatter suggests, perhaps, creation of the feature through processing cores and/or reduction of flake blanks into early stage quarry bifaces. The four flake tools recovered with the debitage are not obviously related to reduction activities. However, such items typically augment reduction features in the project area.

Feature 3 provided the opportunity to test a much larger reduction station with several discrete concentrations. Our 8 discontinuous sample units returned 1139 cultural items, heterogeneously distributed across the feature. Figure 84 depicts surface of the feature configuration and the placement of sample units. Table 113 presents the debitage recovered per unit.

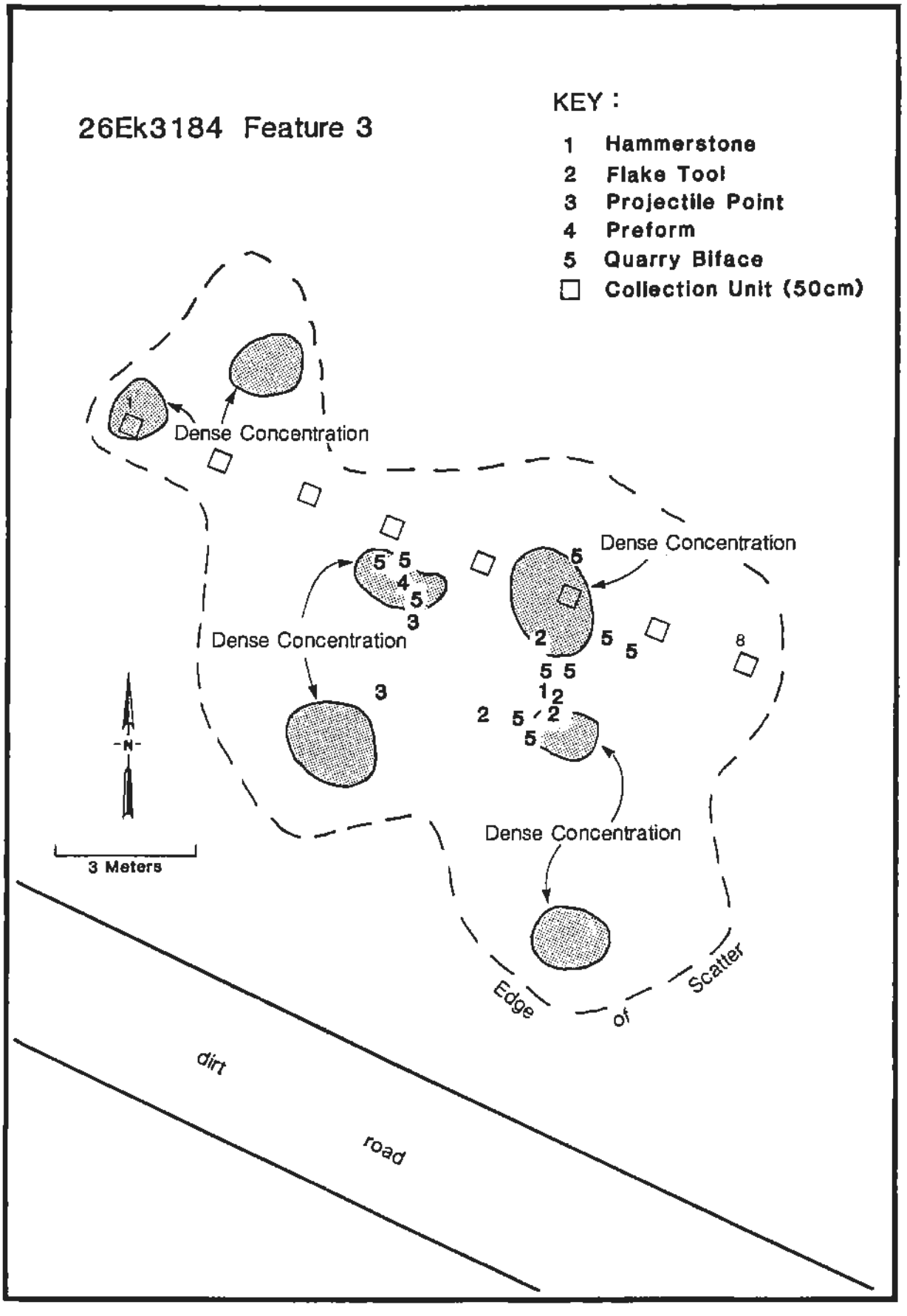
Table 113. Debitage from Sample Feature 3, Site 26Ek3184.

SURFACE COLLECTIONS

Unit	OPALITE DEBITAGE						OTHER		
	Flakes			Shatter			DEBITAGE		
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
1	226	96.9	5.5	7	3.1	12.58	-	-	233
2	21	90.9	1.30	-	-	-	1	9.1	22
3	20	100.0	0.95	-	-	-	-	-	20
4	146	96.1	1.06	2	1.3	0.30	4	2.6	152
5	343	98.6	1.04	5	1.4	1.40	-	-	348
6	156	98.1	0.70	2	1.3	0.80	1	0.6	159
7	177	100.0	0.96	-	-	-	-	-	177
8	7	100.0	0.97	-	-	-	-	-	7
Total	1096	98.1	1.91	16	1.4	6.08	6	0.5	1118

Figure 84. Plan of Feature 3, 26Ek3184.

Figure 84. Plan of Feature 3, 26Ek3184.


26Ek3184 Feature 3
KEY :
1 Hammerstone
2 Flake Tool
3 Projectile Point
4 Preform
5 Quarry Biface
Collection Unit (50cm)
Dense Concentration
Dense Concentration
Dense Concentration
Dense Concentration
N
3 Meters
dirt
road
Edge of Scatter

Comparison of Figure 84 and Table 113 discloses that the extent of the feature is not necessarily predicted by the occurrence of surface material. In fact, debitage recovery is highest in . Unit 5 which falls outside all surface concentrations. These data suggest the possibility that the feature is a single large scatter exposed here and there at the surface. Unit 8 appears clearly to be peripheral to the feature.

The large average size of flakes (5.5 gm) and shatter 12.6 gm) in Unit 1 suggest earlier stage reduction compared to the smaller debitage recovered from the other units along the baseline.

Additionally, the feature yielded a variety of formed artifacts, but all were recovered from non-sample surface contexts. These include nine quarry bifaces (3 of Stage 2, 3 of Stage 3, 2 of Stage 4, and 1 whose reduction stage could not be determined), as well as several scrapers, a Cottonwood Series projectile point, and a shaft abrader (cf. Table 111).

Feature 8 was similar to other reduction stations, with two distinct opalite debitage concentrations of moderate density. However, it was distinguished by a small (1 m by 20 cm) surface cluster of quarry bifaces, cores, and other formed artifacts. On the possibility that this represented a cache or discrete workshop area, we superimposed a 1 m by 1 m shovel skim unit on the artifact concentration, subsequently excavating to a depth of 20 cm.

All formed artifacts occurred on the surface or within the upper 10 cm of the deposit (Table 111). A total of 19 quarry bifaces was revealed within the artifact cluster: 9 were recovered from the surface of the concentration and 11 from the 2-10 cm of the excavation. Reduction stages are divided between Stage 2 and Stage 3.

Surface skimming and excavation also recovered 2035 pieces of debitage (1949 waste flakes and 86 pieces of shatter); all except 2 obsidian flakes are opalite (Table 112).

Use of 1/8" mesh screen inflated debitage yields and greatly diminishes apparent average size of waste flakes. This renders raw results uncomparable to other samples recovered with 1/4" mesh. However, comparable data are provided by size grading waste flakes in the laboratory. Items in the 1/8" fraction of our sample are by far the most abundant, accounting for some 60% (n=1180) of debitage recovered but only 3% (65.2 gm) by weight. However, the 1/4" fraction contains amounts and sizes of debitage within ranges of 1/4" samples recovered elsewhere in the project area, reflecting early and intermediate stages of reduction also apparent in bifaces from the feature (Table 112).

26Ek3190

Site 26Ek3190 occupies the knoll top immediately to the east of 26Ek3184 and is separated from the Outcrop Quarry of 26Ek3191 by a shallow intermittent drainage (Figure 85). Like its neighbor to the west, the site contains opalite exposures but none of these evidence use; the 11 cultural features of the site relate almost entirely to toolstone reduction (Table 114).

Table 114. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Reduction Complex Site 26Ek3190.

Feature Number	Type	Area (sq m)	ARTIFACT CLASSES: Reduction CR	QB	SB	PB	IB	Points PT	FG	Processing SC	KN	PG	MP	GS	Total
* 1	Biface Reduction/ Residential	31	3	15	7	-	5	1	3	14	3	2	1	-	54
* 2	Biface Reduction	9	-	9	2	-	1	-	-	2	-	1	-	-	15
3	Biface Reduction	4	-	-	-	-	-	-	-	-	-	-	-	-	0
4	Biface Reduction	60	-	5	-	-	-	-	-	-	-	-	-	-	5
5	Biface Reduction	19	-	1	1	-	-	-	-	1	-	-	-	1	4
6	Biface Reduction	69	-	4	-	-	-	-	-	1	-	-	-	-	5
7	Biface Reduction	14	-	2	-	1	-	-	-	-	-	-	-	-	3
8	Biface Reduction	12	-	-	-	-	-	1	-	-	-	-	-	-	1
9	Core Reduction	2	-	-	-	-	-	-	-	-	-	-	-	-	0
10	Biface Reduction	50	-	-	-	-	-	-	1	-	-	-	-	-	1
11	Core Reduction	43	-	1	-	-	-	-	-	-	-	-	-	-	1
-	Extra-Feature	N/A	11	1	-	-	-	-	-	1	-	-	-	-	14

* Sample Feature

Key to Artifact Classes

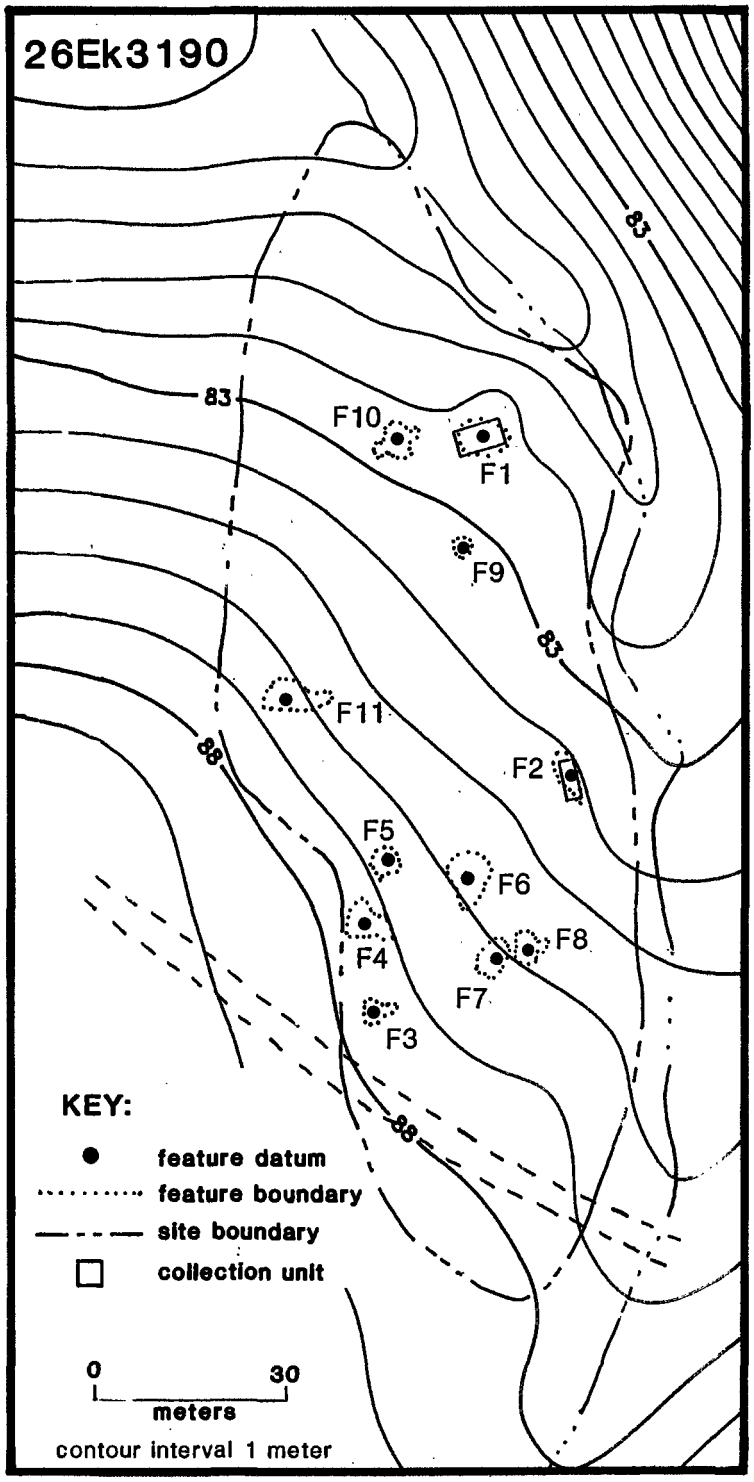
Reduction Tools and Artifacts
CR = cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces
IB = Indeterminate Biface Fragments

Maintenance/Processing
SC = Scrapers and Spokeshaves
KN = Knives
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
GS = Groundstone

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Feature 1 was manifest on the surface by a moderate density scatter of opalite debitage. It was selected for sampling due to the presence of numerous tools and the non-opalite lithic waste materials (obsidian, jasper, and basalt) on its surface. The entire horizontal extent of the feature was removed with 28 1 m by 1 m shovel skim units. Where surface density was highest, the deposits were probed by excavation of a 1 m by 0.5 m unit to a depth of 20 cm.

Figure 85. Site map, 26Ek3190.


26Ek3190
83
83
83
88
88
F10
F1
F9
F11
F2
F5
F6
F8
F4
F7
F3
KEY:
feature datum
feature boundary
site boundary
collection unit
0
30
meters
contour interval 1 meter

The test recovered a large assemblage of formed tools in a wide variety of types (Table 114); all recovered from the surface (< 0-2 cm). While artifacts directly related to opalite processing predominate (n=30), maintenance and subsistence tools occur in nearly equal numbers; together, they comprise some 44% of the assemblage. Among these are a Desert Side-notched projectile point and several unidentifiable fragments, as well as numerous scrapers, knives, perforators, and other flake tools. The abundance of formed artifacts from this feature suggest the possibility of uses beyond those directed at toolstone reduction, i.e., as a hunting camp or other special task site.

The reduction assemblage, on the other hand, offers evidence of toolstone-oriented behaviors characteristic of the project area as a whole. The 15 quarry bifaces (13 Stage 2 and 2 are Stage 3), the cores, and the average size and relative abundance of opalite waste flakes and shatter (Table 112) suggest reduction tasks focused on processing or conversion of flake blanks into into quarry bifaces.

Small bifaces are noteworthy for their abundance (n=7). Such implements, presumably en route to terminal forms such as knives, or possibly dart points, are nowhere more abundant in any of the features sampled within Holeplug Ridge. At Features 1 and 2 at 26Ek3192, both of which contain "domestic" artifacts as well, small bifaces occur in similar quantities. The presence of small bifaces suggests the production of maintenance/subsistence tools intended for immediate use, rather than (as presumed of quarry bifaces) the production of portable "toolstone packages" intended for further processing and creation of tools elsewhere.

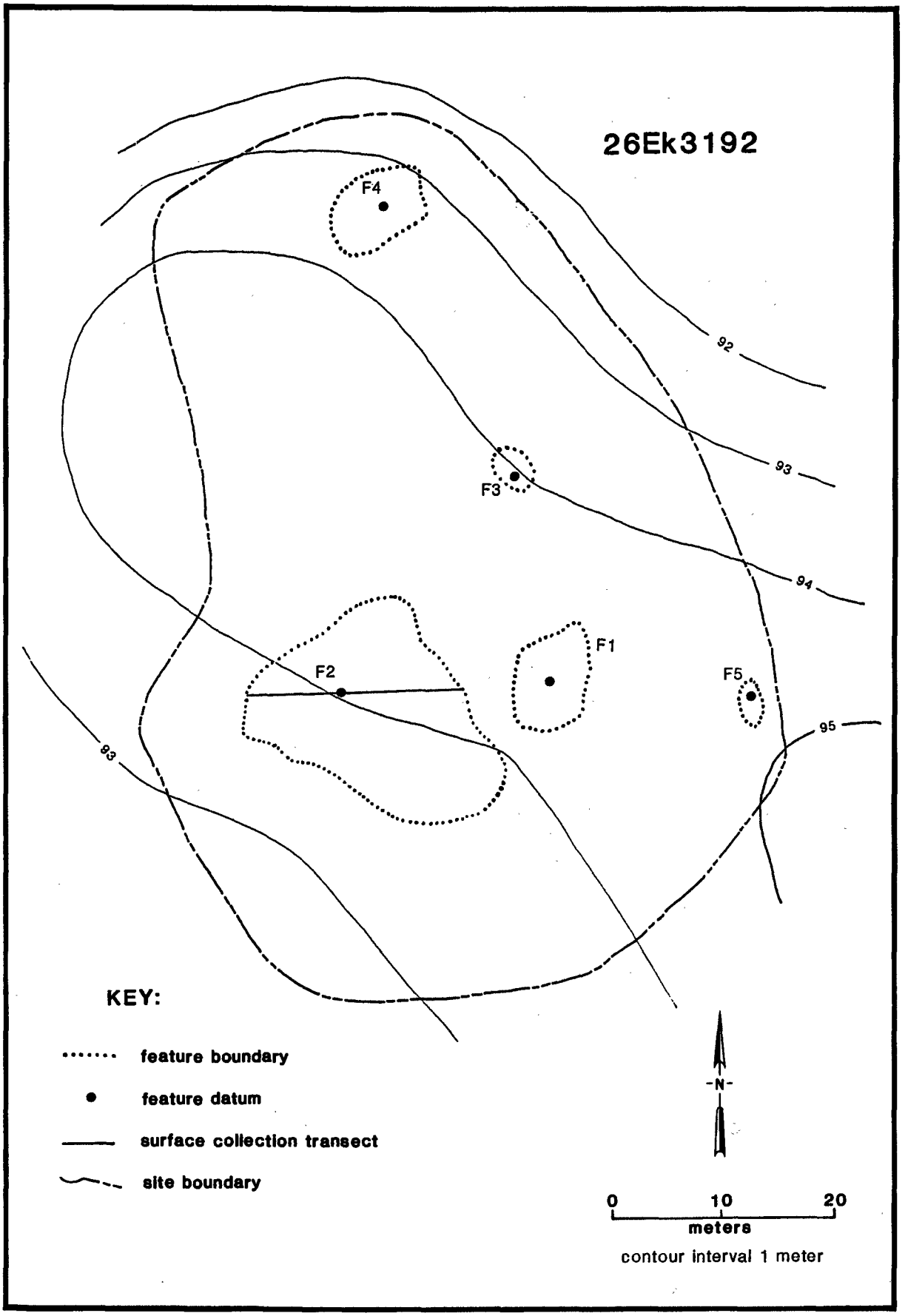
Feature 2 was tested as a more typical representative of the reduction stations at the site. Manifested by two moderate to high density flake concentrations and an intervening more diffuse scatter, it lacks the artifact diversity of Feature 1. Twelve 1 x 1's collected its entire surface expression.

Although including some non-reduction related tools (cf. Table 114), and lithic debris other than opalite (Table 112), the 5 Stage 2 and 2 Stage 3 quarry bifaces and the character of the debitage in Feature 2 suggest that it functioned principally as an early-stage reduction station.

26Ek3192

Site 26Ek3192 lies just off crest of the prominent knoll rising abruptly above Undine Gorge at the northern margin of the Holeplug study area (Figure 82 and 86). It is flanked on the east and west by outcrop quarries 26Ek3193 and -3191. The depositional context of 26Ek3192 contrasts strongly with that of both the neighboring sites and throughout USX-East as a whole.

Figure 86. Site map, 26Ek3192.


26Ek3192
F4
F3
F2
F1
F5
92
93
94
95
93
KEY:
feature boundary
feature datum
surface collection transect
site boundary
N
0
10
20
meters
contour interval 1 meter

The upper few cm of deposits are loess, overlying colluvial surfaces exposed at most locations in the project area. The area occupied by the site is smooth and flat, with no erosion or colluvial redeposition so prevalent elsewhere. Thus, aeolian accumulation appears to have buried and sealed essentially intact cultural features.

Five cultural features were recorded on the surface of 26Ek3192. Features 3-5, based on inventory-level examinations, are typical reduction stations of the kinds observed elsewhere (Table 115). Features 1 and 2 also include reduction station attributes in addition to large and diverse artifact assemblages. These characteristics led us to choose these as sample features.

The occurrence of these two large, complex and functionally distinct features at site 26Ek3192 invited special scrutiny during testing. Owing in part to the magnitude of our sampling there, and as well to artifact abundance and density in these two Sample Features, artifact collections are the largest of all sites tested. Some 35,130 cultural items were recovered from the site, and of these, 308 consist of bifaces and tools (cf. Table 115).

Feature 1

Feature 1 was marked on the surface by a scatter of opalite debitage and a cluster of 6 opalite Quarry Bifaces that we suspected was a biface cache. Initial shovel skimming of the feature recovered materials of uncommon abundance and diversity. Our initial 24 m^2 of shovel skimming encompassed virtually all of the visible surface scatter and produced 37 quarry bifaces and 19 sherds of pottery in addition to abundant debitage. A 1 m by 50 cm excavation unit (Unit 1) was centered on the surface biface cluster (Figure 87) and excavated to a depth of 20 cm, uncovering 35 additional bifaces. These close proximity and orientation suggested they had been placed in a basin-shaped depression about 50 cm in diameter and 20 cm deep. No evidence of a pit could be detected during excavation, but a slightly dark stain can be seen in a slide of the feature shot through a polarizing filter. Several hundred small opalite waste flakes occupied the matrix immediately surrounding the cache.

Where shovel skimming revealed an abundance of pottery sherds and burned opalite flakes, excavation Unit 3 was opened to check for the presence of a hearth. Neither a hearth, nor any additional pottery, was discovered, but the unit yielded over 700 small (avg. wt. 0.16 gm) flakes, many of them burned.

Subsequent to excavation of these two initial units, we opened a much larger area around Feature 1, entailing the excavation of an additional 11 m^2 (units 11-15) to depths of

Table 115. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Reduction Complex Site 26Ek3192.

Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction HM	CR	AS	QB	SB	PB	IB	Points PT	FG	Processing SC	PG	MP	OT	GS	Other CE	IC	Total
1*	Biface Cache/Residential/ Reduction	19	1	8	1	90	3	1	11	1	1	44	4	4	1	1	39	-	213
2*	Biface Reduction/Residential	396	2	7	1	23	8	1	5	5	7	15	-	1	2	1	1	1	80
3	Biface Reduction	12	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
4	Biface Reduction	64	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	4
5	Biface Reduction	8	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	3
Extra-Feature		N/A	-	-	-	5	-	-	-	-	-	2	-	-	-	-	-	-	7

* Sample Feature

Key to Artifact Classes

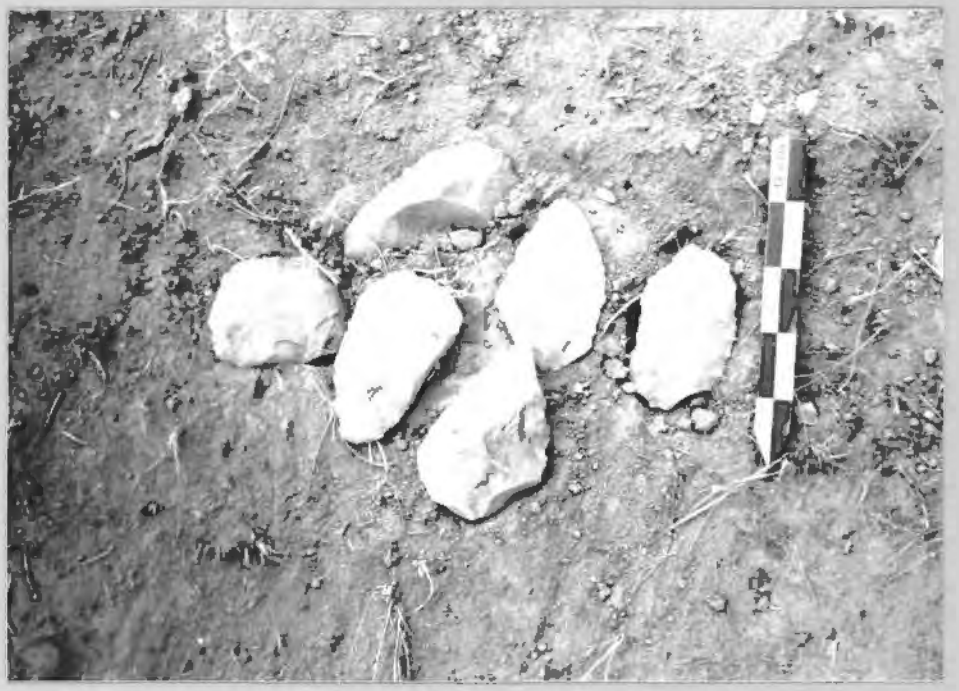
Reduction Tools and Artifacts
HM = Hammerstones
CR = Cores
AS = Assayed Stones
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces
IB = Indeterminate Biface Fragments

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Other
CE = Cerammic Sherds
IC = Incised cylinder

Maintenance/Processing
SC = Scrapers and Spokeshaves
PG = Perforators and Gravers
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tool
GS = Groundstone

Figure 87. Biface cache at 2 cm below surface (a) and 10 cm below surface (b), site 26Ek3192.



a.



b.

between 20 and 40 cm (Figure 88, inset). By the close of operations, Feature 1 yielded 213 items including 90 quarry bifaces (41 of which constituted the cache), 39 Shoshone Brownware sherds, scores of flake tools (including a pair of end scrapers and 4 perforators), a projectile point, and a mano (Table 115). Opalite debitage was correspondingly abundant and included small amounts of obsidian and jasper as well (Table 112).

What appears to be a buried cultural feature was encountered by our broad subsurface exposure. Between 20 to 30 cm below surface (at an average depth of 26 cm), 9 contiguous excavation units centered on the biface cache (Unit 1) displayed a scatter of large flakes, hammerstones, unmodified opalite cobbles, and a few cores and biface fragments (Figure 88). This zone has the appearance of a workshop surface although analysis is pending. We note that the surface apparently underlay the lowest extent of the biface cache.

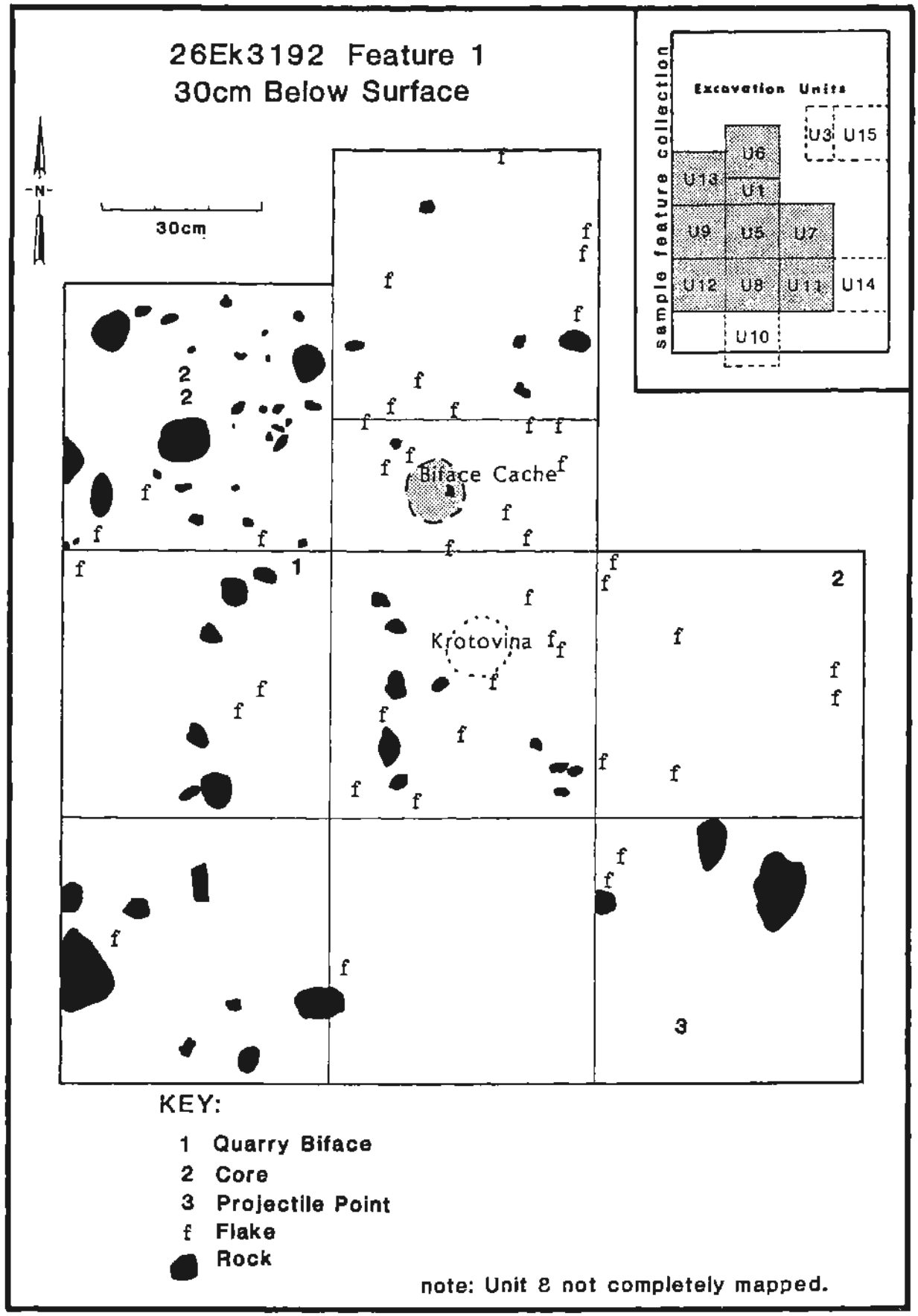
It would appear, overall, that Feature 1 functioned as a biface reduction station. Quarry bifaces recovered from the feature in its entirety (i.e., including the cache) suggest early to intermediate reduction: of the classifiable specimens, 50% are Stage 3, 35% are Stage 2, and ca. 7% were Stage 4. Within the cache itself were 30 (73%) Stage 3 bifaces, 10 (24%) Stage 2, and a single (2.4%) Stage 1 form (see Chapter 3, this volume, for detailed presentation of quarry biface cache data). The relative frequency and average size of opalite debitage fit biface reduction. The recovery rates for opalite shatter are lower in Feature 1 than usually found at other sites with similar assemblages of quarry bifaces.

Dating this feature rests on the evidence provided by pottery and projectile points. Shoshone Brownware (all of which was recovered in the upper 2 cm of the deposit) probably post-dates A.D. 1300 (Madsen 1977). The single projectile point recovered was a Humboldt Series specimen in brown, heat-treated opalite. Although Humboldt Series points are thought to be unreliable time-markers (Thomas 1980), this specimen could mark visitation of the site between ca. 3000 B.C. and A.D. 700. It was recovered from the 20 to 30 cm level of Unit 11 and is perhaps coeval with the buried surface partially exposed in that level.

Feature 2

Located some 20 m to the west of Feature 1, Feature 2 comprises two dense lithic concentrations against a a more diffuse lithic scatter. In addition to the dominant opalite debris, obsidian, basalt, and various chert debitage were present within the scatters. Inventory of the feature surface revealed numerous quarry bifaces, cores, modified flakes, one

Figure 88. Plan of Feature 1 at 20 to 30 cm below surface, site 26Ek3192.


26Ek3192 Feature 1
30cm Below Surface
N
30cm
Biface Cache
Krotovina
Excavation Units
sample feature collection
U3
U15
U6
U13
U1
U9
U5
U7
U12
U8
U11
U14
U10
KEY:
1 Quarry Biface
2 Core
3 Projectile Point
f Flake
Rock
note: Unit 8 not completely mapped.

sherd of Shoshone Brownware, and an incised stone cylinder. The assemblage also included 2 steep-edged, high-domed unifacial scrapers and a basalt Stemmed Series projectile point base. (Several additional, but equivocal, basalt fragments appeared to represent another stemmed point specimen.) Since the scrapers and the projectile point resemble forms characteristic of the pre-Archaic period, Feature 2 was selected for sampling.

A discontinuous transect of 20 shovel scrape collection units was intended to document variability in density of debitage in addition to sampling the larger and denser of the surface two concentrations (Figure 89). The recovery rates of these units is summarized in Table 116.

Table 116. Debitage from Sample Feature 2, Site 26Ek3192.

SURFACE COLLECTIONS

Unit	OPALITE DEBITAGE						OTHER DEBITAGE		
	Flakes			Shatter					
Number	(n)	(%)	(Av Wt)	(n)	(%)	(Av Wt)	(n)	(%)	Total
1	13	100.0	1.38	-	-	-	-	-	13
2	14	93.3	1.08	1	6.7	2.50	-	-	15
3	14	100.0	0.51	-	-	-	-	-	14
4	48	85.7	1.35	6	10.7	3.90	2	3.6	56
5	69	82.1	1.35	8	9.5	2.58	7	8.3	84
6	32	91.4	1.05	-	-	-	3	8.6	35
7	53	86.9	0.84	5	8.2	2.94	3	4.9	61
8	20	80.0	0.42	3	12.0	1.06	2	8.0	25
9	28	100.0	1.10	-	-	-	-	-	28
10	63	92.6	0.98	4	5.9	1.00	1	1.5	68
11	182	94.8	1.13	10	5.2	1.77	-	-	192
12	326	93.7	2.79	22	6.3	1.58	-	-	348
13	677	96.1	1.21	26	3.7	2.83	1	0.2	704
14	213	99.5	1.57	1	0.5	10.60	-	-	214
15	303	96.8	0.76	10	3.2	2.31	-	-	313
16	212	98.1	0.88	4	1.9	5.20	-	-	216
17	110	100.0	1.14	-	-	-	-	-	110
18	79	87.8	0.85	10	11.1	3.57	1	0.1	90
19	19	86.4	0.75	3	13.6	2.13	-	-	22
20	32	71.1	0.89	13	28.9	1.20	-	-	45

Comparison of Table 116 with Figure 89 suggests that the subsurface component of the larger of the 2 surface scatters closely approximates its surface configuration (cf. units 19-18). The average size of debitage tends to be greater within the concentration.

Two excavation units explored the subsurface where debitage was most dense within the concentration. Excavation Unit 1 (1 m by 50 cm) was taken to a depth of 20 cm, terminated when the incidence of cultural material fell off sharply and the fine silt of the uppermost stratum became increasingly burdened with clay.

Excavation Unit 4 (1 m by 1 m) encompassed surface sample Unit 15, and was dug to a depth of 80 cm below surface; Figure 90 depicts the stratigraphic profile of its East wall.

At Excavation Unit 4, an upper silty, root-laden zone is underlain by 20 to 35 cm of clayey silt that has seen massive rodent disturbance. Sloping sharply downward to the south (from 25 to 62 cm below surface) is friable, silty clay, underlain on the north by a weathered opalite bedrock and on the south by a massive clay.

The upper 10 cm level yielded opalite flakes, a mano, a Desert side-notched projectile point, 4 non-diagnostic projectile point fragments, 7 obsidian flakes, quarry biface fragments, and several small bifaces (including one of obsidian). Subsequent levels yielded diminishing numbers of flakes and other artifacts. Below 50 cm, virtually all cultural materials were recovered from krotovina; a Cottonwood Triangular projectile point was found in such a context between 60 and 70 cm. In the deepest level excavated (70-80 cm) only krotovina was excavated, for a return of one quarry biface fragment and ca 30 waste flakes.

The abundant and diverse artifacts of Feature 2 suggests multiple activities, not all related to reduction of toolstone. The quarry biface assemblage occurring at the feature appear similar to that of adjacent Feature 1. Of the 23 bifaces from Feature 2, 12 (52%) are Stage 3, 6 (26%) are Stage 2 and the remaining 5 are of indeterminate stage. The diversity of the assemblage suggests that, like Feature 1 at 26Ek3198, Feature 1 at 26Ek3190 and Feature 1 at 26Ek3185, and others, it may have served at times as a hunter's temporary camp. The possibility of great antiquity was not confirmed in subsurface deposits. However, the accumulation of loess may have obscured older remains. The apparent depth of deposits merits further exploration.

Small Reduction Complexes

Raven's (1988) survey of USX-East recorded five sites classified as Small Reduction Complexes: 26Ek3172, -3173, -3185, -3188, and -3189. Sites of this type occur only within the Holeplug Ridge portion of the project area. Compared to Large Reduction Complexes, Small Reduction Complexes contain lower numbers of features and fewer formed artifacts within features. However, the relative proportions of artifact classes are essentially the same at both types of site (Table 108).

Figure 89. Plan of Feature 2, site 26Ek3192.

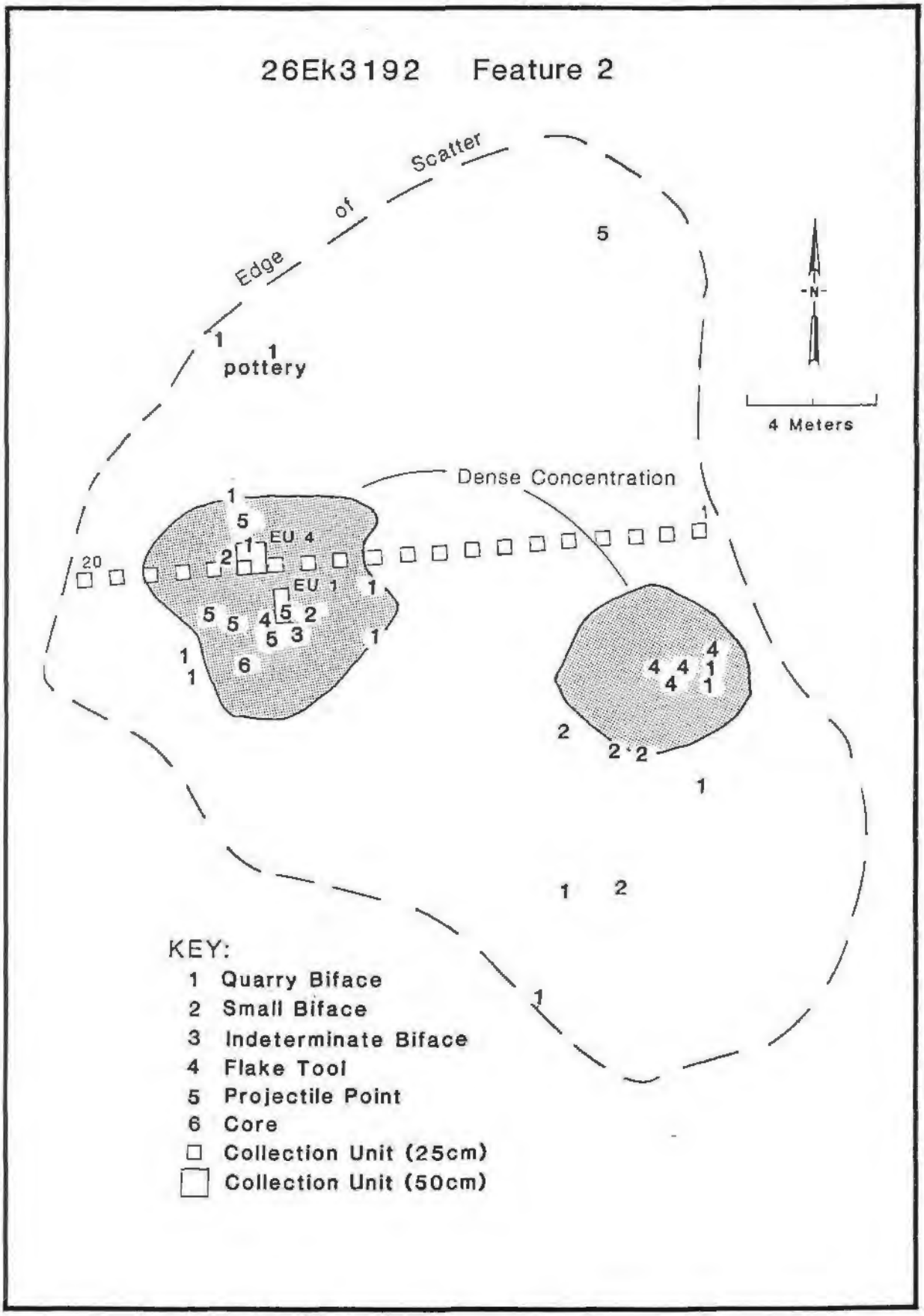
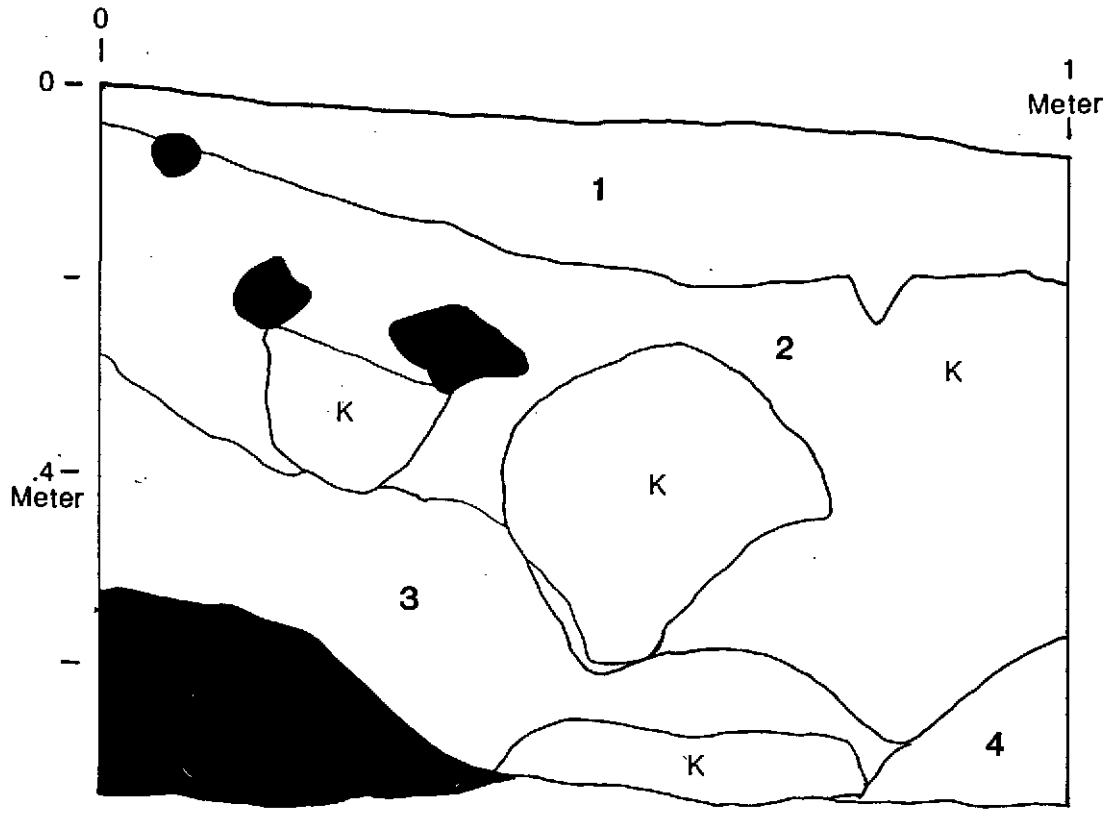

26Ek3192 Feature 2
Scatter
Edge of
pottery
Dense Concentration
EU 4
EU 1
20
N
4 Meters
KEY:
1 Quarry Biface
2 Small Biface
3 Indeterminate Biface
4 Flake Tool
5 Projectile Point
6 Core
Collection Unit (25cm)
Collection Unit (50cm)

Figure 90. 26Ek3192 east wall profile, Feature 2, excavation Unit 4.

1. Loose loam with organics (root zone), 10YR 5/3.
2. Loose loam with light clay, 10YR 6/3.
3. Friable silty clay, 10YR 6/4.
4. Massive plastic clay, 10YR 4/3.

26Ek3192

EAST WALL, UNIT 4, FEATURE 2



KEY:

K **krotovina**

rock

Small Reduction Complexes are located at the geographical extremes of the Holeplug area. Two, 26Ek3172 and -3173 occupy relatively flat areas on the crest of Ramadan Ridge in the southwestern quarter of the project area and the remaining three, 26Ek3185, - 3188, and -3189, are positioned immediately upslope from the Large Reduction Complexes and Outcrop Quarries near the northern terminus of Holeplug Ridge (Figure 82).

Recall that 26Ek3188 and -3189 were not tested by "Sample Feature" techniques; our characterization of these two sites relies on information garnered from surface inspections during inventory procedures. The formed artifact assemblages obtained from each of the Small Reduction Complexes are summarized by Table 117, and debitage recoveries are presented in Table 118.

26Ek3172

Site 26Ek3172 is the largest of the Small Reduction Complexes, and, of those, the most depauperate in formed artifacts. Only Feature 4 contained a formed artifact (a small biface) on its surface. The additional four quarry bifaces and one more small biface recovered from the site were all retrieved from extra-feature contexts (see Table 117).

Feature 1, marked on the surface by a close-set pair of small concentrations of opalite debitage, were selected as our "Sample Feature" because of the presence of a single obsidian flake on the surface. Our block of 8 1 m by 1 m shovel skim units collected the entire visible surface extent. Artifacts obtained by the exercise - exclusively lithic debitage - are summarized in Table 118.

In the absence of formed reduction products at Feature 1, attributes of the debitage assemblage suggest that toolstone production tasks were performed at the feature, much like those expressed by reduction features elsewhere. The average individual sizes of flakes and shatter, ca 1.5 gm for both, is relatively small, suggesting the processing of intermediate stage reduction artifacts. The low incidence of shatter and absence of cores implies perhaps, that raw materials arrived at the Feature in the form of Stage 2 quarry bifaces. The four quarry bifaces collected from non-feature contexts seem to suggest this for the site as a whole, in that of those of identifiable reduction stage, 2 are Stage 2 forms and 1 is a Stage 4.

Table 117. Description of Artifact Classes Recovered from Feature and Extra-Feature Contexts at Small Reduction Complexes, Holeplug Ridge.

Site Number	Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction HM	SS	CR	QB	SB	PB	IB	Points PT	FG	Processing SC	KN	MP	OT	GS	Total
26Ek3172	1*	Biface Reduction	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	2	Biface Reduction	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	3	Biface Reduction	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	4	Biface Reduction	8	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	5	Biface Reduction	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	6	Biface Reduction	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Extra-Feature		N/A	-	-	-	4	1	-	-	-	-	-	-	-	-	-	5
26Ek3173	1*	Biface Reduction	25	-	-	-	6	2	-	-	-	2	3	-	-	-	-	13
	2	Biface Reduction	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	3	Biface Reduction	60	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
	4	Biface Reduction	24	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	Extra-Feature		N/A	-	-	-	1	-	-	1	-	-	1	-	-	-	-	3
26Ek3185	1*	Biface Reduction	16	1	1	1	6	1	3	-	3	2	7	1	1	0	1	27
	2	Core and Biface Reduction	14	-	-	1	2	-	-	-	-	-	-	-	-	-	-	3
	3	Biface Reduction	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	4	Biface Reduction	13	1	-	-	1	-	-	-	-	-	-	-	-	-	-	2
	5	Core and Biface Reduction	26	-	-	-	4	-	-	-	-	-	-	-	-	-	-	4
	6	Biface Reduction	12	-	-	-	1	1	1	-	-	-	1	-	-	-	-	4
	7	Core and Biface Reduction	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Extra-Feature		N/A	-	-	-	4	2	-	-	-	-	1	-	1	-	-	8
26Ek3188	1	Biface Reduction	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
26Ek3189	1	Core Reduction	19	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
	2	Biface Reduction	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	3	Biface Reduction	9	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
	4	Biface Reduction	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Extra-Feature		N/A	-	-	-	1	-	1	-	-	-	-	-	-	1	-	3

* Sample Feature

Reduction Tools and Artifacts
HM = Hammerstones
SS = Scratched Stones
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
PB = Preform Trajectory Bifaces
IB = Indeterminate Biface Fragments

Key to Artifact Classes

Maintenance/Processing
SC = Scrapers and Spokeshaves
MP = Multipurpose Flake Tools
OT = Indeterminate Flake Tool
GS = Groundstone

Projectile Points
PT = Classifiable Points
FG = Unclassifiable Fragments

Table 118. Debitage from Sample Feature Collections, Small Reduction Complexes, Holeplug Ridge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3172	1	6	8	162	1250	96.2	1.57	40	3.1	1.54	9	0.7	1299
26Ek3173	1	25	40	66	2396	90.8	2.25	238	9.0	2.76	5	0.2	2639
26Ek3185	1	16	20	95	1833	96.3	1.6	67	3.5	.98	4	0.2	1904

SUBSURFACE COLLECTIONS

Site Number	Fea. No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	Flakes (%)	Flakes (Av Wt)	Shatter (n)	Shatter (%)	Shatter (Av Wt)	OTHER DEBITAGE (n)	OTHER DEBITAGE (%)	Total
26Ek3173	1	1 / D	20	0.075	1456	93.6	2.26	96	6.2	4.21	1	0.2	1553
26Ek3185	1	1 / D	10	0.05	279	97.8	0.50	5	1.7	1.34	1	0.5	285

Key to Excavation Unit Type
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen

26Ek3173

Located slightly higher on Ramadan Ridge, 26Ek3173 contains four reduction features. All of these are somewhat larger than those at 26Ek3172, but with one exception, are similarly depauperate in formed artifacts. However, Feature 1 contained several quarry bifaces and a pair of projectile point fragments. For this reason it was chosen for sampling. Our 40 1 m by 1 m shovel skim units collected the entire feature, consisting of a moderate density lithic scatter with dense central concentration of debris. The resulting debitage retrievals are summed by Table 118.

Overall, units averaged 60 flakes. However, adjoining units 26 and 29, on the concentration of debris in the center of the feature, yielded densities of 263/m^2 and 363/m^2, respectively. Flake densities of units that fell beyond the confines of the scatter visible on the surface (units 32-40) provided correspondingly low flake yields (averaging 18/m^2). The feature, thus proved to have been spatially discrete and was recovered in its entirety.

A 1 m by 0.5 m excavation unit was placed where debitage densities were highest, in surface collection units 26 and 29. The upper level of the deposit (2-8 cm) returned some 1400 pieces of lithic debitage, including 1 waste flake of obsidian. Level 2, excavated in only one-half of the unit, returned only 80 pieces of opalite debitage.

Although the surface assemblage of Feature 1 included minor evidence for tasks other than toolstone processing (the projectile point fragments and 3 scrapers) its use seems related overwhelmingly to opalite reduction. Reduction stages displayed by the quarry biface collection (2 Stage 2, 3 Stage 3, and a Stage 4), as well as the debitage assemblage, suggest that Feature 1 was created from by-products of intermediate reduction. Pieces of shatter are relatively rare and are outnumbered by opalite flakes on the order of 10:1. This, coupled with the absence of cores, suggests that, like Feature 1 at 26Ek3172, opalite raw materials arrived at Feature 1 in an already reduced state, presumably as Stage 1 quarry biface flake blanks or Stage 2 quarry bifaces.

26Ek3185

Site 26Ek3185 lies just off the crest of Holeplug Ridge, immediately to the south of, and slightly higher than the Large Reduction Complex 26Ek3184. Seven reduction features, consisting of accumulations of opalite processing debris, occur at the site. Our "Sample Feature" Feature 1, is accompanied as well by an array of reduction artifacts, as well as a variety of maintenance and subsistence tools represented by three projectile points (1 Cottonwood Triangular; 2 Desert Side-notched), point preforms, a mano, and numerous flake tools of various kinds (Table 117). Our block of 20 shovel skim units were centered on the single dense concentration of opalite debris at the feature. Subsequent testing added only a few flake tools and quarry bifaces to the assemblage.

Activities not strictly directed at toolstone processing occurred at the feature, given the abundance and variety of maintenance/subsistence tools it contains. Like similar features nearby (e.g., Feature 1 at 26Ek3190, Feature 1 at 26Ek3191, and Feature 2 at 26Ek3192), the assemblage of Feature 1 here probably represents a hunter's temporary camp, or an overnight stop by people engaged otherwise in the procurement of opalite. The diagnostic projectile points in the feature suggest post-A.D. 1300 occupation.

While considering the age of Feature 1 we note that, like Feature 2 at 26Ek3192 and in several locations with 26Ek3184 and -3190 close by, its tool assemblage includes several (n=4) domed, steep-edged, unifacial end-scrapers reminiscent of pre-Archaic tools throughout the Great Basin. Although the utility

of such items specimens as time-markers has not been demonstrated, their presence may indicate earlier use of the site than is implied by the the other temporally diagnostic artifacts recovered.

26Ek3188 and 26Ek3189

Sites 26Ek3188 and -3189 are two Small Reduction Complexes tested only by an inventory of surfaces contexts. These sites occupy the ridge slopes immediately across a shallow drainage to the east of 26Ek3185 (Figure 82). They contain between 1 and 4 reduction features, respectively, composed of moderate to high density accumulations of opalite debitage. The single large feature composing 26Ek3188 lacks formed artifacts; the formed artifact assemblage at 26Ek3189 is depauperate as well (Table 117). A Stage 2 quarry biface and one core were observed at Features 1 and 3 respectively, and an additional Stage 2 quarry biface and one projectile point preform were retrieved from extra-feature contexts.

Compared to those of other Small Reduction Complexes, the features at these two sites are similar with their low numbers of formed artifacts and abundant toolstone processing debris.

Reduction Stations

All the Reduction Stations recorded at USX-East occur within the Holeplug Ridge area, with the exception of site 26Ek3178 which lies isolated far to the east within the Undine Gorge component. By definition, Reduction Stations are manifest by no more than two cultural features, and these are typically accumulations of opalite toolstone processing debris. Most of these sites appear to be the functional equivalent of Reduction Features within larger sites in the project area. Most of these sites are found on microtopographic flats throughout the central mid-slopes of Holeplug Ridge. Site 26Ek3174 occupies the highest bench on Ramadan Ridge (Figure 82).

Of the eight Reduction Stations tested, only three, 26Ek3179, -3181, and 3183 were addressed by Sample Feature procedures; the remainder are known only from surface inventory. Formed artifact recoveries are summarized by Table 119 and debitage from Sample Features appears in Table 120.

Table 119. Description of Artifact Classes Recovered from Reduction Stations, Holeplug Ridge.

Site Number	Feature Number	Type	Total Area (sq m)	ARTIFACT CLASSES: Reduction CR	QB	SB	IB	Processing SC	MP	GS	Other CE	Total
26Ek3174	1	Biface Reduction	82	-	-	-	-	-	-	-	-	0
	2	Core Reduction	102	-	1	-	-	-	-	-	1	2
26Ek3175	1	Core and Biface Reduction	85	-	1	-	-	-	-	-	-	1
26Ek3179	1*	Core and Biface Reduction	6	1	1	2	1	3	-	-	-	8
	2	Biface Reduction	2	-	-	-	-	-	-	-	-	0
26Ek3180	1	Biface Reduction	12	-	1	-	-	-	-	-	-	1
26Ek3181	1*	Biface Reduction	19	-	9	-	1	6	1	1	2	20
26Ek3183	1*	Biface Reduction	8	-	4	-	-	-	-	-	-	4
26Ek3186	1	Unspecified Reduction	55	-	-	-	-	-	-	-	-	0
	2	Biface Reduction	19	-	1	-	-	-	-	-	-	1
26Ek3187	1	Unspecified Reduction	49	-	-	-	-	-	-	-	-	0

* Sample Feature

Key to Artifact Classes

Reduction Tools and Artifacts
CR = Cores
QB = Quarry Trajectory Bifaces
SB = Small Trajectory Bifaces
IB = Indeterminate Biface Fragments

Maintenance/Processing
SC = Scraper
MP = Multipurpose Flake Tools
GS = Groundstone

Other
CE = Ceramic Sherds

26Ek3179

Site 26Ek3179 is located just downslope and to the west of Large Reduction Complex 26Ek3194 and contains two reduction features. The larger of these, Feature 1, was selected as our sample feature. Feature 1 was a comprised of several small, moderate density concentrations of opalite debitage within a surrounding light density lithic scatter. A core, one quarry biface (Stage 3), and one small biface were visible on the surface of the scatter during initial inspection.

Shovel skimming 13 1 x 1 m units encompassed the entire surface extent of the feature, but added only one small biface, an unidentified biface fragment, and 3 flake scrapers to the formed artifact assemblage (Table 119). The remainder of the spoils consisted of opalite debitage and a single jasper waste flake (Table 120).

Table 120. Debitage from Sample Feature Collections, Reduction Stations, Holeplug Ridge.

SURFACE COLLECTIONS

Site Number	Fea No.	Total Area (sq m)	Skim Area (sq m)	Mean Density (sq m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
26Ek3179	1	6	13	100	1218	93.7	1.16	81	6.2	1.79	1	0.1	1300
26Ek3181	1	19	24	107	2356	91.8	2.12	190	7.4	1.01	21	0.8	2567
26Ek3183	1	8	15	148	2169	97.8	1.13	43	1.9	1.03	6	0.3	2218

SUBSURFACE COLLECTIONS

Site Number	Fea. No.	Unit No./Type	Depth (cm BS)	Volume (cu m)	OPALITE DEBITAGE Flakes (n)	(%)	(Av Wt)	Shatter (n)	(%)	(Av Wt)	OTHER DEBITAGE (n)	(%)	Total
26Ek3181	1	1 / D	10	0.05	1194	96.4	1.06	30	2.4	0.71	15	1.2	1239

Key to Excavation Unit Type
A = 1 by 1 m, 1/8 in. screen
D = 50 cm by 1 m, 1/8 in. screen

The test suggests that the surface expression of the feature only partially predicts the abundance of flakes just below the surface. Overall, units returned a mean density of waste flakes of ca 93/m^2. Where units coincided with surface concentrations, flake densities were higher (e.g., Unit 4, 162/m^2; Unit 9, 294/m^2). However, Unit 10, adjacent to a surface concentration and displaying only a light scatter on its pre-skimmed surface, yielded some 283 waste flakes. The concentrations thus appear to represent high density clusters of debris within an otherwise moderate density scatter that is immediately below the ground surface. The horizontal limits of this slightly buried deposit do seem to be fairly well predicted by the light density surface scatter surrounding the concentrations. Units 1, 6, and 12 placed tangential to, but outside, the visible perimeter of light lithic scatter posted returns of only 17, 13, and 23 waste flakes respectively.

The average size of opalite waste flakes and shatter is relatively small, ca 1.2 gm and 1.8 gm respectively. Coupled with the low incidence of shatter (flake to shatter ration = 15:1) this suggests that raw materials processed at the feature likely arrived as well-prepared cores and/or Stage 1 blanks.

26Ek3181

Site 26Ek3181 occupies the central mid-slope of Holeplug Ridge (Figure 82). It consists of one reduction feature defined by a single concentration of opalite debris and a peripheral lower density lithic scatter. Within the concentration and a radius of ca. 1 m around it, were 3 quarry bifaces, two scrapers, a mano, and an obsidian waste flake. Like the assemblages encountered at numerous other reduction features in the vicinity, these suggest maintenance/subsistence activities. Our 24 contiguous 1 m^2 shovel skim units collected the whole surface expression of the site, yielding 3 additional quarry bifaces, the remainder of the flake tools (Table 119) and a quantity of opalite debitage (Table 120).

Recovery rates for opalite waste flakes reveal that the visible surface concentration is surrounded by a somewhat larger area of dense debitage immediately below the surface. The concentration, occupying the highest point on the slope, is probably the source of materials found in areas outside and downslope.

The mean density of waste flakes recovered from the feature as a whole was ca 98/m^2. Where debitage was densest on the surface (i.e., in portions of units 18 and 21) flakes were retrieved at a rate of 307/m^2 and 327/m^2. Contiguous units 20 and 23, upslope and outside the concentration, contained dense accumulations of flakes as well, ca 383/m^2 and 199/m^2, respectively. All additional areas sampled yielded far fewer cultural materials; diminishing recovery rates appear to correspond to site slope. The 6 units that sampled the upslope half of the feature, in or adjacent to the concentration, provided on average some 142 waste flakes per m^2, while the 6 grid units placed over the downslope half of the feature contained debris only approximately one-third as dense, ca 55 m^2. While this heterogeneous distribution of debitage suggests that the areal extent of the feature may be the result of colluvial redeposition, these forces do not appear to have size-sorted the debris to any great extent. Average individual sizes of waste flakes range widely across the feature, from as large as 4 gm in Unit 23 to as small as 0.6 gm in Unit 17, both within the upslope contexts of the scatter; the average flake weight over the entire feature is ca. 2 gm per item. Its upslope and downslope halves, however, yield flakes of essentially equivalent average sizes, ca 1.8 gm.

Our 1 m by 0.5 m excavation unit sampled shovel-skimmed deposits, debitage returns were highest in surface collection Unit 20. By the time we reached clay soil at a depth of 10 cm, all cultural material had apparently been collected. The exercise contributed 3 more quarry bifaces to the formed artifact assemblage; several jasper waste flakes, and a predictably large quantity of opalite debitage (Table 120). In addition, a recently burned sage stump contributed abundant charcoal and red oxidized soil to the deposit.

The formed reduction artifacts recovered included 9 opalite quarry bifaces, 1 Stage 4, 4 Stage 2, and 4 Stage 3. As at other sites somewhat far removed from source locations, the high incidence of waste flakes to shatter (ca 10:1) suggest raw material was brought to 26Ek3181 in a preprocessed state, presumably as initially reduced cores and/or Stage 1 forms.

26Ek3183

Located ca 50 m to the east and slightly downslope from 26Ek3181, 26Ek3183 is likewise defined by a single cultural feature, composed of four moderate density concentrations of opalite debitage and a peripheral light density lithic scatter (Figure 82). The site/feature is distinctive for its complete lack of formed artifacts other than those directly related to opalite processing. Fifteen contiguous shovel skim units collected entire surface extent of the feature and retrieved 4 quarry bifaces: one example each of Stages 2-4, plus an unidentified specimen (Table 119). Almost all of the debitage is opalite save for 4 small obsidian waste flakes and two of jasper (Table 120).

The distribution of debitage recovered in collection units suggest that the concentrations of debris visible on the surface accurately map the occurrence of debitage below the surface. For the most part, concentrations are spatially discrete; flake density in three units coinciding with concentrations ranged between (447/m^2 and 172/m^2); mean flake densities in surrounding units were about 140 m^2. The fourth concentration contains about 150 flakes/m^2.

Opalite shatter is exceedingly rare at the site. It is outnumbered by waste flakes 50 to 1 and consists of small individual pieces, averaging ca 1 gm each. This, combined with the formed reduction artifact collection, implies that toolstone processors were unwilling to transport raw materials laden with waste fractions very far from a source and suggesting that "toolstone packages" arrived at site in already reduced forms.

The site seems to have functioned as an opalite reduction workshop where Stage 2 quarry biface forms were processed through Stage 4 secondary thinning. Presence of the four very small (ca 0.1 gm each) obsidian waste flakes likely reveal an episode of tool maintenance as well.

The five remaining Reduction Stations (26Ek3174, -3175, -3180, -3186, and -3187) would appear to have served a similar range of functions as those sampled and described previously. Our opting not to sample these sites was due largely to the fact that they did seem to represent remains identical to those encompassed by Reduction Stations already tested.

Summary

The nineteen sites within the Holeplug Ridge study area are almost entirely the consequence of toolstone reduction. Primary sources of opalite are virtually absent from the area, and where they do occur within the precincts of Holeplug sites (in 26Ek3191 and -3193) they appear to be of low toolstone quality and evidence use that appears to have been expedient and episodic. Nowhere within the subarea did toolstone sources inspire the excavation of quarry pits or other intensive means of extraction. Instead, the archaeological record of Holeplug Ridge seems to derive largely from the processing of lithic raw materials that were liberated from bedrock and rendered into portable forms at other sources located nearby.

Tests revealed two of the Holeplug sites to be particularly informative laboratories at which to address several of the research domains pertinent to the Tosawihi Quarries and the immediate vicinity (Elston 1988; Chapter 1, this volume). Site 26Ek3184 offers the project area's largest suite of reduction stations; based on test actions, many of these features are relatively spatially discrete to suggest that their contents and configuration remains comparatively little altered by post-depositional processes. Additional mapping and excavation of select features would go far toward defining the range of variation in reduction stations reflecting on group size, the conduct of ancillary activities, and the place of the site's workshops in local reduction trajectories. Such efforts likewise would contribute to modeling the timing, duration, and frequency of visits, thus clarifying the energetic expenditure at the area's principal workshop complex.

At 26Ek3192, the assemblage diversity characteristic of Feature 1 and 2 suggest that they should be particularly informative of the range of variation in site function. The cache at Feature 1 (like that encountered at 26Ek3095 at USX-West) carries important implications for understanding the "package size" and perceived units of transportability in which Tosawihi opalite was exploited. Too, the staging of reduction strategies is well studied at Feature 1, where, in its later component, a particular stage appears to be isolated from episodes of preliminary manufacture and transport. Site formation processes likely to be revealed at the feature include the preparation of heat-treating hearths, the reduction of Stage 2 to Stage 3 bifaces, and the storage of pieces for future reduction or transport. The apparent earlier component at Feature 1 is also likely to have important implications for analysis of site structure, since numerous tools and by-products appear to rest on an intact loess-buried surface. Feature 2 will provide important chronological data on early use of the project area if it proves possible to isolate an assemblage associated with Early Archaic artifacts.

Part VI. Conclusions

Chapter 18: SUMMARY AND CONCLUSIONS

by Michael P. Drews, Robert G. Elston, Melinda Leach, Christopher Raven, and Dave N. Schmitt

Of 214 prehistoric archaeological sites discovered during survey of the North Access Corridor, and the USX-West and USX-East project areas, 65 (30%) were tested as reported in the present volume. In order to address the significance of the sites, and to assess mitigation needs, substantial quantities of data were gathered. Their analysis focused on the ability of any particular site to address particular research goals defined for Tosawihi Quarries (Elston 1988 and this volume). Our findings are summarized here under five topical headings: Paleoenvironments and Chronology; Site Function, Assemblage Composition and Diversity; Site Structure and Formation Processes; Organization of Lithic Procurement; and Implications for Data Recovery.

Paleoenvironments and Chronology

Paleoenvironmental data appear not well preserved in the shallow, open sites so far investigated at Tosawihi Quarries. Pollen weathers badly in unprotected eolian, colluvial and alluvial sediments, and most sites in the study areas lack any kind of plant macrofossil preservation. Stratigraphy is also problematic in most of the shallow deposits of open sites at Tosawihi Quarries. Eolian silts and colluvium usually have been churned by slope movement and bioturbation. Nevertheless, natural stratigraphy is present in alluvial terrace deposits of site 26Ek3092 (USX-West) and sites 26Ek3251 and 26Ek3237 (North Access Road). Of course, deposits filling quarry pits are very well stratified, but such sediments are nearly all cultural in origin and have little to do with paleoenvironments. Faunal remains recovered from stratified alluvial deposits (cf. site 26Ek3092) may well provide the best opportunity for the study of paleoenvironments in the Tosawihi vicinity. For instance, bison scapluae recovered from quarry pits at 26Ek3208 and 26Ek3200, as well as possible bison bones at site 26Ek3092, help document the distribution of a poorly known species in the western Great Basin (Elston and Budy 1990).

The absence of Mazama tephra (ca 6,900 years B.P.) in most tested sites is chronologically limiting and possibly suggestive of paleoenvironmental change. Mazama tephra or volcanic ash is present in alluvial sediments of Ivanhoe Creek, Willow Creek, and Antelope Creek, below 5600 feet in elevation, but to date, unassociated with cultural remains. The ash has not been observed in alluvial, eolian, or cultural sediments in the upland environment of Tosawihi Quarries. Here, shallow eolian/colluvial sediments, sometimes containing cultural

remains, rest on bedrock or unconformably on a strong paleosol of at least Pleistocene age. This suggests the possibility of past environmental conditions in which early Holocene deposits containing Mazama tephra were washed off slopes and flushed out of drainages in the Tosawihi uplands, possibly during increased summer precipitation of the mid-Holocene (cf. Davis 1983; Katzer 1990). Nevertheless, it seems unlikely that all tephra would be washed away, and probably means that we have not yet looked in the right places for it. If Mazama ash eventually turns up at Tosawihi Quarries, it will provide an invaluable time-stratigraphic marker for the calibration of both paleoenvironmental and cultural events.

The cultural chronology of the Upper Humboldt region outlined in Chapter 1 (see Figure 4) was constructed from radiocarbon dates and temporally sensitive artifact types such as projectile points and pottery. So far, radiocarbon dates are few from Tosawihi Quarries, although the discovery of charcoal in quarry pits offers opportunity to date closely sequences of quarrying events and differences in quarrying intensity at various sources and areas as discussed below. In addition, obsidian artifacts are fairly common in sites adjacent Tosawihi Quarries, offering opportunity for dating through the obsidian hydration method (cf. Hughes 1984). For the time being, with the exception of Clovis, virtually the full range of time-diagnostic Great Basin projectile points and pottery has been observed in and adjacent Tosawihi Quarries.

Great Basin Stemmed Series points at Tosawihi suggests that pre-Archaic people began to visit the quarries and vicinity during the Dry Gulch Phase of 8,000 years ago, and possibly earlier. Rusco (1982:34) reports a GBSS point fragment made of opalite from the Rossi Mine area about 15 km to the southeast, but all the Great Basin Stemmed Series points that we have collected from Tosawihi Quarries are made of obsidian, basalt, or other volcanic rocks. These points usually are found as isolates or in questionable association with surface lithic scatters, such as at site 26Ek3107. While these Great Basin Stemmed points may be broken and worn out tools discarded during retooling, they could also represent hunting losses. There is presently no direct evidence confirming that the earliest visitors to Tosawihi Quarries actually quarried toolstone there or stayed long enough to generate camp site debris typical of Archaic sites. The lack of evidence for early quarrying and residential use of Tosawihi Quarries, however, could just as well be due to geological and biological processes which (as discussed in more detail below) render progressively older cultural deposits less visible.

What kinds of cultural variation through time did testing reveal at Tosawihi? In the absence of many radiocarbon dates and without detailed qualitative and quantitative analyses beyond the scope of the test phase, we see as yet very little

evidence for temporal change in reduction technology or toolstone extraction techniques. What is apparent, however, are changes in the frequency of various time sensitive projectile points. Arranging the frequencies of point series in chronological order suggests variation in frequency of point loss or discard through time. Further calculating and plotting the cumulative frequencies of point series arranged in chronological order produces a characteristic "curve" for each site or group of sites. The question of what these curves actually mean in terms of functional, technological, or spatial behavior of people is begged for the time being. Nevertheless, for heuristic purposes, one may advance the hypothesis that the loss/discard rate is roughly the same from place to place and time to time. Differing rates between areas or time periods then signal the possibility of functional, technological, or spatial variability, which can be investigated further.

Frequencies of various projectile point series by project area are given in Table 121. Humboldt and Large Side-notched points are not included in these data since their chronological ranges are so great. The samples for the USX-West and USX-East areas are roughly similar in size as well as in shape of their frequency distributions; the North Access sample is less than half as large, but its frequency distribution seems to be different from the other two.

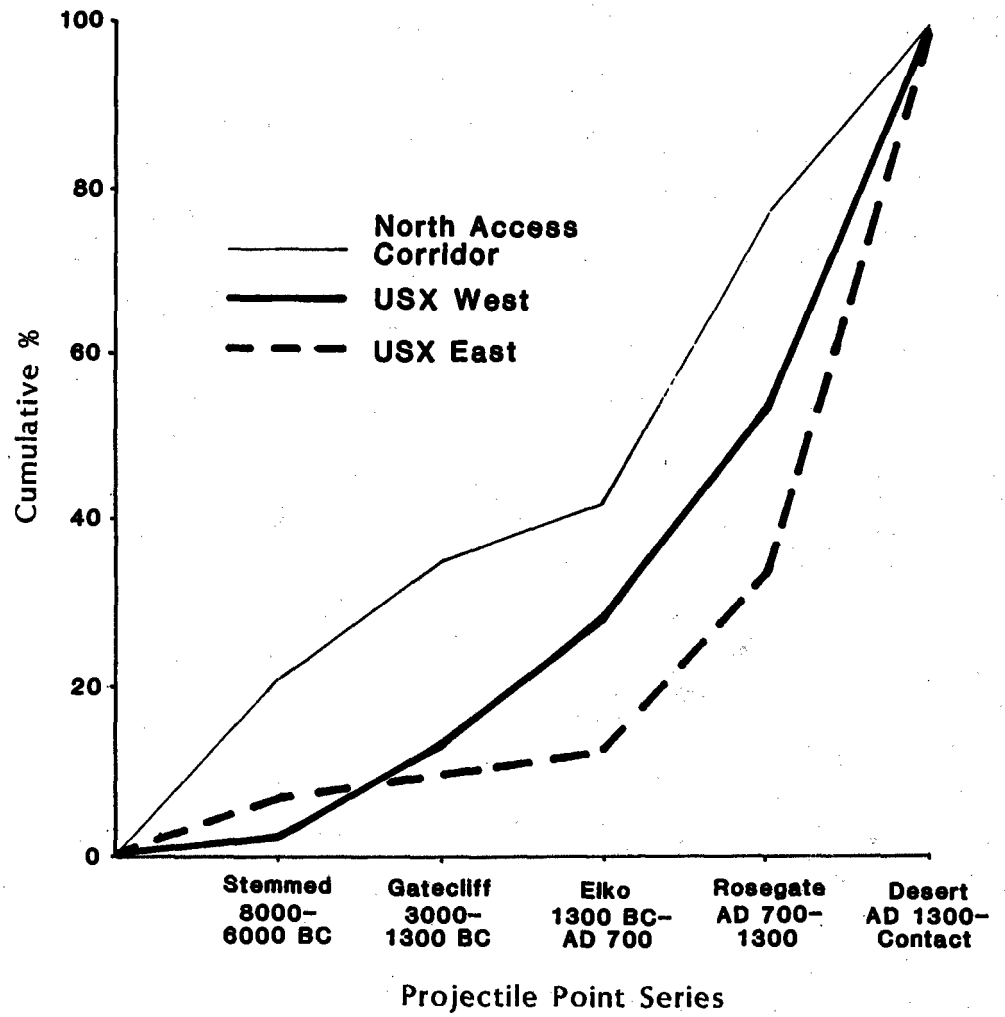
Table 121. Frequency of Projectile Point Series by Study Area.

	West		East		North	
Series	N	f	N	f	N	f
Desert	16	.44	25	.61	3	.21
Rosegate	9	.25	8	.20	5	.36
Elko	6	.16	1	.02	1	.07
Gatecliff	4	.11	4	.10	2	.14
Stemmed	1	.03	3	.07	3	.21
Total	36		41		14	

Figure 91 plots cumulative frequencies of projectile point series by study area, using data from Table 121. The resulting "temporal curves" allow graphic comparisons among the three areas.

The North Access sites (specifically 26Ek3237) have the highest frequencies of Great Basin Stemmed Series and Gatecliff Series points, resulting in a steep, convex curve on the left side of the graph. The low frequency of Elko Series points causes a "flat" place in the middle of the curve, followed by another steep climb with high frequencies of Rosegate Series and Desert Series points. Because of relatively low frequencies of

Figure 91. Cumulative frequencies of projectile points by geographic area.


100
80
60
40
20
0
Cumulative %
North Access Corridor
USX West
USX East
Stemmed 8000–6000 BC
Gatecliff 3000–1300 BC
Elko 1300 BC–AD 700
Rosegate AD 700–1300
Desert AD 1300–Contact
Projectile Point Series

early point series, the curves for cumulative frequency distributions in USX-West and USX-East are both relatively flat on the left side of the graph, but increase in steepness toward the right, due to sharp increases in frequencies of Rosegate and Desert Series points. The East and West differ mainly in frequencies of Elko Series points which are much more abundant in USX-West.

Thomas (1988) has observed that cumulative ogives sometimes suggest similarities or differences between frequency distributions that are not statistically significant. Differences between pairs of cumulative frequency distributions can be assessed using the Kolmogorov-Smirnov (KS) two-sample test (Blalock 1979), wherein the frequency distributions are considered distinct only if observed differences in cumulative frequencies exceed a predetermined critical value.

Using the KS test, a number of questions can be asked of the data. The greatest differences (Figure 91) appear to be between the North Access curve and the curves for USX-West and USX-East. Is this supported by The KS test? As shown in Table 122, there appears to be no difference between the North Access area and the pooled frequencies of the USX-East and West areas at the 0.05 level of significance. All frequency distributions and the curves they describe could have been drawn from the same population.

Table 122. Maximum Observed and Critical Values for North Access Versus Pooled East and West Frequencies (0.05 significance level).

	n1 Sample Size	n2 Sample Size	Critical Value	Maximum Observed Value
USX-West + USX-East/North Access	75	14	.396	.346

Are the differences between frequency distributions of study area pairs then significantly different from each other? Table 123 shows that the frequency distributions of USX-East and North Access sites are significantly different, but that the null hypothesis cannot be rejected for curves comparing USX-West/USX-East and USX-West/North Access. That is, the curves for those areas could both have been drawn from the same population.

While Figure 91 suggests an early high frequency in point loss in North Access sites compared to sites adjacent the Tosawihi Quarries, that is true only when contrasted with sites of USX-East.

Table 123. Maximum Observed and Critical Values Between Geographic Profiles (0.05 significance level).

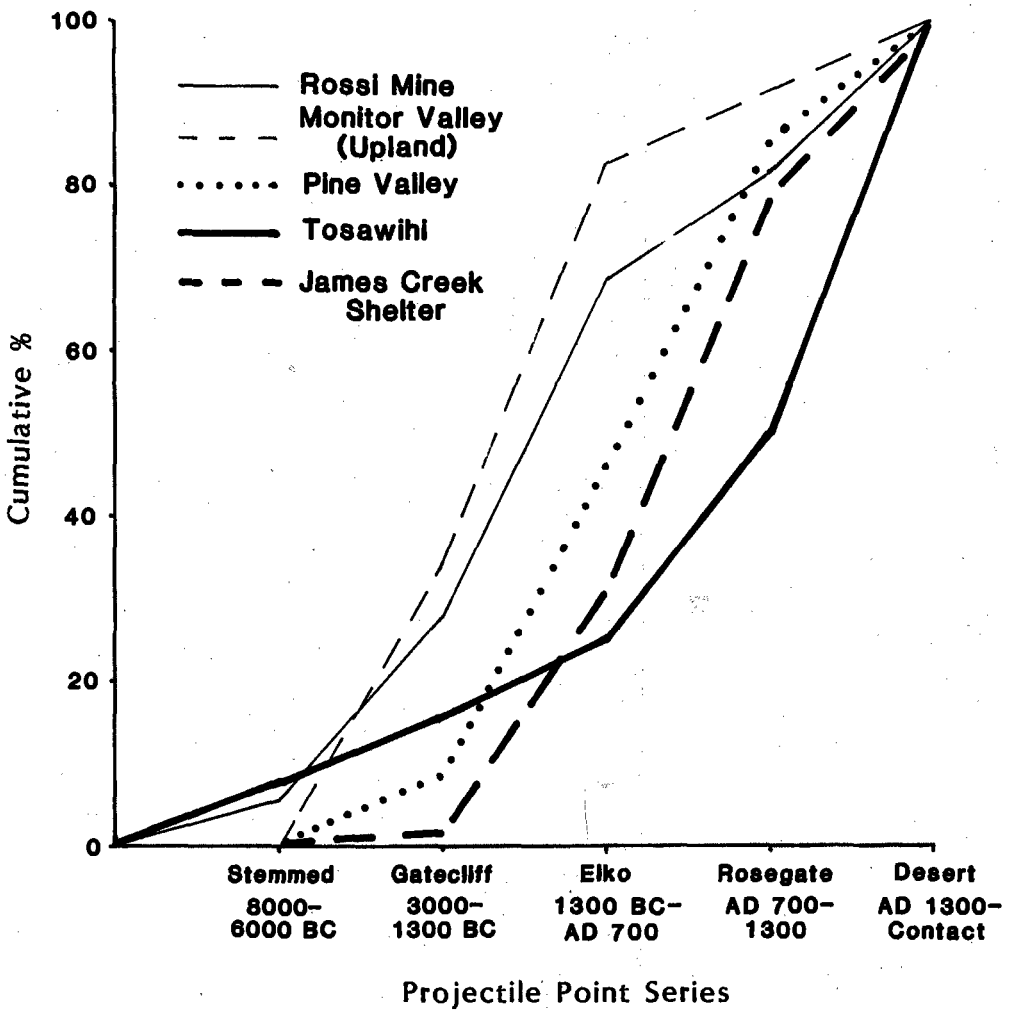
	n1 Sample Size	n2 Sample Size	Critical Value	Maximum Observed Value
USX West/USX East	37	38	.314	.199
USX West/North Access	37	14	.426	.245
USX East/North Access	38	14	.425	.444

We tentatively conclude a similar history of projectile point loss and discard in all three areas from 8000 B.P. to Historic Contact, with a sharp increase during the Late Archaic (Maggie Creek and Eagle Rock phases). For now, the differences we observe graphically between areas are not statistically significant at the 0.05 level. Does this mean that the differences are not real or are not interesting in an archaeological sense? Perhaps, but whether or not they could signify important trends in the data is obscured by the small sample size for the North Access area and by the limited numbers of Great Basin Stemmed, Gatecliff, and Elko points; several cells contain only one item. Discovery of one or two additional points of any of the earlier point series easily could alter the results of the KS test.

However differences in early rates of point loss between areas eventually play out, there is no doubt that in the Late Archaic Maggie Creek (Rosegate Series) and Eagle Rock (Desert Series) phases, projectile point frequencies in all three areas increase rapidly. In USX-East, for instance, 65% of the points are Desert Series and over 80% of the points post-date the Elko Series. Do these trends signal increased rates of point loss/discard with the introduction of the bow and arrow? Or did increases in the abundance of other resources, such as bison, attract more people to the area?

Broad changes in technology, resource availability, or population, however, ought to be reflected regionally. Are the trends in the Tosawihi data mirrored elsewhere in the Great Basin? In Figure 92, projectile point frequency distribution from all three Tosawihi project areas combined are compared to projectile point frequencies from other upland sites and localities in the central Great Basin. The Tosawihi Quarries curve is distinctly different. Figure 92 shows that curves for upland sites all contain an upward trend, but this occurs during the Middle Archaic when Elko points are in use. The frequencies for Late Archaic Rosegate points are high in the upland assemblage but the frequencies of late prehistoric Desert Series fall off. At Tosawihi, major increases in point frequencies occur throughout the Late Archaic.

Figure 92. Cumulative frequencies of various upland site and Tosawihi projectile points.


100
80
60
40
20
0
Cumulative %
Rossi Mine
Monitor Valley (Upland)
Pine Valley
Tosawihi
James Creek Shelter
Stemmed 8000–6000 BC
Gatecliff 3000–1300 BC
Elko 1300 BC–AD 700
Rosegate AD 700–1300
Desert AD 1300–Contact
Projectile Point Series

When compared to the upland curves with the KS test, the Tosawihi Quarries distribution is distinctly different (Table 124); critical values are exceeded in all cases.

Table 124. Maximum Observed and Critical Values Between Tosawihi and Upland Profiles (0.05 significance level).

	n1 Sample Size	n2 Sample Size	Critical Value	Maximum Observed Value
Tosawihi/Pine Valley	89	80	.210	.356
Tosawihi/James Creek	89	78	.211	.288
Tosawihi/Rossi Mine	89	38	.264	.322
Tosawihi/Monitor Upland	89	62	.225	.425

This suggests that something different happened at Tosawihi Quarries than at other upland areas of central Nevada. We strongly suspect that these projectile point frequency changes are somehow linked to increased intensity in the exploitation of Tosawihi opalite. Why this increase occurred and how it could have been sustained are topics of upcoming research, as discussed below.

Site Function, Assemblage Composition and Diversity

Although numerous sites represent on or near-surface manifestations which may contain palimpsest accumulations (e.g., overlapping accumulations of artifacts deposited during different occupations; see especially Thomas 1988:380-382), the presence of domestic equipment, fabricating tools, and weaponry clearly attests to subsistence activities performed in support of forays for toolstone procurement. Even so, the proximity to sources of toolstone heavily influences the content of site assemblages. Table 125 shows numbers of quarry and maintenance tools and percentage of quarry tools by area and subarea. Within each area, subareas are arrayed by increasing distance to toolstone source (please refer to subarea maps throughout this report), and the reader will notice that the proportion of quarry-related tools decreases as expected in each case.

For instance, with the presence of numerous on-site opalitic cobble and outcrop sources along Undine Gorge, artifact assemblages from sites there reflect activities largely, but not exclusively, directed toward the acquisition of toolstone. Prehistoric occupants employed diverse extraction techniques including pit excavation, outcrop reduction, cobble deposit assay, and bedrock excavation. Seventy percent of Undine Gorge sites contain at least one lithic source and the proportion of

quarrying to non-quarrying tools is 73%. Exclusion of campsite 26Ek3198, with its abundant hunting, fabricating, and processing equipment, increases the proportion of quarrying tools in Undine Gorge sites to 83%.

Table 125. Quarry and Maintenance Tools by Subarea.

	Quarry	Maint.	Total	% Quarry
NORTH ROAD				
Ivanhoe Creek	76	104	180	42
Perron Canyon	15	95	110	14
USX-WEST				
Rodent Valley	112	27	139	81
Basalt Canyon	94	77	171	55
Bitterroot Ridge	771	649	1420	54
USX-EAST				
Undine Gorge	315	115	432	73
Ramadan Ridge	124	85	209	59
Holeplug	369	266	635	58

A similar proportion of quarrying tools (81%) is found in several large and diffuse reduction complexes of Rodent Valley, located between the western boundary of the Tosawihi Quarries on the north and the Red Hill quarries to the south. Some Rodent Valley assemblages contain non-quarrying artifacts (e.g., scrapers), but cores and quarry bifaces dominate. On Red Hill, in addition to several minimally exploited outcrop quarries, are other high quality outcrops with substantial quarry pit features and massive accumulations of quarry debris (most notably 26Ek3085/3208 and 26Ek3084). These deeply stratified deposits of quarrying waste indicate an extraordinary expenditure of effort. The sites do not appear in Table 125 because their documentation emphasized stratigraphic recordation rather than artifact collection.

At the subarea level, then, the proportion of quarry tools decreases with distance to major toolstone source, but at the site level it varies as a function of the number, size, and type of sources present, as well as with the degree of "residentiality", or signs of short-term domestic use of the area in the form of maintenance and food-processing assemblages. For instance, both Ramadan Ridge sites (26Ek3170 and 26Ek3171), where the proportions of quarry tools are only 57% and 64% respectively, contain one or two open quarry pits; these are relatively small, discrete features. The residential character of these sites also serves to inflate the proportion of non-quarry tools, as it does in site 26Ek3198 along Undine Gorge where the proportion of quarry tools is only 48%

In portions of USX-East lacking toolstone sources, we find only low-intensity reduction stations containing products of transported and reduced quarry bifaces and cores. The proportion of quarrying tools in sites along Hole Plug Ridge is 58%. Only two Hole Plug sites (26Ek3191 and 26Ek3193) have lithic sources, both diffuse outcrop quarries with minimal signs of exploitation. This suggests that the topography and ecology of Hole Plug Ridge may have offered opportunities more suited to the reduction of partially reduced bifaces transported from the Undine Gorge sources and possibly, as well, the procurement and processing of non-lithic resources. This almost certainly is the case for the Basalt Canyon and Bitterroot Ridge areas, with 55% and 54% quarry tools respectively. Both are adjacent bitterroot patches and riparian resources, well removed from toolstone sources. Both areas reflect later stage toolstone reduction and short term occupational use indicated by assemblages with abundant small bifaces, projectile points, scrapers, perforators, and ground stone. This is particularly evident at Bitterroot Ridge sites 26Ek3160 and 26Ek3116 where the proportion of quarrying tools is only 42% and 32%, respectively. Perhaps these larger scatters indicate a strategy in which hunting and plant preparation were embedded in toolstone procurement and processing forays.

The North Access Road offers the best opportunity to examine the relationship between increasing transport costs with distance from the Quarries and technological decision making. The distance from major toolstone sources to sites located in the North Access Road is greatest, and these sites contain the fewest quarrying artifacts. This is most evident in the Perron Canyon subarea which includes site 26Ek3251 on Willow Creek (the site most distant from known toolstone sources), where small and preform bifaces abound and quarry bifaces are scarce. In fact, quarry tools account for only 8% of the assemblage from this site. The numerous flake tools, groundstone fragments, and other non-quarrying artifacts attests to the residential character of the site.

Although assemblage content appears to be related closely to distance from toolstone source, assemblage diversity (numbers of tool classes) may be related to differences in the use of sites. Figure 93 is a semi-log plot of the number of artifacts (log transformed) against the number of classes of artifacts (untransformed), intended for preliminary data exploration. The well known correlation (Jones, Grayson and Beck 1983; Thomas 1983b) between assemblage size and diversity (numbers of classes) is quite strong, with $r = 0.94$.

Nevertheless, the plotted data also suggest a fair amount of structure. For clarity, the points in the plots have been enlarged to circles and filled with different patterns, each representing a functionally different type of site. Note that the array of sites appears to form three groups along the

regression line. Reduction stations, reduction complexes, and shelters have similar distributions and are present in both the lower and middle groups, supporting the hypothesis that most small Tosawihi rockshelters were used more as lithic reduction stations than as residential bases. None of the sites deemed "residential" in the graph is associated with quarrying, and each contains between 8% and 66% quarry tools; all are in the middle and upper groups. Sites 26Ek3160, 26Ek3271, and 26Ek3095 comprise the uppermost group.

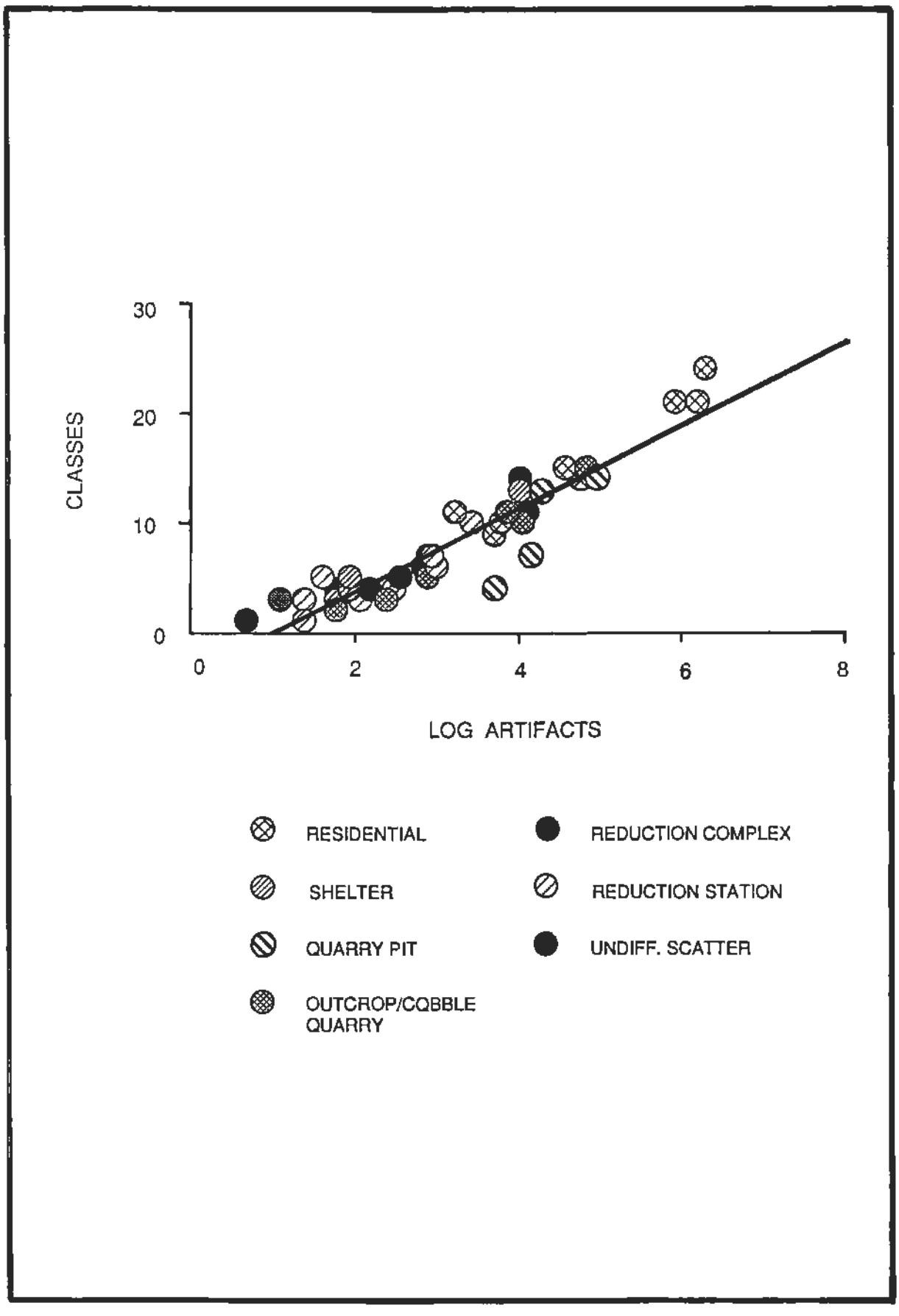
Quarry pit sites are exclusive to the middle group, except that two sites (26Ek3195 and 26Ek3197) fall substantially below the regression line. This supports the hypothesis that quarry pit assemblages are likely to contain a more limited range of artifact types than assemblages from other site types. The two quarry pit sites falling on the regression line are 26Ek3170 and 26Ek3171, both with strong "residential" components, as previously discussed.

All this suggests that, with additional data, further analysis of assemblage composition and diversity will aid substantially the interpretation of archaeological variability at Tosawihi Quarries. The structure of these relationships can be investigated through site-by-site comparative studies of fall-off rates in numbers, size, and reduction stage of quarry tools and debitage, while controlling for changes in other variables such as type of toolstone source, intensity of toolstone exploitation, and use of non-toolstone resources. For instance, multiple opalite sources are accompanied by numerous - reduction localities exhibiting early stage toolstone processing in USX-East. Because of the diversity of lithic material extraction techniques and the staged reduction of transported quarry blanks, this area promises to add important information to our study of tool procurement and processing strategies. Further, with additional data recovery an assessment of how variation in toolstone quantity and quality across the project area affected prehistoric behavior and, hence, site character will be possible.

In USX-West, we have documented the most functionally diverse suite of localities in the entire project area. The western sites can contribute significantly to an understanding of toolstone reduction strategies on the periphery of the Tosawihi Quarries. The large residential complexes, such as the stratified buried site in Basalt Canyon (26EK3092), representing a series of repeatedly occupied short-term campsites, are significant for their complex internal structure and what they reveal about organization of the groups using the quarries (eg. group size and gender constituency, subsistence activities, seasonality of site use, and duration of stay).

Although many sites have a strongly residential character, early stage reduction dominates many of the discrete features in each, suggesting western sites may have been important staging

Figure 93. Numbers of artifacts (log transformed) versus numbers of artifact classes.


30
20
10
0
CLASSES
0
2
4
6
8
LOG ARTIFACTS
RESIDENTIAL
SHELTER
QUARRY PIT
OUTCROP/COBBLE QUARRY
REDUCTION COMPLEX
REDUCTION STATION
UNDIFF. SCATTER

areas for the prehistoric quarriers as they left the primary toolstone procurement localities. Evaluation of the intensive exploitation of the Red Hill quarries offers an excellent opportunity for reconstructing time-allocation and energy expenditure in concert with experimental quarrying studies now underway.

It may be possible to identify how subsistence and technological strategies interdigitated: did intensive toolstone quarrying represent a singular activity that involved an entire residential group, or rather logistically organized, task-specific groups? Did toolstone distribution and regional demand condition toolstone procurement to be a directly targeted task, or one embedded in food-getting activities?

North Access sites show some variability among reduction loci in the stage of bifaces being produced, indicating there may have been a difference in the function of particular sites along a toolstone processing trajectory. Further study of North Access sites will allow examination of the role of short-term residential sites as temporary field camps along a logical transport corridor to and from the Tosawihi Quarries.

With additional data recovery, and refined chronological studies, it will be possible to evaluate long-term change in the use of the Tosawihi environs, to assess temporal variability in site function, and to examine shifts in the structure of the subsistence/economic system.

Site Structure and Formation Processes

Much of the field effort of the Tosawihi testing program was spent extracting information on the spatial distributions of components of the archaeological record. We were interested on the one hand in the spatial organization of behavior, and in the degree to which that organization is reflected in patterns observed archaeologically. On the other hand, we wished to assess with specific reference to Tosawihi sites the degree to which natural processes (e.g., slope movement, eolian and alluvial deposition, and bioturbation) may have affected the behavioral "readability" of distributions. Accordingly, site structure and site formation processes were identified as research issues meriting special consideration, and our testing was designed to evaluate the quality of data on each. Three structural patterns predominate at Tosawihi, reflecting the principle functional classes identified by analysis of assemblage compositions.

Quarry Features are characterized by generally dense concentrations of primary debitage and shatter, focused either along linear surface exposures of opalite outcrops or on subsurface point sources of opalite bedrock.

In the case of the former, quarrying materials tend to accumulate as talus slopes along the base of bedrock faces. Such deposits sometimes cover hundreds of square meters. Often, significant deposition is found coincident with the most favorable expanses of high quality toolstone. The dimensions of outcrop quarry features are governed largely by the extent of the workable face, while the density and depth of their associated debitage deposits is a function of the relative accessibility of quality toolstone in the exposed bedrock.

Prehistoric quarry pits were excavated at the base of outcrops as well as in open surfaces with no outcrops. At quarry pits, site structure is a function of the removal of overburden, primary extraction of raw toolstone, and natural processes of deposition. Because non-toolstone material (soil and bedrock) must be removed before opalite quarrying can begin, such features tend to be more restricted in area (average area = 109 m^2) than at outcrop quarries. Quarry pits are roughly circular in plan (although some are elongate or trench-like), and ringed by berms composed of both overburden backfill and discarded opalite quarrying debris. Their depth is governed by the distance from surface of exploitable bedrock, varying from less than .5 m (e.g., Feature 1 at 26Ek3171) to nearly 3 m (at 26Ek3208).

Quarry pit deposits invariably are well stratified. Moreover, the accumulation of sharp, angular quarry debris and mineral soil in quarry pits appears to be a poor substrate for living creatures with the result that such deposits evidence little or no bioturbation.

The removal of overburden and waste rock, extraction of opalite toolstone, toolstone assay and processing, and natural accumulation of sediments all produce characteristic deposits. These deposits also tend to occur in characteristic positions in and around quarry pits. The simplest quarry pit results from a single episode of excavation to bedrock, toolstone extraction, and abandonment. A model of the life of a simple quarry pit follows:

1. Remove soil overburden to bedrock with a digging stick, and place it outside the pit on the down-slope side in contact with the unmodified ground surface. Overburden deposits have similar texture and clasts to undisturbed soil adjacent to the pit (usually loams), but differ in color and structure because of mixing during removal and redeposition. Overburden is often the basal deposit in the berm around the pit.

2. With hammerstones, wedges, and levers, remove non-toolstone bedrock to expose and/or isolate opalite toolstone. This creates at least two

kinds of deposit. "Hash" is probably a byproduct of removal of non-toolstone bedrock through battering, and is comprised of fine angular opalite fragments, pulverized tuff, silt and/or clay. In the simple pit, hash characteristically is found in thin lenses resting directly on bedrock in pit bottoms. Waste rock removal also produces layers of coarse rubble comprised of pebble to cobble sized angular chunks of tuff and opalite with opalite flakes. These layers often contain broken hammerstones and hammerstone spalls. In the simple case, coarse rubble is piled around the edges of the pit and forms most of the deposits in the berm.

3. With hammerstones, wedges, levers, and possibly fire, extract the now isolated toolstone. This may produce a coarse deposit such as the one just described (also with hammerstones and spalls), but it contains more opalite than tuff. These deposits also tend to be deposited on the berm. Charcoal deposits and burned stones in the pit fill may signal small fires set to crack and separate isolated masses of toolstone.

4. With hammerstones, process the extracted toolstone; create large flake blanks and perform initial biface reduction. These activities produce layers composed mostly of flake debitage (much of which is large) that may also contain bifaces and cores. Hammerstones and spalls are also present, but much smaller in size than those described above. These deposits occur within pits and on pit berms; in the simple case, these are the last cultural deposits created before abandonment.

5. Abandon the pit. Natural processes (slopewash, frost heaving) cause the inner slopes of the pit walls and berm to contribute material that accumulates in the pit bottom. Vertical size sorting may occur as fine material settles among larger objects. If left undisturbed, eolian accumulation of fine sediment and organic material may fill the pit bottom and begin to form a humic horizon.

This simple model remains unobserved in the field. All the quarry pits that we have examined demonstrate multiple episodes of quarrying and abandonment in the same pit or in adjacent pits. Old quarry pits are filled with overburden and waste from new pits. Multiple quarrying episodes in pits on open surfaces

tend to move uphill; those at the base of bedrock outcrops tend to move into the bedrock exposure, and probably laterally along the outcrop as well. But because the deposits generated during different phases of quarrying are so distinct, it should be possible to separate discrete episodes in complex quarry pit fills.

Reduction Features consist of moderately dense scatters of secondary debitage, biface thinning flakes, cores, and bifaces, generally limited in horizontal extent (average area = 41 m^2) and confined vertically to a thin film seldom exceeding a few cm in depth. For obvious reasons, reduction features are most visible in areas away from quarries and their associated accumulations of debris. Most reduction features appear to be products of single event reduction episodes involving no more than two or three actors, since the distribution of debitage tends, where not modified by post-depositional processes, to concentrate in one to three loci within the scatter, from which a rapid fall-off in density occurs. Whether these multiple nuclei represent contemporaneous episodes (i.e., a three member reduction party) or are palimpsests of spatially coincident reuse awaits data recovery and the close monitoring of distributions by reduction stage and material type.

Residential Localities, by virtue of the greater diversity of activities performed at them, of the greater population densities and durations of habitation that they sustain, and of their tendency to accumulate palimpsest assemblages, tend to be much less structurally lucid than single event or single activity features. Apparently lacking facilities such as houses, storage pits, or many visible external hearths to articulate space within their boundaries, such sites often exhibit relatively amorphous scatters of multifunctional artifacts and debitage (e.g., 26Ek3092, 26Ek3170, 26Ek3171, and 26Ek3251), against which background only the most recently formed features are distinguishable. More rarely, such as at 26Ek3095, relatively discrete multifunctional features punctuate a landscape dominated by fairly barren inter-feature space, suggesting that such places are products of a smaller residential group size, shorter duration of habitation, or less frequent revisits.

The occurrence of these distinctive structural patterns, of course, is not mutually exclusive at Tosawihi, nor do they often occur as isolated instances of their class. More commonly, in fact, clusters of functionally related features form complexes that, until chronological controls can be imposed, ambiguously reflect either concentrated activity loci or long scenarios of revisitation; the 27 reduction features at 26Ek3184 comprise a case in point, and their implications for understanding the organization of work are affected profoundly by which interpretation is favored. Likewise, subsurface quarrying features occur often in coalescent clusters that reflect

prolonged exploitation, although not necessarily during the same season, of the same toolstone source.

More complex, because it blurs structural distinctions, is the frequent coincidence of separate classes of feature. Quarrying features, for instance, are almost always accompanied by reduction stations nearby, and most often actually are intruded by them. As described above, early stage biface manufacture frequently takes place on and about the berms of quarry pits, and the interior depression receives much of the discard. Too, all residential localities are characterized by at least a few reduction stations, and some (e.g., 26Ek3170 and 26Ek3171) subsume quarrying features within their boundaries. Structural analysis in these cases will require the meticulous teasing apart of the products of functionally distinct episodes of deposition.

Additional to behavioral patterning, observable site structure is a function of various natural processes that have contributed to, obscured, or deformed original patterns. At Tosawihi we have noted all these effects; reading of original (behavioral) patterns.

Some of these processes were touched upon previously in the quarry pit model. Because abandoned quarry pits function somewhat as catchment basins, these processes actually clarify some aspects of behavior. Slope wash and eolian material accumulating during episodes of non-use delimits stratigraphic units that otherwise would be more difficult to isolate. Such delineation helps to emphasize structural differences between quarry pits (e.g., the deep pits at 26Ek3208, products of progressive working against a vertical face, from Feature 7 at 26Ek3171, the product of horizontal advance across a bedrock floor, with many episodes of backfilling). Importantly, such intercalation underscores that many quarrying features have resulted from several reiterative episodes, sometimes widely separated in time, rather than from single, sustained efforts.

Doubtless many prehistoric features in open sites and alluvial situations have been obscured by soil accumulation. We have noted in the USX East area, particularly, that eolian deposition has covered numerous reduction features with a film often no more than 2 cm thick. Since such features are rendered invisible to surface examination, structural analysis must rely in part on subsurface control.

Deformation is largely a product of slope movement and bioturbation. At Tosawihi, such processes most notably have affected reduction stations which tend, because they consist of patterned but very shallow scatters, to diffuse through time. On slopes, they undergo a general down slope migration, probably with measurable size sorting, until eventually they disappear as discrete entities. Similar dispersal, although less

directional, is produced by burrowing rodents and the passage of livestock; the former may entail vertical displacement as well.

To the degree that behavior can be inferred from site structure, and structure from observed distributions, the spatial dimension of Tosawihi archaeology will repay overt measures of data recovery to understand it. Both behavioral and depositional models will have to be invoked.

The Organization of Lithic Procurement

Binford (1979, 1985a, 1985b; Binford and Stone 1985) maintains that toolstone procurement by hunter-gatherers is always "embedded" in other activities, occupies slack time, or is pursued when primary target resources fail to materialize. However, Gould (Gould 1980, 1985; Gould and Saggers 1985) counters that hunter-gatherers may make forays targeted specially at toolstone, when demand is high because of critical task requirements, or religious or trade incentives.

Tosawihi Quarries provides an excellent test ground for evaluation of these two competing models. As we have seen, Tosawihi Quarries is in a hinterland, not an easy place to be for any length of time in most seasons and over 40 km from the nearest known ethnographic winter base camp. Quarry pit excavation and toolstone processing must have been difficult and time consuming, and yet were carried out there on a scale unprecedented elsewhere in the Great Basin. Hundreds, perhaps several thousand, of quarry pits occur as individual features or in groups.

We doubt that this level of activity could be accomplished through a purely "embedded" strategy of exploitation, by people dallying a few hours on their way through the area. Extraction and processing (including heat treatment) could easily occupy several days. Steward (1941:337) quotes a Reese River Shoshone informant that flint was "put under the ashes for 5 nights". By definition (Binford 1980), the establishment of an overnight camp away from the residential base is logistical behavior.

Nevertheless, the question is not whether specialist task groups were employed who did nothing but extract and process toolstone, but how people could afford to spend several days at the quarries since food and water appear to have been limited there. Obviously, even though lithic resources were targeted at the quarries, visiting them was probably more advantageous at certain times of the year than at others.

Metcalfe (personal communication) suggests that people are more likely to move to lithic resources during times when the variance between different food resource return rates is low enough that the added lithic utility makes the lithic source

more attractive than other places. This could be seasonal; food resource return rates are leveled during the winter, but the climate mitigates against spending too much time at Tosawihi then. Moreover, we have seen no archaeological evidence shelters or food storage that would support winter occupation at Tosawihi. Spring and early summer seem to be the most productive times at Tosawihi, and resource return rates are leveled by general abundance at that time; that is, there is abundance everywhere. Too, differential food resource return rates are created on an irregular basis, such as when the quarry vicinity hosts a herd of antelope or bison.

In any case, the presence of biface caches suggest that sometimes more toolstone was produced than could be transported. If conditions sufficient to support task groups at the quarries occurred infrequently and/or at irregular intervals, the biface caches could be part of a deliberate strategy to maximize production while it was possible to do so, and store the surplus to be retrieved on short term, "embedded" trips over the next months or possibly years.

The definitive answer to the question of how toolstone procurement was organized at Tosawihi Quarries lies in the analysis of a variety of problem areas discussed throughout this report and summarized here. These include elucidating the technology of extraction, processing, and manufacturing; estimating time and effort required for extraction and processing; and estimating the size of groups visiting the Quarries and the duration of their stay.

Implications For Data Recovery

The intent of the testing program was to identify those sites that retain data relevant to a suite of research issues, and to delineate those problem areas in which additional work would be rewarded. To this end we have invoked multiple strategies of testing and data evaluation, aware that in few cases could we expect to answer fully the questions posed by our research issues, but that in all cases we should be able to sort productive from non-productive lines of inquiry. Additional to the data reported here, then, the testing program has yielded two important kinds of information, one substantive and one methodological, affecting the structure and strategy of subsequent data recovery. On the one hand, the testing results allow us to categorize the subject sites in terms of their potential contribution to various of the identified research issues, and to isolate those at which problem-driven data recovery seems appropriate. In all, eight sites in the USX-East area (26Ek3170, 26Ek26Ek3171, 26Ek3184, 26Ek3192, 26Ek3195, 26Ek3198, 26Ek3200, and 26Ek3204), seven in USX-West (26Ek3084, 26Ek 3085, 26Ek3092, 26Ek3095, 26Ek3160, 26Ek3165, and 26Ek3208), and two in the North Access Corridor (26Ek3237 and

26Ek3251) promise to return data bearing importantly on the strategies and economics of toolstone procurement at Tosawihi (cf. Chapter 2). As well, most of these appear to be informative of site structure, function, assemblage composition, and site formation processes; a few (especially 26Ek3092, 26Ek3198, 26Ek3237, and 26Ek3251) are likely to contribute to understanding local subsistence patterns and cultural chronology. Accordingly, data recovery plans have been prepared to guide further investigation of the 17 sites identified above, with special emphasis given the extraction of data directly relevant to the research issues they are most likely to inform (IMR 1988).

On the other hand, we have gained from testing some useful methodological insights about how to reliably and efficiently get data from sites at Tosawihi. The strategy of scraping and screening a 2 cm veneer from the surface of reduction features, for example, yielded data nicely compatible with ethnographic models of small scale spatial behavior (Binford 1978, 1980). Horizontal controls of 1 m^2 allow both intra- and inter-feature comparisons, while limited test excavations placed within scraped features suggest that visible reduction stations at Tosawihi consist largely of surface or near-surface phenomena. Too, the use of 1/8 in. mesh for the recovery of a sample of such features (with the rest screened through 1/4 in. mesh) allows control for the relative frequency of small debitage without inflating overall recovery rates as would occur were 1/8 in. mesh used throughout.

The use of backhoes proved an effective and efficient method for exposing the internal structure of complex quarrying features. We believe that quick access to stratigraphic cross-sections, drawn in detail and further characterized by the collection of material samples, can return data sufficiently robust that the loss incurred by coarse-grained extraction techniques is outweighed substantially. Since quarry features (especially pits and their associated berms) tend to be composed of densely packed blocks of unconsolidated cultural material, the recovery of relevant data through hand excavation rapidly accumulates enormous costs in field and laboratory time not repaid by analytical benefits.

In sum, efficient data recovery at Tosawihi should exploit proven successes while minimizing fruitless, irrelevant, or redundant lines of inquiry. Attention should focus only on those sites demonstrated by testing to hold data pertinent to the research questions identified in Chapter 2, and should employ techniques (such as the shovel-skimming of reduction features and the mechanical dissection of backhoe trenches) that confront cleanly and directly the data needs posed by those questions.

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SITES 26EK3032, LOCALITIES 26 AND 27, AND 26EK3516: AN ARCHAEOLOGICAL TESTING PROGRAM AT TOSAWIHI QUARRIES

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Elko Resource Area

On behalf of
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CULTURAL RESOURCES MANAGEMENT SUMMARY

Intensive minerals exploration and extraction is proposed in the Ivanhoe Mining District, located along Little Antelope Creek, Elko County, Nevada, on lands administered by the Bureau of Land Management, Elko Resource Area (BLM).

Intermountain Research conducted archaeological tests on behalf of Ivanhoe Gold Company, in response to impacts anticipated as a result of two separate mine-related construction activities in and around the Tosawihi Quarries, archaeological site 26Ek3032. The larger of the proposed actions involved engineering changes to ore processing facilities in the vicinity of Little Antelope Creek. These developments portended impacts to two archaeological locations additional to those addressed in earlier work (Elston 1989). Both of these are components of the Tosawihi Quarries, a National Register property: Locality 26, a quarry pit complex and Locality 27, an open residential site. As such, testing in this area was undertaken for the purpose of developing a data recovery plan (see Intermountain Research 1988e). Subsequent to testing, however, changes in mine design eliminated the need for further archaeological investigation. Results of the testing fieldwork are reported here.

The second testing exercise addressed potential impacts posed by realignment of a southern segment of the proposed Main Access Road linking Ivanhoe Gold Company's Hollister Mine with State Route 18 (Intermountain Research 1988c). Testing was undertaken with the goal of clarifying the National Register of Historic Places eligibility status of previously identified archaeological site 26Ek3516, located just outside and adjacent the northwestern boundary of the Tosawihi Quarries (Intermountain Research/BLM correspondence 11/11/88).

The present evaluation concludes that 26Ek3516 is ineligible for nomination to the National Register of Historic Places. We propose that testing recovered the full information content of the site and that construction of the Main Access Road to the mine will pose no adverse effects.

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Chapter 1

INTRODUCTION

Intensive minerals exploration and extraction is proposed in the Ivanhoe Mining District, along Little Antelope Creek, Elko County, Nevada (Figure 1). Activities focus on that portion of the district referred to as the Ivanhoe Project Area on lands administered by the Bureau of Land Management, Elko Resource Area (BLM).

This report documents the results of archaeological tests conducted by Intermountain Research on behalf of Ivanhoe Gold Company. The need for testing was triggered by impacts anticipated as a result of two separate mine-related construction activities in and around the site 26Ek3032, Tosawihi Quarries. Archaeological resources within each of the areas of potential effect held differing status in terms of the National Register of Historic Places. As a result, the focus and goals of the test programs within them were somewhat different.

The larger of the proposed actions involved engineering changes to ore processing facilities in the vicinity of Little Antelope Creek. These developments portended impacts to two archaeological locations (Figure 2) additional to those addressed in earlier work (Elston 1989). Both are components of the Tosawihi Quarries, site 26Ek3032, a National Register property: Locality 26, a quarry pit complex and Locality 27, an open residential site. As such, testing in this area was undertaken for the purpose of developing a data recovery plan. This goal was accomplished (Intermountain Research 1988e), and the plan appeared as an amendment to the second volume in a series of data recovery plans developed for the Ivanhoe Project (Intermountain Research 1988a, 1988b, 1988c, 1988d). Subsequent to testing fieldwork however, proposed changes in mine design were abandoned, eliminating the necessity for further investigation of Localities 26 and 27.

The second testing program reported here addressed potential impacts posed by realignment of a southern segment of the proposed Main Access Road linking the mine with State Route 18 (Intermountain Research 1988c; see Figure 2). In this case, testing was undertaken with the goal of clarifying the National Register eligibility status of previously identified site 26Ek3516, located just outside and adjacent the northwestern boundary of the Tosawihi Quarries (Intermountain Research/BLM correspondence 11/11/88).

In this report we present the outcome of the testing programs. For both, we rely heavily upon citation of extant archaeological literature on the Tosawihi vicinity for the portrayal of cultural and environmental context as well as for specifics of field methods and the rational for their application. Chapters 2 through 5 offer the findings of work at Localities 26 and 27, 26Ek3032. Chapter 2 provides an overview of the Localities 26, 27 study area, its physical setting and its cultural content. Chapter 3 outlines the field methods employed. The results of the testing program are encompassed by Chapter 4, commencing with a description of the content and structure of site deposits as revealed by stratigraphic analyses and followed by a description of the artifact assemblage. Chapter 5 concludes discussions of Localities 26 and 27 with a consideration of their data potential in light of their ability to address questions pertinent to Tosawihi research. The final chapter, Chapter 6, presents testing results for site 26Ek3516 and an assessment of the effect that proposed construction will have upon the site.

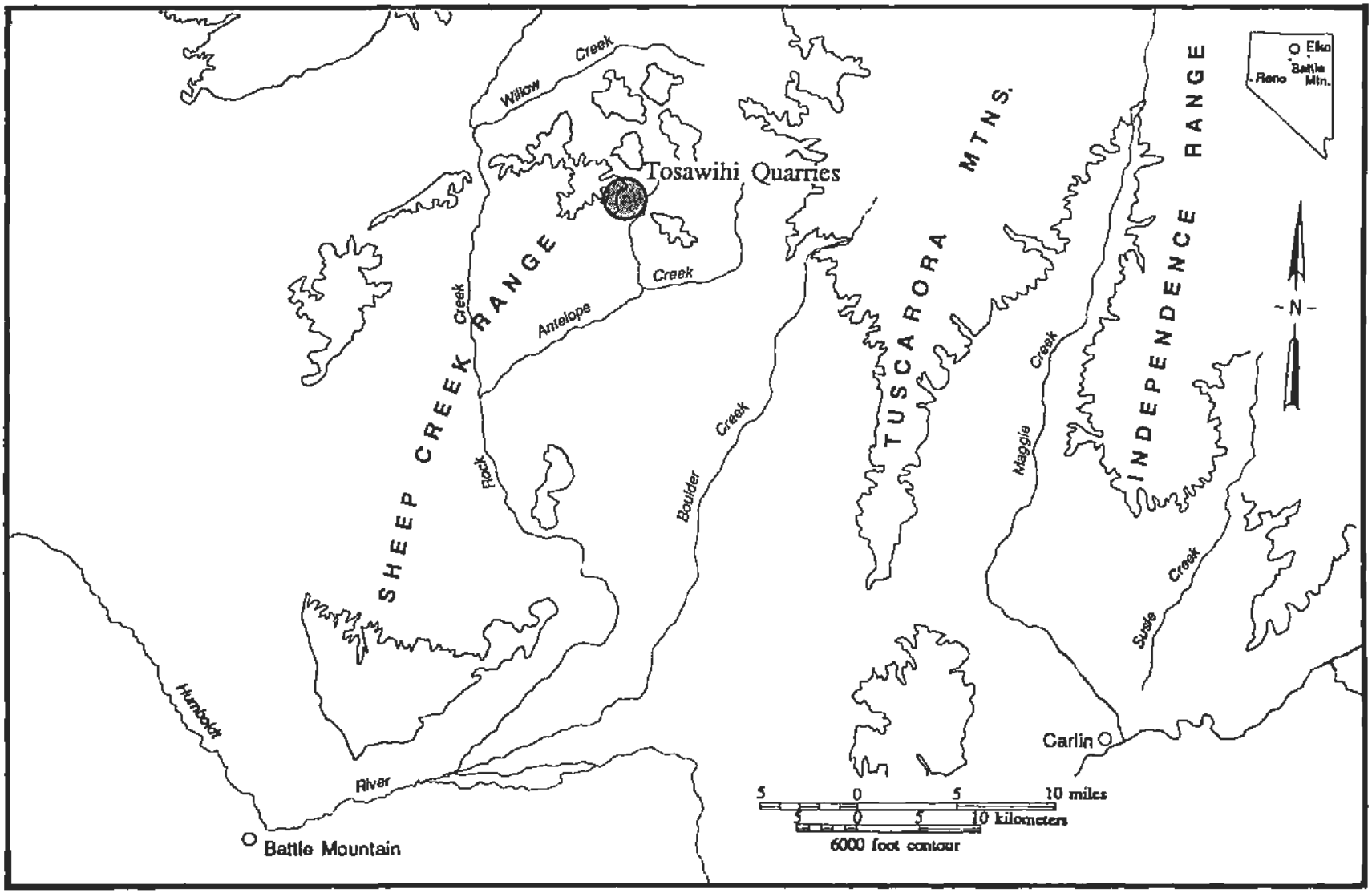


Figure 1. Regional map.

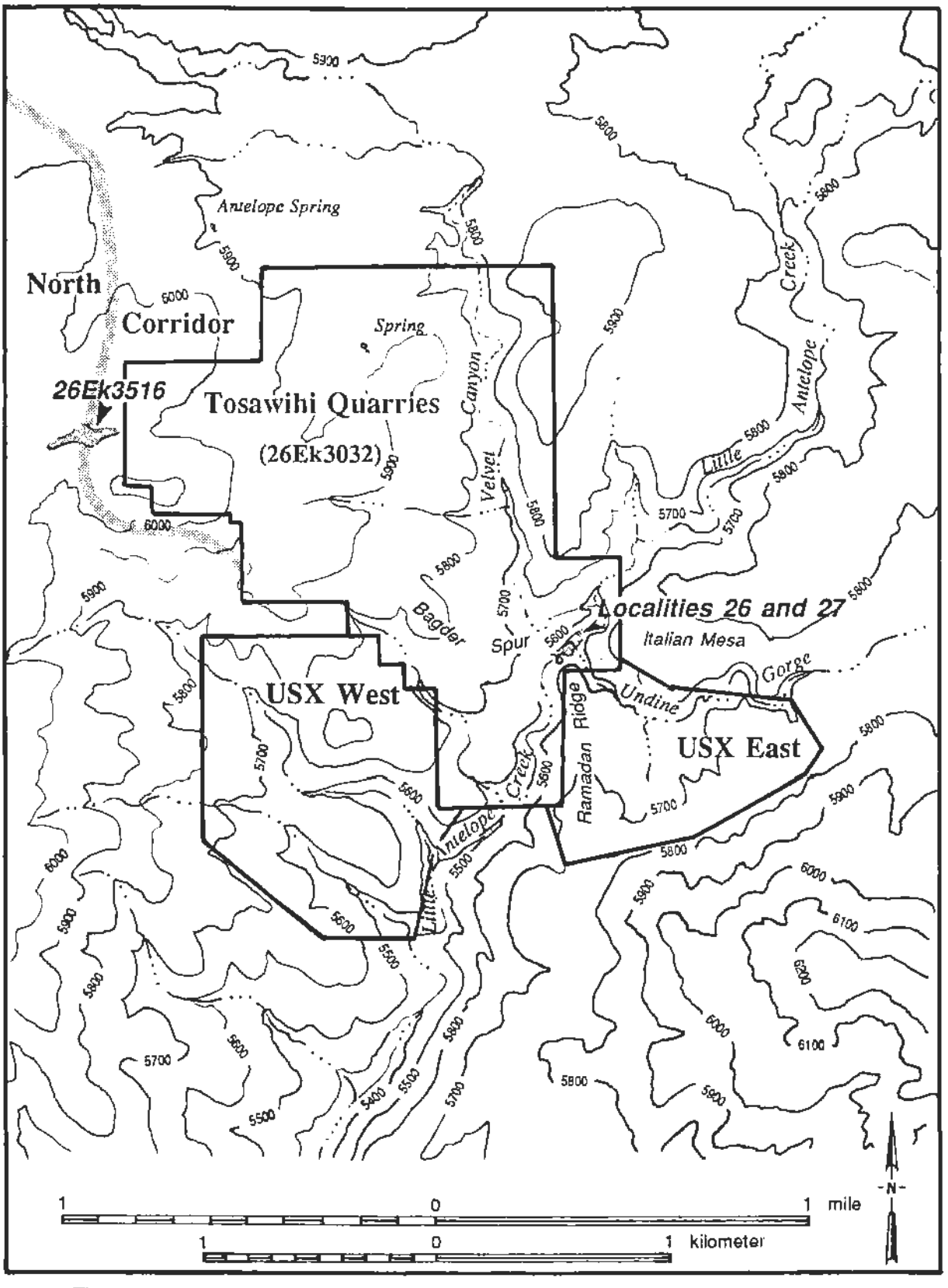


Figure 2. Study area map.

Chapter 2

DESCRIPTION OF LOCALITIES 26 AND 27

The Localities 26, 27 study area represents a small northward expansion of the USX-East Project Area and, as such, falls entirely within the Tosawihi Quarries site, 26Ek3032 (Figures 3, 4; cf. Elston 1989). Specific information regarding the physical setting and archaeological content of these areas is available in numerous previous accounts of Tosawihi focused research (i.e., Elston, Raven, and Budy 1987; Intermountain Research 1988a, 1988b; Elston 1989; Elston and Raven 1991). Our most comprehensive and, to date, most highly evolved understanding of the interplay of Tosawihi landscape and prehistoric land use is offered by Raven (1991a). Botkin, Dugas, and Elston (1991) describe the archaeological content of the USX-East project area and adjoining portions of the Quarry proper. Here, only details pertinent to the study area itself are addressed.

Physical Setting

The study area occupies an irregularly shaped parcel of 8.5 acres along a short reach of Little Antelope Canyon between the northern terminus of Ramadan Ridge and the southern footslopes of Badger Spur (Figure 3). The northern two-thirds of the area encompasses Big Meadows, a broad, grassy system of stream terraces surrounding the confluence of Little Antelope Creek and the drainage of Undine Gorge. Elevated from ca. 0.5 m to 3 m above the active streambed at the confluence (5560 feet [1695 m] amsl), Big Meadows is relatively flat, is mildly dissected by a series of abandoned channels, and is open in aspect. The steep colluvial slopes of Badger Spur and talus cones buttressing Italian Mesa impinge on Big Meadows along the west and east, respectively; their toeslopes constitute the boundaries of the study area in these quarters. The southern portion of the study area subsumes the lowest, northernmost extent of Ramadan Ridge where it coalesces with the stream terraces of Big Meadows (Figure 5).

Several physical attributes conducive to human occupation coincide in the study area and likely conditioned aboriginal use of the place. In terms of its provision of water, the study area is more favorably endowed than virtually any other location in the eastern periphery of the Tosawihi Quarry. For part of the year at least, surface water is available essentially "on-site". One of the only two springs that emerge in the Quarry rises within Big Meadows at the foot of Badger Spur. As well, Antelope Creek and Undine Gorge channel copious flows during spring runoff and deep intermittent pools persist along the streambeds until late June.

The riparian location of the study area positions it on the most direct foot-route between the Tosawihi Quarries and ethnographic White Knife Shoshone winter villages on the Humboldt River. For people traveling the system of watercourses that link these two locations, the relatively well watered flats of Big Meadows offer one of the first (or last) places suitable for residential bases close to the quarry area (Elston, Raven, and Budy 1987:40).

Prior to the middle of the last century, we suspect that by local standards, the study area constituted a comparatively rich foraging patch for its offering of productive riparian plant species and the game attracted to them (cf. Raven 1991a). Today, with the spring developed for livestock use, cattle that congregate there have rendered the vegetation of Big Meadows a sparse cover of cheat grass dotted by isolated clumps of Great Basin Wild Rye and tall sagebrush. Sporadic growths of sedge and wild rose occur along the stream bottoms. Higher on the slopes vegetation is similar to that found elsewhere in the vicinity. Ramadan Ridge and adjacent upland contexts support a non-nutritious mosaic open stand of tall and low sagebrush accompanied by rabbitbrush, phlox, and sparse grasses.

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

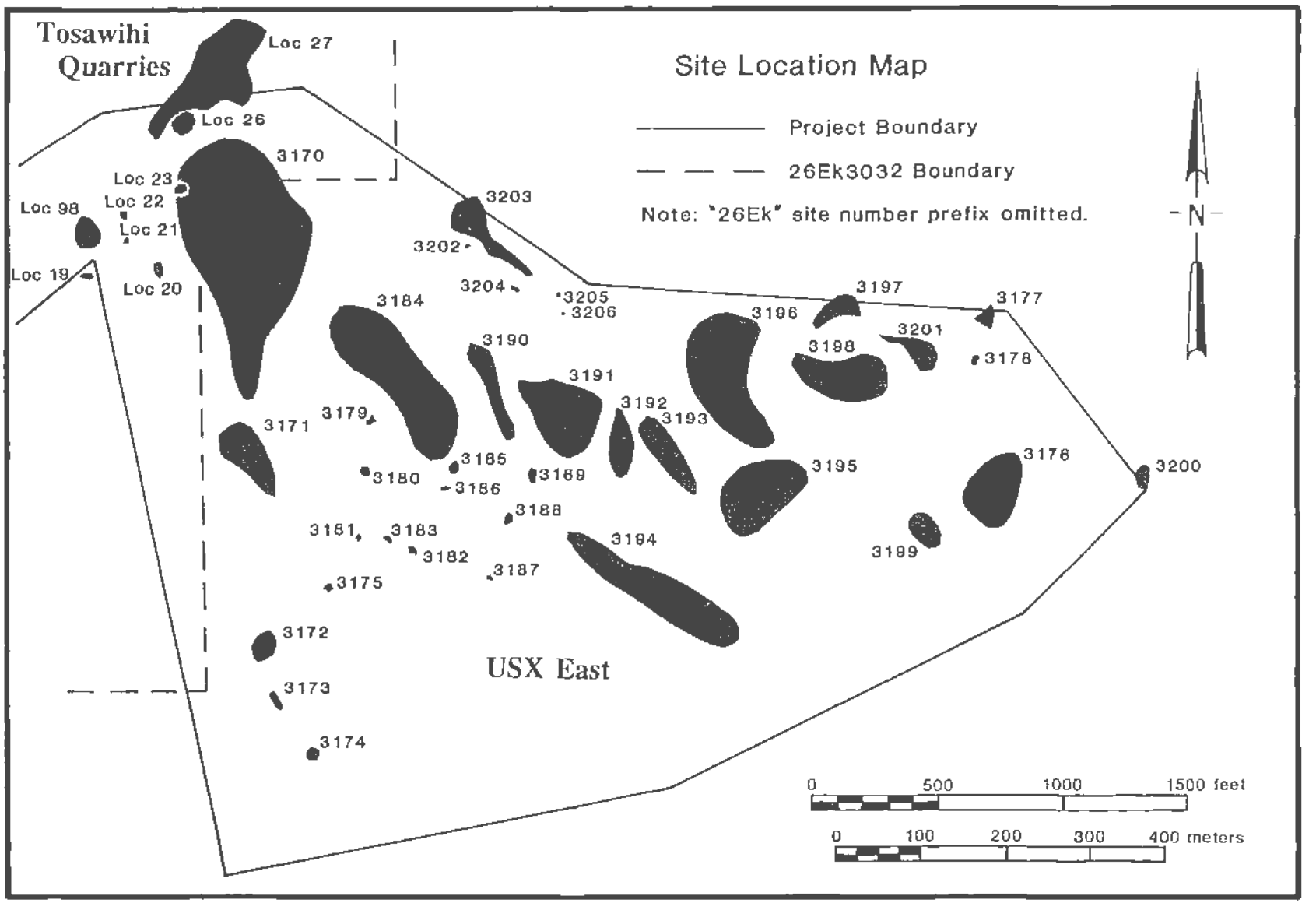


Figure 4. USX-East, site location map.

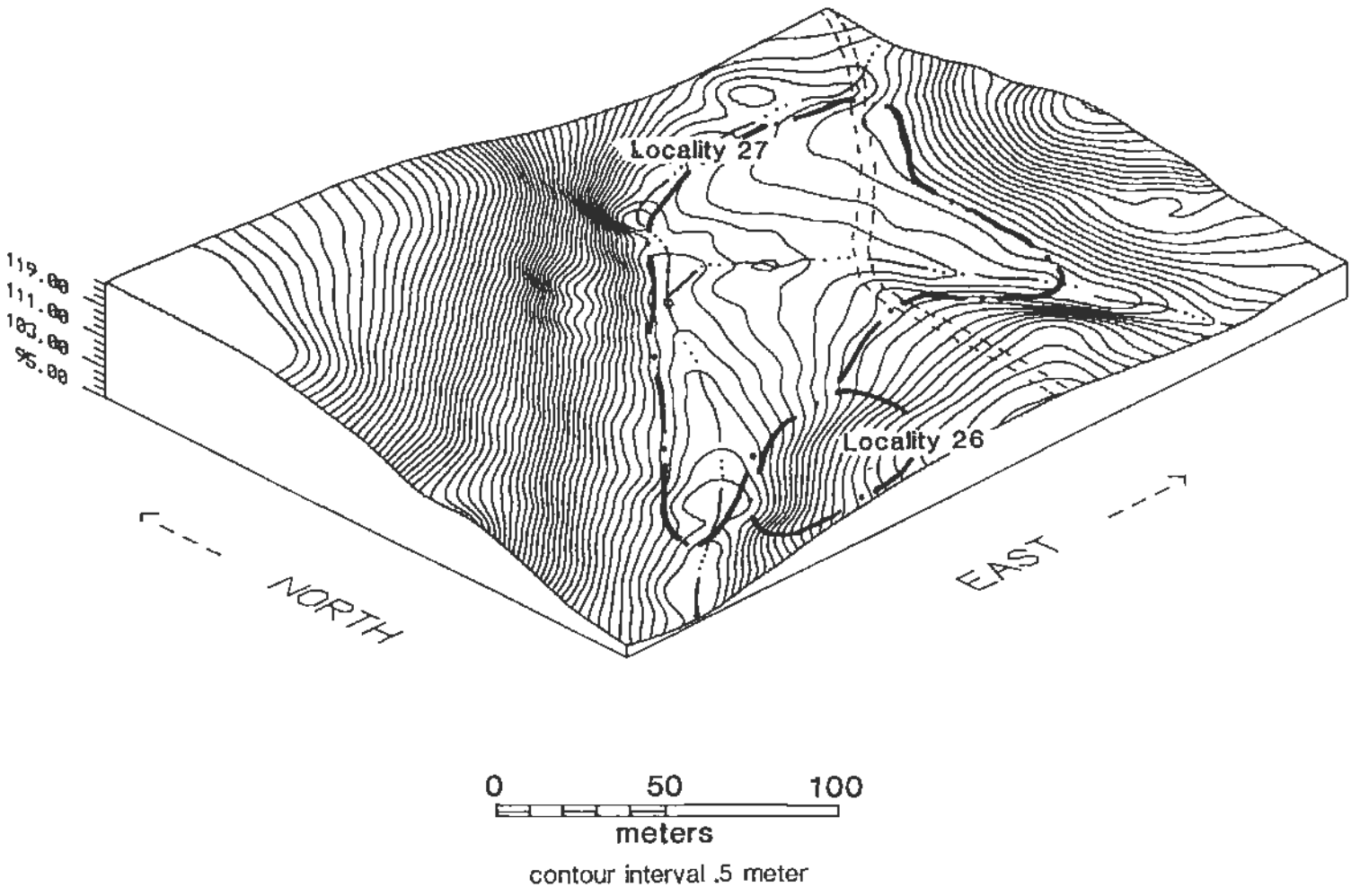


Figure 5. Topographic setting of 26Ek3032, Localities 26 and 27.

Toolstone sources are comparatively meager within the study area proper. They are restricted to the near surface bedrock supplies along the highest stream terrace on Ramadan Ridge (Locality 26) and to the opalite cobbles that bottom the streambeds of Undine Gorge and Little Antelope Creek (Locality 27). The location of the study area does, however, position it central to numerous lithic sources close by. The nearest of these, seven quarry pits defining Locality 29, lie perched on the crest of Badger Spur just 80 m north of the study area. Immediately beyond these occur the extensive quarry pit complexes in the heart of the Tosawihi Quarries. As well, opalite toolstone is available close at hand within several sites in the USX-East project area, all of them accessible via the easily navigated terrain southeast of the study area (cf. Elston, Raven, and Budy 1987:38; Botkin, Dugas, and Elston 1991; Raven 1991b).

Geologic and Geomorphic Setting

Components of surficial deposits within the study area include alluvial deposits from Little Antelope Creek and Undine Gorge, associated colluvial materials from adjacent slopes, silts and ash of eolian origin, and debris from cultural activities (quarrying).

The beds of the currently active channels are entrenched to about 1 meter below the meadow surface and contain, along with gravels and coarse sands to silt, rounded to subangular boulders and cobbles composed of reworked older alluvial deposits, and colluvial debris from adjacent slopes where products of relatively recent weathering of the various bedrock types, including opalite, are being introduced into the system. These two drainages are responsible for a series of active and abandoned channels, and interrelated surface and subsurface terrace features in the site area. These will be discussed in more detail later.

Bedrock geology in this region of Elko County is dominated by mid-Tertiary age volcanics. These are primarily phenorhyolitic to phenodacitic ignimbrites produced by the eruption of hot debris-charged gas clouds or they are exogenous domes and flows of porphyritic phenorhyolitic and phenodacitic rocks (Coats 1987). Alkali olivine basalts are present in significant amounts. In the immediate site area rocks that underlie the meadow and comprise the ridges west and south of the meadow commonly are opalized, massive airfall and ashflow tuffs, and reworked tuffaceous sediments with Valmy Quartzite and chert clasts in a silicified matrix. Ramadan Ridge, which separates the drainages of Little Antelope and Undine Creeks, is composed of massive to flowbanded, ignimbritic rhyolite with quartz phenocrysts. These are capped by opalized tuffaceous sediments (Bailey and Phoenix 1944; Granger et al. 1957; Cornucopia 1987). Opalization of bedrock and the resultant occurrence of toolstone is an important aspect of the geology in this area.

The present structural character of the rocks in this area is predominately the result of Tertiary to recent normal faulting, typical of the Great Basin. The regional dip is about 30° to the southeast.

Site Descriptions

Localities 26 and 27 constitute two adjacent but functionally distinct prehistoric activity areas: Locality 26, a small quarry pit complex; and Locality 27, an open residential locality. Both are components of the Big Meadows Archaeological Neighborhood of site 26Ek3032 (see Figure 3) and were recorded originally during intensive survey of the Tosawihi Quarry (Elston, Raven, and Budy 1987).

Locality 26

Locality 26 is manifest on the surface by three close-set quarry pit depressions centered on a microtopographic flat provided by an ancient stream terrace along the western flank of Ramadan Ridge (Figure 6). Elevated some 7 m higher than the current bed of Little Antelope Creek, the pit berms coalesce to create an anthropic talus of quarry debris that extends downslope onto the southern edge of Big Meadows, covering the original ground surface up to a meter deep.

The cultural content of Locality 26 suggests that it served almost exclusively as a source of good quality toolstone. Throughout its 1900 m^2 extent, the locality is paved with a dense accumulation of opalite debitage and biface fragments. Virtually the entire artifact collection obtained by testing is directly referable to toolstone extraction and early through intermediate stage processing tasks.

Locality 26 remained essentially undisturbed by historic impacts prior to our tests. Colluvial redeposition has altered original site contexts. The large, clastic quarry debris seems to have proven unattractive or impenetrable to burrowing animals.

Locality 27

Locality 27 is defined by a moderate density lithic scatter that covers 11,000 m^2. Its boundaries are congruent with the entire expanse of Big Meadows south of Badger Spur (see Figure 6). Little Antelope Creek flows through the western portion of the locality. The seasonal stream that drains Undine Gorge roughly bisects the locality east to west en route to its confluence with Little Antelope Creek at the western edge of the site. The steep slopes of Badger Spur and Italian Mesa tangent Locality 27 on the west and east, respectively. On the north, Locality 27 is differentiated arbitrarily from an apparently similar locality by a segment of Little Antelope Creek. On the south, Locality 26 and Locality 27 share a common boundary for a distance of ca. 40 m along the slopes of Ramadan Ridge where opalite debris derived from the quarry pits at Locality 26 merges with the surface lithic scatter of Locality 27.

The topography of Locality 27 is largely the product of the downcutting and filling accomplished by Little Antelope Creek and Undine Gorge (see Figure 5). The ground surface is generally flat; subtle undulation has been imparted by a network of inactive drainage channels and a series of stream terraces. Soils vary considerably across the site and include alluvial deposits from the creeks, colluvial materials from the surrounding slopes, as well as contributions of eolian silts and ash.

The surface lithic scatter is dominated by debris from opalite processing accompanied by a high incidence of maintenance/subsistence tools. Absent the discernible concentrations of artifacts commonly encountered as cultural features at most other sites in the vicinity, the scatter litters the surface in amorphous fashion throughout its extent. Unlike the exclusively surficial nature of most Tosawihi sites however, the scatter at Locality 27 overlies subsurface deposits of similar cultural content augmented by ceramics and non-utilitarian artifacts to depths of over 1 m.

Natural and human induced disturbances have affected Locality 27. However, it appears for the most part to remain well preserved. A modern dirt road transects its eastern quarter and a scatter of recent and historic debris throughout its northern portion attests to casual intermittent use up through the present time. Cattle grazing and its attendant trampling and exacerbation of erosion is locally intensive. Natural post-depositional processes effecting the integrity of Locality 27 are comparable to those observed at sites throughout the Tosawihi vicinity (Elston and Dugas 1991). Turnover by rodent and badger burrowing is pronounced, and flooding and migration of drainage channels undoubtedly have altered deposits.

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

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Chapter 3

FIELD METHODS, LOCALITIES 26 AND 27

Field techniques at Localities 26 and 27 were designed to recover data appropriate to research questions we have identified for the larger Ivanhoe Project (Budy, Elston, and Raven 1989; Elston et al. 1991). Particular data retrieval strategies were tailored to the character of each locality—the primary toolstone source at Locality 26 and the residential and reduction deposits at Locality 27. Contour mapping, intensive surface reconnaissance, systematic surface collection, backhoe trenching, and judgmental and random sampling of major physiographic strata and depositional contexts were employed.

Locality 26

To illuminate the nature and extent of prehistoric quarrying activities at Locality 26 and to allow examination of the geomorphology of the setting, we excavated one backhoe trench (Figure 7) parallel to the slope, intersecting one of the quarry pits first identified during survey and exposing it to bedrock. Two additional subsurface quarry pits were exposed thereby. Details of the worked bedrock surfaces, quarry pit stratigraphy, and sediment profiles were recorded, and are discussed below. Sediment samples were collected and processed.

Upon completion of stratigraphic profiling in Trench 1 at Locality 26, quarry pit deposits were sampled systematically, resulting in the collection of 33 bulk lithic samples. Generally, trench sampling sought to chronicle the quarrying events responsible for the creation of Locality 26. Specifically, samples were obtained with the goal of illuminating quarry pit formation processes and temporal variation in the techniques of toolstone procurement and processing.

Lithic samples taken from Locality 26 were bulk samples of approximately 7 liters each, composed of all cultural and non-cultural lithics, soil matrix, organic debris, etc., that occurred within a given location on the trench sidewall. Using profile drawings and descriptions as a guide, at least one such sample was troweled from each of the stratigraphic units comprising the deposit.

Selection of the location for sampling within a stratigraphic unit was judgmental. Where a unit contained relatively homogeneous contents and was of limited horizontal dimension, a spot that appeared to be "representative" of the unit was chosen for sampling. Conversely, a unit displaying heterogeneity of composition was sampled along its horizontal extent to document this variability. Where units clearly represented fill within quarry pits, samples were taken from locations corresponding to bottom, slope, and berm of the deposit. To the extent that the texture of any given stratigraphic unit allowed, field workers attempted to restrict samples to as small and spatially discrete an area of the unit as possible in order to insure sampling only within that unit. In most instances, the desired 7 liter sample could be obtained by troweling a 50 cm by 30 cm niche some 20 cm deep into the sidewall.

In sampling several of the stratigraphic units, collection methods deviated from the approach just described. Where a unit occurred as a thin veneer in profile, extending only a few centimeters into the sidewall, it was necessary to collect a sample from a broad expanse of the unit in order to obtain the standard sample volume. Samples taken in this manner tended to homogenize diversity artificially within units. Also, some units proved too small in all dimensions to provide quantities of material sufficient for our standard volume. Here, we collected as much of the unit as possible, sometimes retrieving as little as 2 liters of deposit.

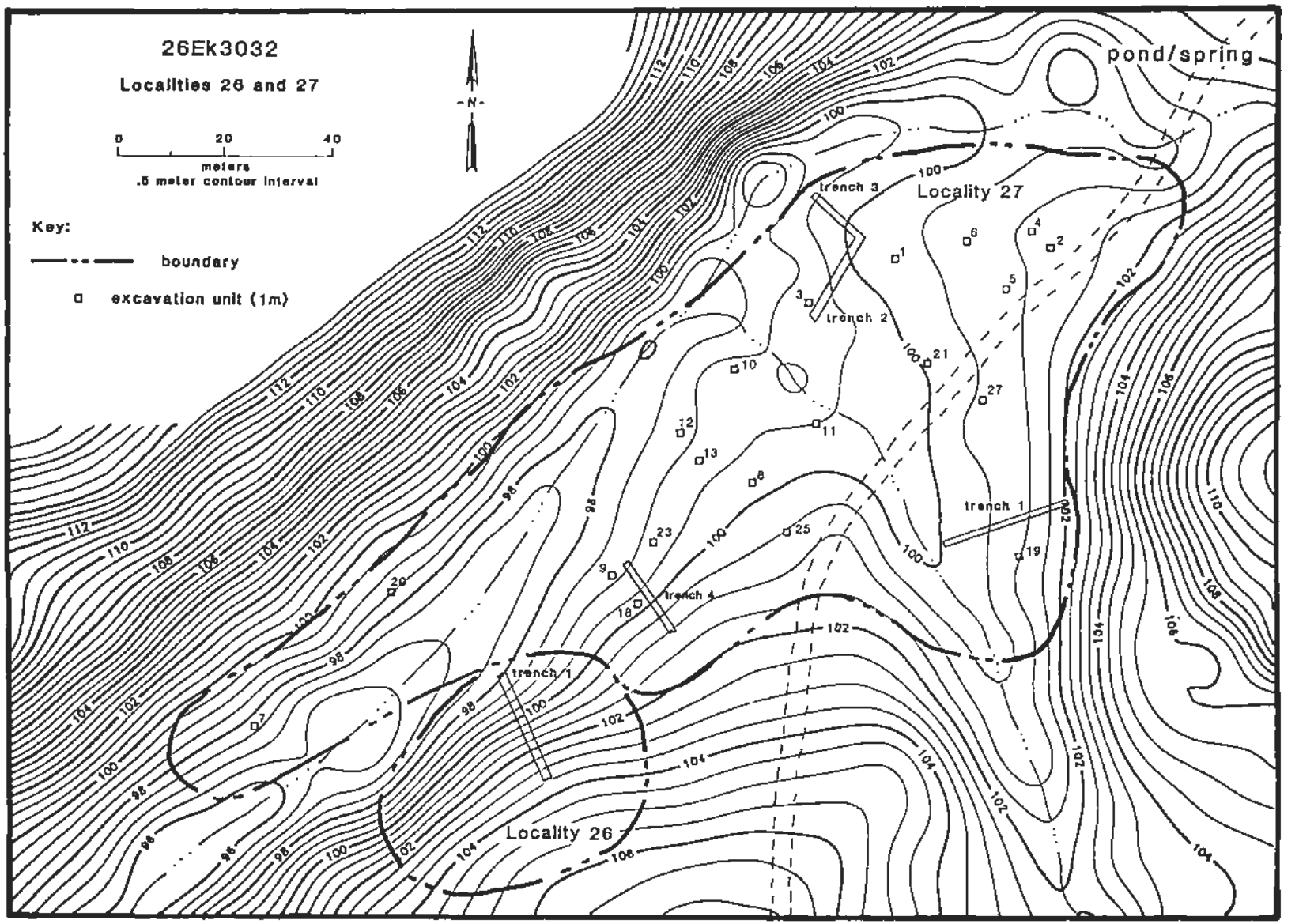


Figure 7. Location of backhoe trenches and excavation units, 26Ek3032, Localities 26 and 27.

After collection, the location and extent of each sample was plotted on the stratigraphic profile drawings. Field notes that recorded qualitative comments about the placement and content of samples, as well as any deviation from standard collection methods, were maintained throughout the exercise. Each sample was bagged separately and affixed with appropriate provenience data.

Post-field preparation of lithic samples was minimal. Each raw sample was weighed and then washed in 1/8 in. mesh trays. Only large root fragments and other recent organic debris were culled manually from the samples. Materials passing through the mesh consisted almost exclusively of the soil matrix, pulverized tuff, minuscule charcoal flecks, and opalite "hash" composed of minute shatter and flake fragments. After drying, samples again were weighed, then rebagged, ready for analysis.

Because the surface of the locality was paved with considerable quantities of debitage, shatter, cores, hammerstones, and bifaces, we undertook an intensive, systematic surface reconnaissance to locate and collect all formed artifacts.

Locality 27

To isolate potential surface cultural features, we first scrutinized the surface of the locality and mapped and collected all formed artifacts and obsidian debitage large enough for source characterization. In an attempt to expose potential buried features and identify the depth and complexity of deposits, we then excavated 20, 1 m x 1 m units placed to sample five topographic strata defined by stream cuts and depositional variability within the meadow/drainage system (see Figure 7). The locations of 18 excavation units were assigned at random within four sampling strata, and two units were placed judgmentally in the fifth to explore the low terrace southwest of the meadow and across Little Antelope Creek.

Excavation units were dug by 10 cm level, with soil and cultural material screened through 1/4 in. mesh. Artifacts (debitage, formed tools, ceramic sherds, and ornaments), excluding angular debris, were retained, bagged by provenience and processed. Two excavation units (EUs 4 and 8) served as control units, each containing a 50 cm x 50 cm quadrant which was screened through 1/8 in. mesh.

The 20 excavation units removed 4.6 m^3 of subsurface deposits. In most cases, excavation ceased upon encountering the impenetrable stream cobble substrate that underlies the alluvial soils of Big Meadows or the culturally sterile indurated red clay immediately above the cobbles.

Additionally, four backhoe trenches were excavated to examine details of past creek behavior, sedimentation history, and subsurface terrace features (see Figure 7). Stratigraphic profiles of selected portions of these trenches were drawn. These are discussed in the following chapter.

Chapter Four

TEST RESULTS, LOCALITIES 26 AND 27

Surface Reconnaissance and Collection, Locality 26

Surface collection of the extremely dense concentration of quarrying debris visible at Locality 26 yielded 80 formed artifacts and 3 obsidian flakes (one biface was recovered in the trench excavation). Bifaces dominate the surface assemblage, while hammerstones and cores make up a smaller proportion of the formal tools (Table 1). The assemblage at Locality 26 reflects a clear focus on toolstone extraction and early stage biface reduction.

Table 1. Summary of Formed Artifacts and Exotic Materials Recovered from 26Ek3032, Localities 26 and 27.

ARTIFACT TYPE	MATERIAL TYPE						
	Opalite	Obsidian	Basalt	Quartzite	Rhyolite	Other	Total
Locality 26							
Bifaces	59	-	-	-	-	-	59
Cores	5	-	-	-	-	-	5
Modified Chunks	2	-	-	-	-	-	2
Hammerstones	1	-	-	7	2	-	10
Abraders	-	-	-	-	2	-	2
Choppers	1	-	-	-	1	-	2
Flake Tools	1	-	-	-	-	-	1
Obsidian Flakes	-	3	-	-	-	-	3
TOTAL	69	3	0	7	5	0	84
Locality 27							
Projectile Points	5	3	-	-	-	-	8
Preforms	5	-	-	-	-	-	5
Bifaces	278	-	-	-	-	-	278
Flake Tools	34	4	-	-	-	-	38
Modified Chunks	19	-	-	-	-	-	19
Hammerstones	3	-	1	4	1	-	9
Choppers	-	-	-	-	-	-	0
Cores	13	1	-	-	-	-	14
Ground Stone	-	-	3	-	4	-	7
Pottery	-	-	-	-	-	11	11
Beads	-	-	-	-	-	2	2
Obsidian Flakes	-	38	-	-	-	-	38
Historical Items	-	-	-	-	-	92	92
TOTAL	357	46	4	4	5	105	521

Surface Reconnaissance and Collection, Locality 27

Intensive surface examination of Locality 27 encountered an abundant and diverse array of tools amid the moderate density scatter of opalite debitage that blankets the area. The 167 formed artifacts retrieved by the exercise comprise roughly half the entire assemblage from the locality and include, in addition to bifaces and other opalite processing-related forms, numerous flake tools and projectile points, and six of the seven groundstone implements in the collection (Appendix B).

Nowhere do cultural materials occur in concentrations sufficiently dense or well defined to be identified as the "Reduction Station" features that typify virtually all other sites in the vicinity (cf. Botkin, Dugas and Elston 1991). Instead, surface artifacts are scattered rather evenly across the alluvial flats of Big Meadows. Although three very broad, generalized "clusters" of formed artifacts are discernible within the distribution, these appear to be a fortuitous by-product of the partitioning of the site surface by Little Antelope and Undine Creeks, as well as by the meanders of the inactive channels that cross it. Several shallow depressions in the northern portion of the locus, that attracted attention for their apparent similarity to house depressions, proved instead to be stock wallows.

Excavation Units

The excavation of 20 EUs resulted in the recovery of 224 formed artifacts and copious quantities of lithic debitage. Testing revealed subsurface cultural deposits throughout the horizontal and vertical extent of the locus, averaging ca. 50 cm in depth. Excavation unit depths ranged from 20 cm in the central portion of the locus adjacent Undine Creek to 140 cm along the low bench on the west bank of Little Antelope Creek (EUs 7 and 20) and just east near the base of Ramadan Ridge (EU 9). Except for the lack of groundstone implements, the subsurface assemblage mirrors the content and diversity of that encountered on the surface, and includes, as well, numerous ceramic sherds and two beads.

Although excavations failed to disclose unequivocally the presence of subsurface cultural features, returns from several probes in the south-central and northern quarters of the locus hint at their existence. In EU 9, subsurface finds reflect an increase in the diversity (which includes flake tools, pottery, and groundstone) and density of artifact classes and debitage over surface finds. In EU 1, several small charcoal lenses amid an amorphous zone of diffuse carbon-stained soil and angular clasts within level 3 may represent the remains of a poorly preserved hearth. Its highly turbated state and the local history of recurrent range fires prevent confident identification of a cultural feature.

Excavations in the northeastern quarter of the locus reveal a pronounced concentration of opalite debitage and artifacts at depths of between 20 and 30 cm. The concentration was encountered over an area ca. 20 m in diameter sampled by EUs 1, 2, 4, 5, and 6, and in the case of EU 6, occurs in sufficient density to be discernible in the sidewall. In EU 1, five scraping tools were distributed over the first three levels. The composition and extent of the concentration suggests that it is a buried living surface or special activity area, similar to subsurface features explored at 26Ek3092 in USX-West (Leach, Dugas and Elston 1991), and at Feature 1 at 26Ek3192 in USX-East (Botkin, Dugas and Elston 1991).

Debitage is more widely distributed, achieving its highest densities in the northern half of the site (EUs 1, 2, 5, 6, 9, 19, and 27). Too, there are portions of the site surface which reflect highest debitage

densities in the upper 2 cm of deposit, while other areas of the site reveal significant increases in density below surface (discussed below).

The horizontal and vertical clustering of artifacts at Locality 27 suggests clear potential for examining the spatial segregation of prehistoric activities in a chronological framework. The northeast sector of the site, in particular, may have been the focus of residential activities, while opalite processing and biface manufacture were more broadly distributed.

Stratigraphic Analyses

This section details several analyses conducted after the placement of backhoe trenches through the westernmost quarry pit depression visible on the surface of Locality 26, and through terrace deposits at Locality 27. The first part of the discussion describes the general nature of deposits produced by prehistoric quarrying activities (and defines key terms) as a backdrop for the technical observations made on the stratigraphic profiles that follow.

Quarrying Activities and Resulting Deposits

Deposits produced by quarrying activities and recognized in backhoe trenches can be grouped into general categories relating to the probable method used to extract toolstone (Dugas 1991). For instance, two typical fill types attributed to quarrying are lenses of coarse opalite chunks and flakes, and lenses of very fine opalite chips mixed with silts and pulverized tuff. The term "chunks" describes generally angular opalite or tuff clasts of various sizes that are not considered flakes. "Chips" refers to opalite pieces that are generally finer (2 mm - 3 cm) than chunks and appear to be products of early stage quarrying rather than reduction debris. "Flakes" are pieces produced by toolstone reduction.

Initially, quarrying began by the removal of soil and colluvial cover from the bedrock that, typically, is a combination of tuff and irregular patches and bands of opalite. Once bedrock was exposed, quarrying entailed attempts to remove tuff and poor quality opalite from around usable opalite. This operation apparently was accomplished in part by battering the bedrock with other stones, usually stream cobbles. Products of this activity are likely to be deposits of angular opalite and tuff chunks, mixtures of opalite chips, chunks, and soil from the pit margins, and abundant fine chips of opalite and pulverized tuff, termed "hash". Experiments in creating a quarry pit, using a battering technique, produced such materials (Carambelas and Raven 1991). Battering of the bedrock at the bottom of the pit, in order to remove surrounding tuff or to create cracks that might be used to wedge out pieces, was probably one of the first stages of quarrying. Hash debris is likely to be one of the initial units deposited as pit fill.

Another type of quarry debris, resulting from the reduction of large pieces of opalite to smaller usable pieces, consists of very distinct lenses of medium to coarse, open framework opalite chunks and flakes. "Open framework" refers to deposits in which coarse pieces of rock are lying against or on one another, with abundant open spaces between pieces. This also is referred to as a clast-supported deposit. These units are divided into poor, moderate, or typical open frameworks, depending on the relative amount of void space and matrix present. When the matrix is abundant, and the larger pieces do not rest on one another, it is described as a matrix-supported deposit.

During the stage of quarrying that produced open frameworks, larger flakes and chunks either were dropped to the bottom and sides of the pit to form subhorizontal layers or they were pushed back out of the way as quarrying resumed, resulting in a deposit that is a randomly piled, jumbled mass of clast-supported materials. Typically, this coarser material is accompanied by a sparse matrix of sandy to clayey silt with fine chips of opalite and tuff. This matrix was incorporated into the deposit either by mixing when the clasts were pushed out of the way or by later infiltration of fine material into the open framework.

Although quarrying produced abundant fill episodes, there were gaps in quarrying activity, during which colluvial slopewash and eolian materials were deposited in the pits. Colluvial slopewash constitutes the downslope movement of sediments caused by periodic rains and/or gravity. At Locality 26, slopewash deposits commonly are dominated by a silty matrix, with matrix-supported subrounded pebbles, opalite chunks, chips and flakes, and tuff chunks.

Commonly, later stage reduction debris is present as lenses in this silty material, particularly in units near the surface. This probably results from periodic episodes of toolstone reduction in areas peripheral to the center of the active quarry pit. It is also probable that, like some of the open framework episodes mentioned above, some finer pit fill episodes have been redeposited. The need to reach bedrock for subsequent quarrying would have made it necessary to scoop overlying materials out of the way. Such redeposited units are suggested by a jumbled appearance, with most of the opalite flakes present being matrix-supported in non-horizontal orientations. These are, however, generally difficult to discern from undisturbed slopewash units.

The mixture of quarry debris, thrown out of the pit or washed down from the area around the pit edge, and sediments from natural slopewash processes that were deposited as colluvial talus outside the quarry pits, comprises another general category of deposits commonly seen in backhoe trenches. In the quarry pits at Locality 26, these are predominantly brown to yellowish brown silt loams to clay loams, commonly with matrix-supported subrounded pebbles, subangular tuff and opalite chunks, and opalite flakes. These deposits grade into those of primarily alluvial origin within the meadow. Finally, all the deposits are mantled by eolian silts that comprise much of the current soil surface.

Locality 26: Backhoe Trench 1

The following discussion of the backhoe trench profile at Locality 26 identifies stratigraphic units representative of the types of deposits described above, and also those associated with alluvial activity in the site area.

Backhoe Trench 1, placed on an approximate NNW line through the quarry area (see Figure 7), provides a profile of quarry pits 1 - 3, a downslope accumulation of slopewash and quarry debris forming a colluvial talus, and finally, mixed deposits of slopewash and alluvium. The resulting sidewall profile revealed an 18 m long section of complex, stratified deposits with nearly 7.5 m of total relief (Figure 8).

The onlapping of depositional units from the backfill of one quarry pit over those of another suggests that the pits were worked in succession: the lowest northern-most pit first and the highest southern-most pit last. The fill from the northern-most pit (pit 3), for example, includes stratigraphic units 32 through at least unit 23 (Table 2). These are overlain by silty, predominately slopewash units such as 16 and 17. Note that unit 10 of the middle pit (pit 2) onlaps and truncates units 16 and 17, which in turn overlie units filling the northern pit. This effect also can be seen between the middle pit and the southern pit. There, unit 4 of the southern pit overlies unit 5, which in turn overlies units in the middle pit.

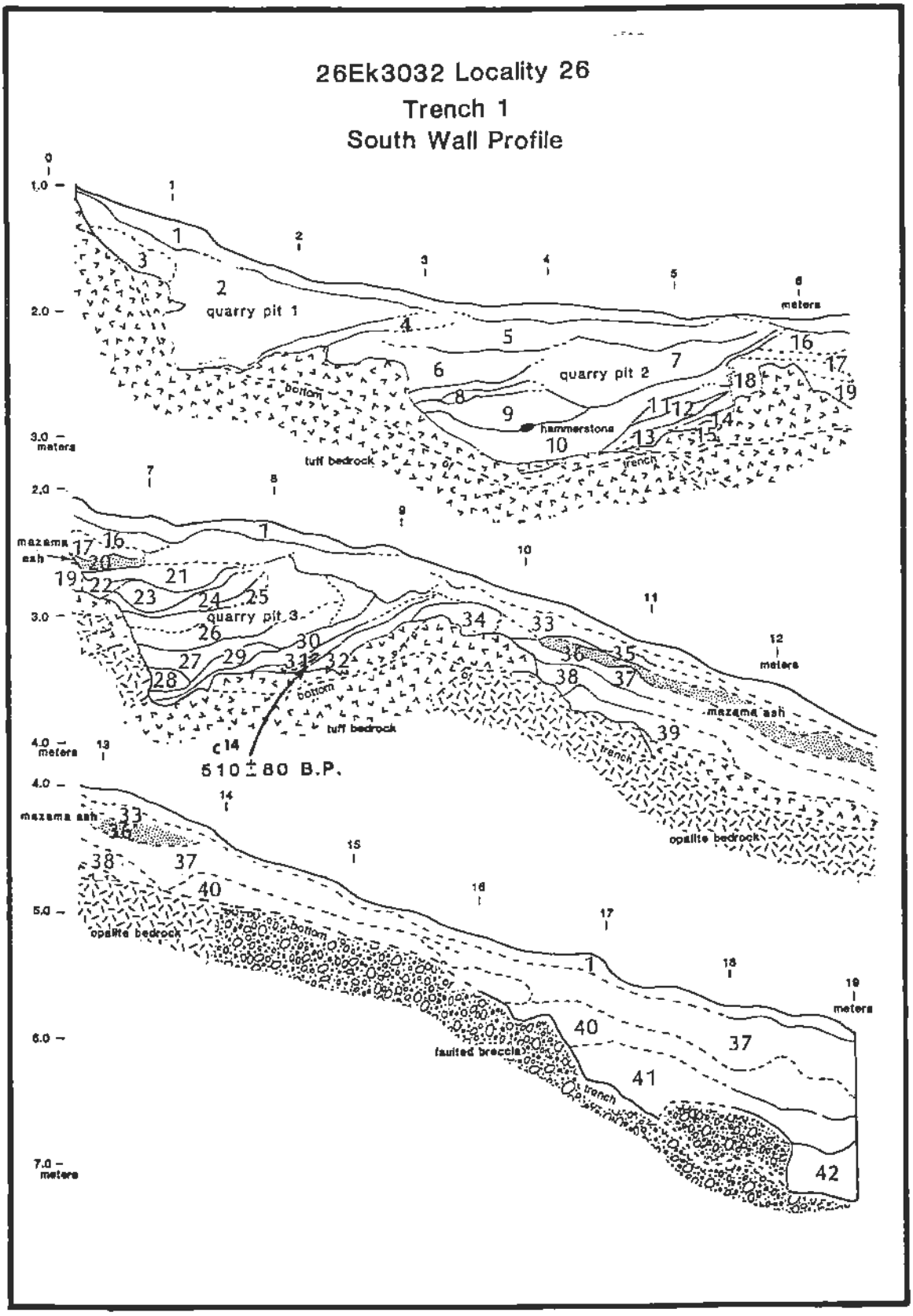


Figure 8. Backhoe Trench 1, south wall profile, 26Ek3032, Locality 26.

Table 2. Description of Stratigraphic Units, Southwest Wall of Trench 1 at 26EK3032, Locality 26.

Stratum	Description
1	Brown (10YR 5/3 dry) silt loam; weak to moderate, very fine granular; abundant fine to medium roots, abundant dry organics at surface; common opalite and tuff chunks and flakes.
2	Light brownish grey (10YR 6/2 dry) and brown (7.5 YR 5/4 dry) mottled, clay silt loam to silt loam; moderate, fine to medium crumb; common fine to medium roots; common fine pores; common opalite chunks and flakes, fairly common tuff clast, all scattered randomly except for a few vague subhorizontal flake lenses. The "reddish" mottling in this unit is more common to the southeast.
3	Brown to dark brown (7.5YR 5/4 to 4/4 dry) sandy clay loam to sandy clay; strong, fine to medium subangular blocky; common fine to medium roots; common to abundant medium to large subangular tuff cobbles with clayey soil matrix thinly separating the clasts. This is the weathered upper portion of the tuff bedrock. There was no cultural quarry debris evident.
4	Pink (7YR 7/4 dry) tuff sand "hash"; varies in texture and inclusions across unit, ranging from a tuff "hash" to slightly open framework tuff clasts with tuff sand matrix, but has the same distinct color throughout.
5	Brown (10YR 5/3 dry) silt loam; weak to moderate, fine to medium granular; common medium roots. This unit has a rubbly appearance with common fine to medium angular to subangular tuff clasts and common fine to medium opalite flakes and chunks.
6	This unit was similar to unit 5 but contains noticeably fewer of the larger clasts of tuff and opalite.
7	Brownish, mostly clast-supported medium to coarse subangular to subrounded tuff chunks and white to pink opalite chunks and flakes in a moderate amount of matrix of coarse tuff sand and brown (10YR 5/3 dry) silt loam.
8	Brown (10YR 5/3) silt loam; weak to moderate, fine granular; common fine roots and pores; rare fine opalite and tuff pieces.
9	Brownish open framework of medium to coarse subangular to subrounded tuff and opalite flakes, chunks, and chips. The matrix is a fairly sparse brown (10YR 5/3) silt loam.
10	Light brown (7.5 YR 6/4 dry) tuff "hash", composed of abundant fine to medium subangular tuff clasts and very fine to medium pink opalite flakes and chips.
11	Light brownish grey (10YR 6/2 dry) silt loam; weak to moderate, fine to medium granular; common fine roots and pores; rare subangular tuff clasts and opalite flakes.
12	Light brown (7.5 YR 6/4 dry) medium to coarse tuff sand mixed with light brown silt loam; abundant fine subangular to subrounded tuff pebbles and common fine pink to white opalite chips and flakes.
13	Brown (7.5 YR 5/4 slightly moist) fine to medium sand with sandy clay patches, clay with fine to medium subangular blocky structure; well consolidated; common to abundant fine to medium tuff and opalite clasts.
14	Moderate open framework of orangish to pink subangular tuff chunks, with pink to white very fine to slightly coarse chips, chunks and flakes. There is a fairly common brown (7.5YR 5/4 slightly moist) clayey sand matrix.
15	Yellowish brown (7.5YR 5/4 dry) and brown (7.5YR 5/4 dry) mottled loam and silty clay loam, respectively; clayey patches with moderate fine blocky structure; common medium opalite and tuff clasts. This unit is mixed with weathered tuff bedrock along its base.
16	Pale brown (10YR 6/3 dry) loam to sandy loam; loose to weak fine granular; abundant fine and medium roots. Fine to coarse opalite and tuff flakes and chunks are common and have a rubbly appearance similar to unit 5.
17	Yellowish brown to dark brown (10YR 5/4 to 4/4 slightly moist) silt loam to clay loam; weak to moderate fine granular to fine subangular blocky; common fine to medium roots; rare to common fine to medium tuff clasts and opalite flakes.
18	Brown (7.5YR 5/4 slightly moist) clay loam; moderate, fine subangular blocky; rare to common fine to medium roots; rare to common fine tuff and opalite clasts.
19	Strong brown (7.5YR 4/6 slightly moist) clay to silty clay; moderate to strong,fine subangular blocky; common fine roots between peds; common to abundant, coarse sand size tuff clasts and opalite chips. This unit grades down to weathered tuff bedrock where it contains coarse to very coarse angular to subangular tuff clasts loosened from the bedrock.
20	Brown (10YR 5/3 dry) silt loam; moderate, fine granular; common fine roots; rare tuff pebbles and opalite chips. This unit contains dirty Mazama ash (see unit 36).
21	Brown (10YR 5/3 dry) and dark brown (7.5YR 5/4 to 4/4 dry) mottled loam and silty clay loam, respectively; moderate, fine granular; common to abundant, fine to medium roots; common to abundant fine to coarse opalite flakes and subangular tuff clasts, in some areas forming slightly open frameworks that have subhorizontally-lying, coarse opalite flakes forming vague lenses.
22	Brown (10YR 5/3 dry) silt loam; moderate, fine granular; common coarse sand size tuff pebbles and opalite chips.
23	Open framework of pink to white opalite flakes, chunks, and chips (very fine to very coarse) with some subangular fine to medium tuff chunks. many of the flakes are thin reduction or thinning flakes and commonly lie subhorizontally. The matrix consists of fairly sparse very fine opalite chips, fine tuff sand, and loam (brown 10YR 5/3 dry).
24	Brown (10YR 5/3 dry) and brown (7.5YR 5/4 dry) mottled silt loam and silty clay, respectively; moderate, fine granular to fine subangular blocky; common fine and medium roots; common fine to medium opalite flakes and chunks and tuff clasts.
25	Moderate open framework of medium to coarse subangular chunks of tuff and rare flakes and chunks of opalite; becomes more coarse and open to the northwest; There is a moderate amount of matrix of brown (10YR 5/3 dry) silt loam.

Table 2, continued.

Stratum	Description
26	Highly banded unit of silt loam to silty clay loam to coarse tuff sand that becomes a moderate open framework to the northwest. Clasts vary from very fine opalite chip, and finer to medium subrounded tuff pebbles, to very coarse opalite chunks and flakes, and coarse subangular tuff cobbles.
27	Predominately an open framework of medium to coarse subangular tuff clasts, with a moderate amount of matrix consisting of brown to yellowish brown (10YR 5/3 to 5/4 dry) loam with coarse tuff sand and very fine opalite chips.
28	Moderate open framework of medium opalite and tuff clasts in a moderate amount of sandy (tuff) loam (yellowish brown 5/4 dry) matrix.
29	Brown (10YR 5/3 dry) silt loam, moderate, fine granular; with mottles and discontinuous bands of strong brown (7.5YR 4/6 dry) sandy clay, very fine subangular blocky; rare fine roots; common fine pores; rare to common fine opalite flakes and tuff clasts.
30	Pale brown (10YR 6/3 dry) silty tuff "hash" with abundant very fine tuff chips to medium chunks, and abundant pink to white, very fine to medium opalite chips and flakes.
31	Brown (10YR 5/3 dry) loam to silt loam; common fine opalite chips and pebbles with rarer coarse clasts of tuff and opalite; some charcoal flecking present.
32	Open framework of medium opalite chunks, with less common medium opalite flakes and subangular tuff chunks. The sparse matrix is brown (10YR5/3 dry) silt loam with common tuff sand and rare small chunks and flecks of charcoal.
33	Brown to dark brown (10YR 4/3 dry) to brown (7.5YR 5/4 dry) sandy clay loam; moderate, fine granular to very fine subangular blocky; abundant fine to medium roots; fairly common fine clasts of subrounded to subangular tuff, with rarer fine opalite chunks and flakes. Contact with unit 1 is very indistinct.
34	Brown (10YR 5/3 dry) silt loam; moderate, fine granular to weak, fine subangular blocky; common fine to medium roots and pores; common fine to medium angular to subangular tuff and opalite chunks, and rare fine opalite flakes.
35	Light brownish grey (10YR 6/2 dry) silt loam; weak, very thin platy to very fine granular; common to abundant fine roots; rare fine to medium subangular tuff clasts and fine opalite flakes.
36	Brown (10YR 5/3 dry) silt loam; moderate, fine granular to weak, fine subangular blocky; common fine roots and pores; rare to common fine to medium opalite flakes and tuff clasts. This unit also appeared somewhat ashy and it is feasible that it is equivalent to the ashy unit 20.
37	Light yellowish brown (10YR 6/4 dry) silt loam; moderate, fine granular to weak subangular blocky; common fine and rare medium roots; common fine subrounded to subangular tuff clasts, and common fine white, or rare pink opalite chunks and flakes.
38	Yellowish brown (10YR 5/4 dry) clay loam; moderate to strong, fine to medium subangular blocky; rare to common fine to medium roots; common fine subrounded to subangular tuff clasts and opalite flakes and chunks.
39	Strong brown (7.5 YR 4/6 slightly moist) sandy clay; strong, very fine subangular blocky, weak clay skins on some ped surfaces; rare fine roots; abundant fine angular to subangular tuff and opalite clasts, and common large clasts of weathered opalite and tuff bedrock. Sandy clay from this unit has filtered down into cracks of the more intact weathered bedrock below.
40	Light yellowish brown (10YR 6/4 dry) to brown (10YR 5/3 dry) mottled silt loam; moderate, fine granular to weak, very fine subangular blocky, well compacted; rare fine roots, common fine to medium pores; rare to common subangular to subrounded tuff clasts and opalite flakes. This unit is has fewer tuff and opalite clasts to the southeast, and it becomes more mottled with brown silt to the northwest.
41	Brown (10YR 5/3 dry) clay loam; moderate to strong, fine subangular blocky, well compacted; rare fine roots, common fine and medium pores; common to abundant medium to coarse subangular tuff clasts and opalite chunks, rare medium opalite flakes.
42	Dark brown (7.5YR 3/4 slightly moist) sandy clay; strong, fine to medium subangular blocky, weak clay skins on a few ped faces, very well consolidated; common to abundant coarse to very coarse, opalite and tuff clasts. There are no cultural quarry debris apparent in this unit.

Within any particular quarry pit, fill deposits tend to alternate between coarser opalite debris, fine opalite chips mixed with pulverized tuffs, or fine silt dominated units, as discussed in the previous section. This variation reflects periods of quarrying followed by periods where natural depositional processes dominated. The northern pit provides a good example of such series of events.

If, as we believe, hash is the initial debris produced in the course of pit refilling, it should be among the lowest stratigraphic units present. In pit 3 of Trench 1 this is illustrated well by units 32, 31 and 30, which lie along the base of the pit, beginning at its lowest point. Unit 30 is a typical example of hash. Following the deposition of unit 30, a slopewash dominated episode occurred that produced unit 29. This is also true of unit 24.

Overlying unit 29 is a series of units, 28-25, which are typical of the coarse deposits produced during initial reduction of larger opalite pieces. Medium to coarse tuff and opalite chunks and flakes are the common constituents of these units. These are open framework clast-supported matrices with large voids.

Within pit 2, open framework units are represented by units 7, 9, 12, 14, and parts of 10. Hash episodes are represented by unit 12 and parts of 10. Unit 10 has elements of both types of material. Units 5, 6, 8, and 11 are fine slopewash episodes. It is possible that units 5 and 6 are reworked backfill from the upslope pit.

In pit 3, the southernmost pit, unit 4 is a combination of fine hash and coarse open framework material, somewhat similar to unit 10 in pit 2. Unit 2 is an interesting combination of fine silts and opalite and tuff clasts, some of which denote vague lenses. The structure of this unit, as compared to other fill episodes, may be the result of the reworking of some quarry debris and flakes in combination with a significant slopewash component readily provided to this highest pit.

Filling in these pits appears to have progressed through various phases until quarrying ceased and natural slope processes predominated or an episode of re-excavation occurred. Evidence of such re-excavation into previous pit fill is fairly common at other sites in the Tosawihi area, but, based on available evidence here, is limited at this quarry site. A possible example of re-excavation within Trench 1 is shown in the truncation of units 22-27 and 30 by the excavation that later was filled by unit 21.

As mentioned previously, another characteristic group of deposits are those making up the colluvial talus and associated alluvial and eolian deposits found outside the pits. These are typically on the downslope side of the pit in the case of Trench 1, where units 1 and 33-38 are part of the colluvial debris. Unit 36 in this sequence and unit 20 are notable for their ashy appearance and similarity to ashy units seen in hand and backhoe excavations at Locality 27.

Continuing downslope, the remaining talus materials become generally finer and pinch out or grade into alluvial units of the southwestern edge of the meadow. Below the main accumulation of colluvium, the sandy clay of unit 39 sits on weathered bedrock. This may represent remnants of a clay-rich red paleosol that appears in other profiles at nearby sites. This paleosol is probably of Pleistocene age, as it lies below the silty ash of unit 36. The stratigraphic relationship among all these deposits is simple, with their dips running parallel to the slope, as opposed to the deposits within the pits that dip into the slope.

The profile at the northwestern end of the trench shows silt loams, units 1, 37 and 40, overlying a clay loam and sandy clay, units 41 and 42. These lower clayey units may be part of a terrace feature, with their sand content the result of alluvial deposition and their clays an indication of their relatively older age. In addition to possible alluvial terrace sediments in this trench, indications of strath terraces (cut into bedrock) also were seen. Notable topographic breaks in the bedrock profile, between 15 and 18 meters along this trench profile, may be the product of alluvial cutting. This bedrock material is actually an accumulation of fine to medium angular gravels and fine to coarse sands that are strongly silicified. This is possibly a breccia associated with faulting in the immediate area.

Tephra (volcanic ash) originating in the Mazama eruption of 6,800 years B.P. (Davis 1978; Appendix A, this report) was identified in Unit 20, and we assume the ashy appearance of Unit 36 is also due to the presence of Mazama tephra. However, a ^{14}C date (Beta-35573; see Appendix E) from charcoal in unit 31 (stratigraphically below Unit 20) returned a date of 510±80 B.P. This suggests two major possibilities. In both we assume that the colluvial deposits on the slope below pit 3 are largely intact, preserving Mazama ash (Unit 36) in its correct stratigraphic position. This in turn suggests that, prior to the excavation of the quarry pits, the entire slope was stratigraphically similar with a buried stratum containing Mazama ash. One possibility is that Stratum 20 was excavated from the slope above during the creation of pit 2 and redeposited to its present location. Another possibility is that pit 3 was originally excavated prior to the deposition of Mazama ash, then abandoned, filled, and reexcavated about 500 years ago.

In any case, Unit 37, below Unit 36, contains flakes, possibly evidence of human activity older than 6800 B.P.

Locality 27: Backhoe Trench 1

Trench 1 was placed on an approximate ENE line, just east of where Undine Creek leaves Undine Gorge to flow across the meadow (see Figure 7). Trench 1 begins at the northeastern bank of the currently active channel of Undine Creek and continues to the foot of the colluvial slope to the northeast. The location of the trench was chosen to enable us to characterize sediments deposited by Undine Creek alone, with as little overprinting from Little Antelope Creek as possible. Also, trench placement was designed to facilitate study of any subsurface indications of terracing that might be related to surface terrace features which were observed in this immediate area. These appeared as a series of two to possibly four, very low relief, topographic breaks that ran parallel to the currently active channel and to an abandoned channel.

The deposits in the 24 meter length of Trench 1 can be described as a fairly thin layer of eolian silt loam soil overlying silty sands and gravels (Figure 9; Table 3). At the southwestern end of Trench 1 the stratigraphy is very simple, with a thin organic silt loam, unit 1, overlying unit 2, a sandy silt, which in turn overlies gravels of unit 3. Unit 3 is a dark brown to strong brown mixture of poorly sorted to vaguely lenticular, medium to coarse sands with clays and fine to very coarse, subrounded to subangular gravels and cobbles. An accumulation of carbonate was noted among these gravels at the northeastern-most end of the profile. Unit 3 was the lowest stratigraphic unit in the profile and was seen throughout the length of the trench and apparently extends under the colluvial materials at the northeastern end of the trench. This indicates that past stream activity here extended closer to the bedrock ridge than at present and that some sort of terrace feature may occur under the unexposed colluvial cover. The coarseness of the clasts in unit 3, and its wide lateral extent, suggests a higher flow regime for this drainage at some time in the past. As the stratigraphy was observed going northeastward in the trench, more units appear in the profile with the addition of unit 4, a silty ash underlying unit 2, and unit 6, a silty sand with gravels that underlies unit 4. Unit 5, which is transitional between units 4 and 6, can be recognized in places. Unit 4 was sampled for analysis and contains Mazama ash (Davis 1978; Appendix A).

Table 3. Description of Stratigraphic Units, Northwest Wall of Trench 1 at 26EK3032, Locality 27.

Stratum	Description
1	Greyish brown (10YR 5/2 dry) silt to silt loam; loose to weak platy, to weak, fine granular or weak, fine subangular blocky; common to abundant fine to medium roots, abundant dry organics near surface; common subangular to subrounded fine to medium gravels; boundary gradual and irregular.
2	Greyish brown to brown (10YR 5/2 to 5/3 dry) sandy silt loam; weak to moderate, granular to subangular blocky; rare fine to medium roots; common fine to medium subrounded to subangular gravels, rare fine to medium cobbles; boundary clear and irregular.
3	Dark brown (10YR 4/3 dry) to strong brown (7.5YR 4/6 dry) medium to coarse sand, with rarer fine sand, clays and fine gravels, all subangular to subrounded. This finer matrix surrounds common medium to very coarse gravels. There are some vague pebble lines present. There is a moderate carbonate accumulation as veins and weak coatings on larger clasts in this unit at the northeast end of the trench (see unit 8).
4	Pale brown to brown (10YR 6/3 to 5/3 dry) silty ash; rare fine and coarse subrounded gravels; boundary clear and very irregular. This unit has an ashy feel and forms a competent face but powders with relative ease. To the southwest this unit becomes siltier and is undiscernible from unit 2. This unit has been identified as Mazama tephra dated to 6,800 B.P.
5	Transition unit with characteristics of both units 4 and 6.
6	Dark greyish brown (10YR 4/2 dry) silty fine to medium sand, with common fine to medium subrounded to subangular gravels; boundary clear and irregular. This unit grades out of the profile to the southwest at about 12 meters and to the northeast at about 17 meters.
7	Brown (10YR 5/3 dry) silt loam; weak granular; rare fine to medium subangular to subrounded gravels; boundary gradual and irregular.
8	Brown (10YR 4/3 dry) silt loam; loose to weak granular; rare to common fine to medium subrounded gravels; rare to common caliche veins, with moderate acid reaction that increases downward to its strongest point at the contact with unit 3; boundary is clear and fairly smooth.

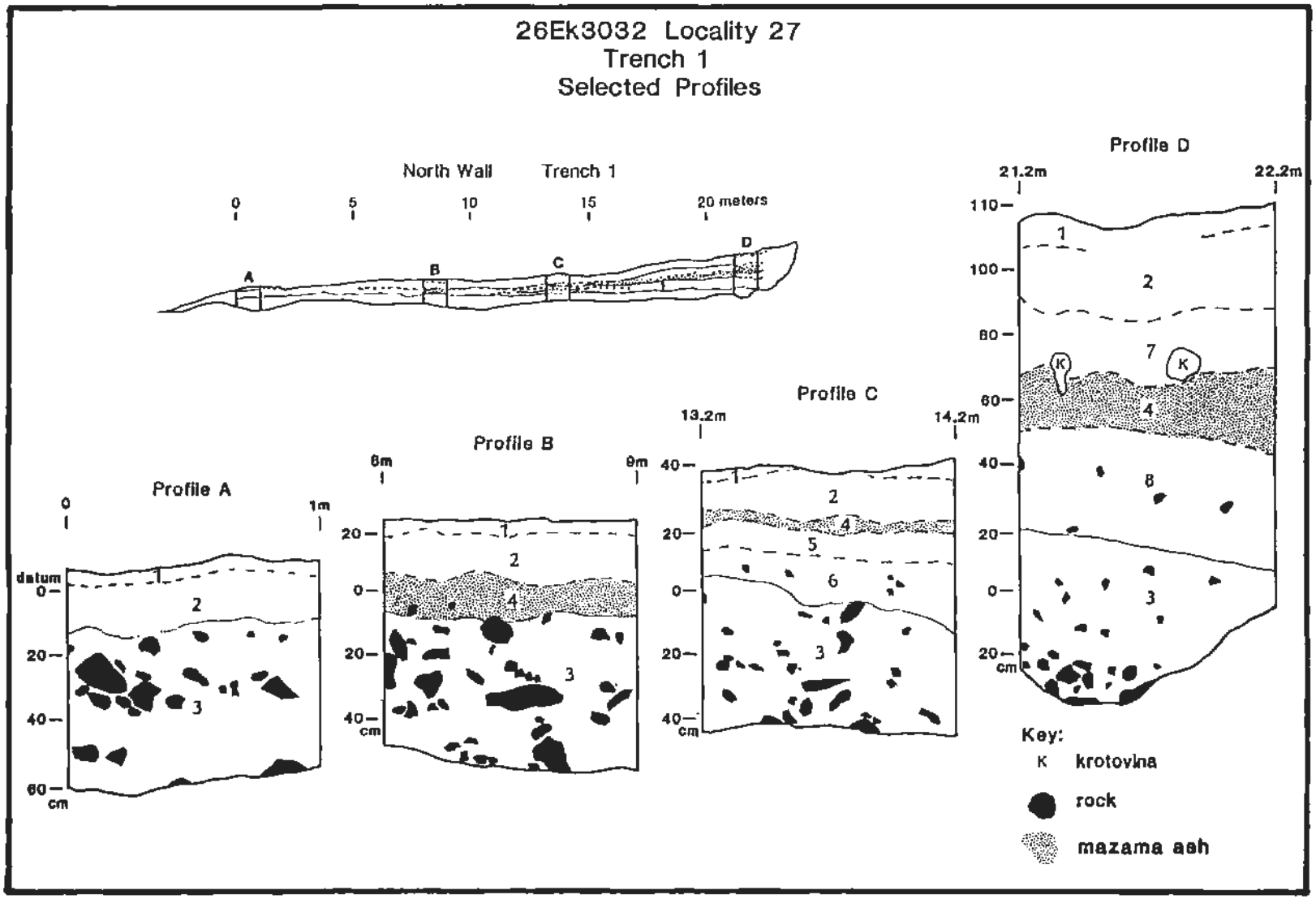


Figure 9. Backhoe Trench 1, selected profiles, 26Ek3032, Locality 27.

Units 7 and 8 are present only at the northeastern end of the trench, while units 5 and 6 disappear. The extent of unit 7, a brown silt loam, might be explained by a past terracing event that stripped it away in the area of the southwestern part of the trench. Alternatively, this unit may be a slopewash deposit that never reached farther down slope. Unit 8, a silt loam with gravels, also may have origins similar to unit 7.

Besides the upper silt loam and ashy units in this area, the deposits in Trench 1 are primarily of alluvial origin, as demonstrated by common subrounded gravels and cobbles. Although no clear evidence of channel cutting or filling could be defined in the subsurface profiles, such alluvial activity is suggested by the upper surface of unit 3, which is irregular and appears to have been eroded. Also, that units 4-8 are not continuous throughout the profile suggests they may have been partially eroded away. Unit 6 may be a sandbar deposit or channel fill.

In summary, Trench 1 contains alluvial depositional units of varying coarseness, overlain by finer silts of eolian and alluvial origin. The most distinct unit in this profile, besides the silty ash, is unit 3. Coarse, somewhat reddish colored sands, clays, gravels and cobbles such as these, appear to underlie most of the site area. Trenches 2 - 4 (see below) and various excavation units show similar deposits. Unit 3 lies below unit 4 (containing Mazama ash) and thus is earlier than 6,800 B.P. This dating accords with the supposition that unit 3 was deposited at some time in the Pleistocene during a period of higher stream discharge than at present. However, there were periods of erosion in this stratigraphic interval lying below the Mazama tephra, especially as indicated by unit 3. This is interesting in light of studies by Haynes (1968) and Madsen (1981) suggesting that in the late Pleistocene and early Holocene, before the Mazama eruption, deposition was predominant in the alluvial systems they studied. Apparently, erosion was also an active, if not predominant, process during this time in the drainage of Undine Creek.

Locality 27: Backhoe Trenches 2 and 3

Trenches 2 and 3 (profiles not shown) are a set of roughly right angle cuts located in the west central area of the meadow (see Figure 7). They were placed here in order to discover any observable interactions between sediments of the two drainages in the area. However, the backhoe was unable to cut through coarse cobbles encountered at shallow depth, and the trenches were only 20 to 80 cm deep. Sediments observed can be summarized as follows. The lowest observed stratum is a coarse layer of subrounded to rounded pebbles and cobbles in a matrix of silty to sandy clays. This coarser unit is generally overlain by clays and silty clays with rarer gravels. Overlying these units are silt loams with pebbles and gravels, some occurring as vague lenses. These units appear to be a combination of sediments of eolian and alluvial origin. Although the deposits in these trenches are clearly the result of sedimentation by the two creeks, segregating them according to which drainage was responsible for a particular deposit was not possible.

Locality 27: Backhoe Trench 4

Trench 4, which runs along a NNW line roughly parallel to Trench 1 at Locality 26, was placed in order to examine an inset alluvial deposit. The deposit was indicated by a vegetation change where the sage brush appeared to be stunted and the grasses were particularly sparse, suggesting some differences in soil or drainage conditions. In addition, there was a break in topography where the steeper relief of the middle and upper hillslope was interrupted by the more gently sloped pocket of materials lying against it.

In Trench 4, evidence for the former position of the hillslope, underneath the inset alluvial deposit, is indicated by the truncation of a carbonate horizon in unit 10 at the southeastern end of the trench (Figure 10; Table 4). Here, the carbonate horizon is part of a reddish clayey paleosol which is commonly found in the subsurface at nearby localities. The truncation of this horizon suggests that former stream activity, at a higher base level, has eroded into the hillside, apparently creating a terrace cut. The clay units, 8 and 9, above this truncated horizon do not appear eroded. Possibly these units were alluvial sediments emplaced after the carbonate truncation episode, and later weathered to clays. There are gravels and cobbles within the clays, suggesting alluvial origins. Another, possibly older, erosional episode is indicated by a break in the relief of the cobbly "bedrock", which itself is probably an older terrace deposit. Clays of unit 6 overlie it. This break occurred about 6.5 meters along the profile from the northwestern end of the trench.

Table 4. Description of Stratigraphic Units, Northeast Wall of Trench 4 at 26EK3032, Locality 27.

Stratum	Description
1	Brown (10YR 5/3 dry) silt loam; weak to moderate, medium subangular blocky; abundant fine roots; rare fine to medium subrounded to subangular gravels; boundary gradual and wavy to irregular.
2	Dark greyish brown (10YR 4/2 dry) silt loam; weak to moderate, medium subangular blocky; common fine roots; rare fine to medium subrounded gravels; boundary clear and smooth.
3	Yellowish brown (10YR 5/4 dry) loam; moderate, medium to coarse subangular blocky; rare to common fine to medium subangular to subrounded gravels; common fine roots; boundary clear and irregular.
4	Light yellowish brown (10YR 6/4 dry) silt loam, with ash; moderate, medium subangular blocky; rare fine roots; rare fine subrounded gravels; boundary clear to abrupt and smooth to irregular.
5	Light yellowish brown (10YR 6/4 dry) silt loam, with some ash; moderate, medium to coarse angular blocky; rare to common fine to medium subangular to subrounded gravels and rare fine subrounded cobbles; boundary clear and irregular.
6	Brownish yellow (10YR 6/6 dry) clay; strong medium to coarse angular blocky; common fine to medium subangular to subrounded gravels and fine subrounded cobbles; boundary clear and slightly wavy.
7	Yellowish brown (10YR 5/8 dry) silty clay; moderate to strong, fine to medium subangular blocky; abundant fine to medium rounded to subrounded gravels and common fine subangular cobbles; boundary unexposed.
8	Yellowish brown (10YR 5/8 dry) clay; strong, medium columnar; rare fine to medium roots; rare to slightly common fine to medium subangular to subrounded gravels and rare fine subrounded cobbles; boundary clear and irregular.
9	Yellowish brown (10YR 6/4 dry) silty clay; moderate, medium subangular blocky; common fine to medium subrounded to subangular gravels, and rare fine subrounded cobbles; boundary clear to abrupt and irregular.
10	Light yellowish brown (10YR 6/4 dry) clay; strong, medium angular blocky; common to abundant (in lower portion of unit) fine subrounded gravels to fine subrounded cobbles; very strong acid reaction on fairly strongly developed carbonate horizon; boundary unexposed.

The clay units mentioned above appear to be part of the inset alluvial deposits detected on the surface. They are not, however, exposed at the surface. Instead, they are covered by silt loams and loams similar to those found elsewhere at this site. In fact, midway along the profile, clays of unit 8 grade into the silty units 2-4, perhaps the result of later alluvial activity that cut into the clays and then incorporated them into the more silty materials. Colluvial processes also may have had a part in this mixing. Unit 9 clays, which seem equivalent to those of unit 6, appear continuous throughout the profile. After examination of the subsurface deposits, it was still unclear as to why the surface vegetation was so sparse; perhaps the clays somehow affected soil drainage.

In summary, the stratigraphy in Trench 4, Locality 27, showed alluvial sediments that had been deposited on an apparent terrace cut into older sediments that had a soil with a calcic horizon partly developed in them. Subsequently, the overlying sediments were weathered to clays, and then eroded and incorporated into adjacent silts. These then were overlain by silts and silt loams.

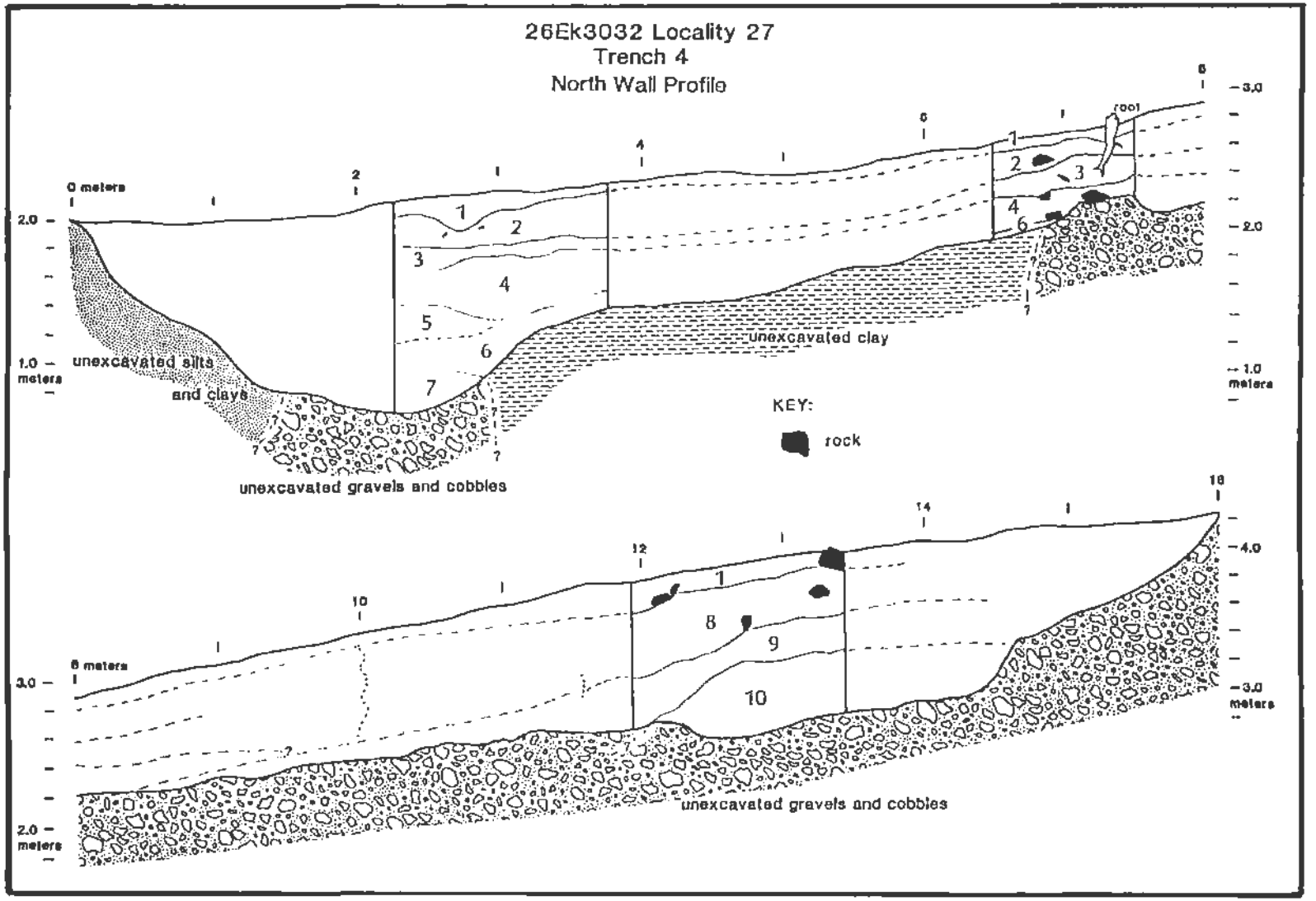


Figure 10. Backhoe Trench 4, north wall profile, 26Ek3032, Locality 27.

Locality 27: Excavation Unit 20

EU 20, a hand dug, 1 m x 1 m excavation unit is approximately 140 cm deep. It is located on a small topographic bench adjacent the west bank of Little Antelope Creek near the southwest corner of the meadow (see Figure 7). The bench is part of a small alluvial terrace related to modern stream activity. Immediately west of EU 20 is a steep, southwest aspect hillslope.

The sediments encountered in this excavation have a simple relationship that is modified by animal burrows (Figure 11, Table 5). Like other profiles examined at this site, the ground surface is covered by a silt loam with common dry organic matter. This surface unit is underlain by two silt loam units distinguished by color. Below these is a transitional unit comprised of silt loam with some ash. This horizon overlies unit 5, a distinctly ashy unit with some silt. Unit 5 contains Mazama tephra and is therefore dated to around 6,800 B.P. (Davis 1978; Appendix A). Below the Mazama tephra are two alluvial units, a gravelly silt loam and an underlying cobbly sandy loam.

Of all the profiles examined at this site, EU 20 contains the cleanest, least silty example of the Mazama tephra. The occurrence of the tephra here and in unit 4 of Trench 1, Locality 27 (see Figure 9), provides a good stratigraphic time marker across the site.

Table 5. Description of Stratigraphic Units, West Wall of Excavation Unit 20, 26EK3032, Locality 27.

Stratum	Description
1	Light Grey (10YR 6/1 dry) silt loam; fine platy to medium subangular blocky; abundant fine roots; abundant fine to medium subangular gravels; boundary clear and smooth.
2	Light brown (10YR 6/2 dry) silt loam; fine subangular blocky; abundant fine roots; common burrows; abundant fine to medium subangular gravels; boundary gradual and irregular.
3	Light yellowish brown (10YR 6/4 dry) silt loam; fine subangular blocky; common fine roots; common burrows; abundant fine to medium subangular gravels; boundary gradual and irregular.
4	Very pale brown (10YR 7/3 dry) silt loam with ash; fine subangular blocky; rare fine roots; common burrows; common fine subangular gravels; boundary gradual and smooth.
5	Light grey (10YR 7/2 dry) ash with silt; fine subangular blocky, forming competent face but powders easily; common burrows; rare fine subangular gravels; boundary clear and smooth.
6	Very pale brown (10YR 7/3 dry) loam; medium angular blocky; common burrows; common rounded to subangular fine to coarse gravels; boundary clear and irregular.
7	Yellowish brown (10YR 5/6) sandy loam; fine angular blocky; common rounded to subangular fine to coarse gravels, abundant rounded to subrounded cobbles, common rounded to subrounded boulders; boundary unexposed.

The profile in EU 20 is the product of both alluvial and eolian input. Units 6 and 7 have conspicuous subrounded to rounded gravels and cobbles, resembling alluvial sediments found below the Mazama tephra elsewhere at the site. Above the tephra are silt loams with subangular to subrounded gravels that are a combination of colluvial slopewash sediments and eolian silts, probably reworked by stream activity. It is interesting to note the similarity of the profile in EU 20 with that of profile "D" of Trench 1, Locality 27. Each profile is situated between a modern stream channel on one side and a steep colluvial hillslope on the other, suggesting that depositional processes across this site are consistent within similar geomorphic settings.

In summary, EU 20 has a profile with seven recognizable stratigraphic units. The upper four are predominately silty units with subangular, colluvially derived, gravels. These are followed by an underlying unit containing Mazama tephra. Below this marker horizon are two alluvial units with common rounded to subrounded gravels and cobbles.

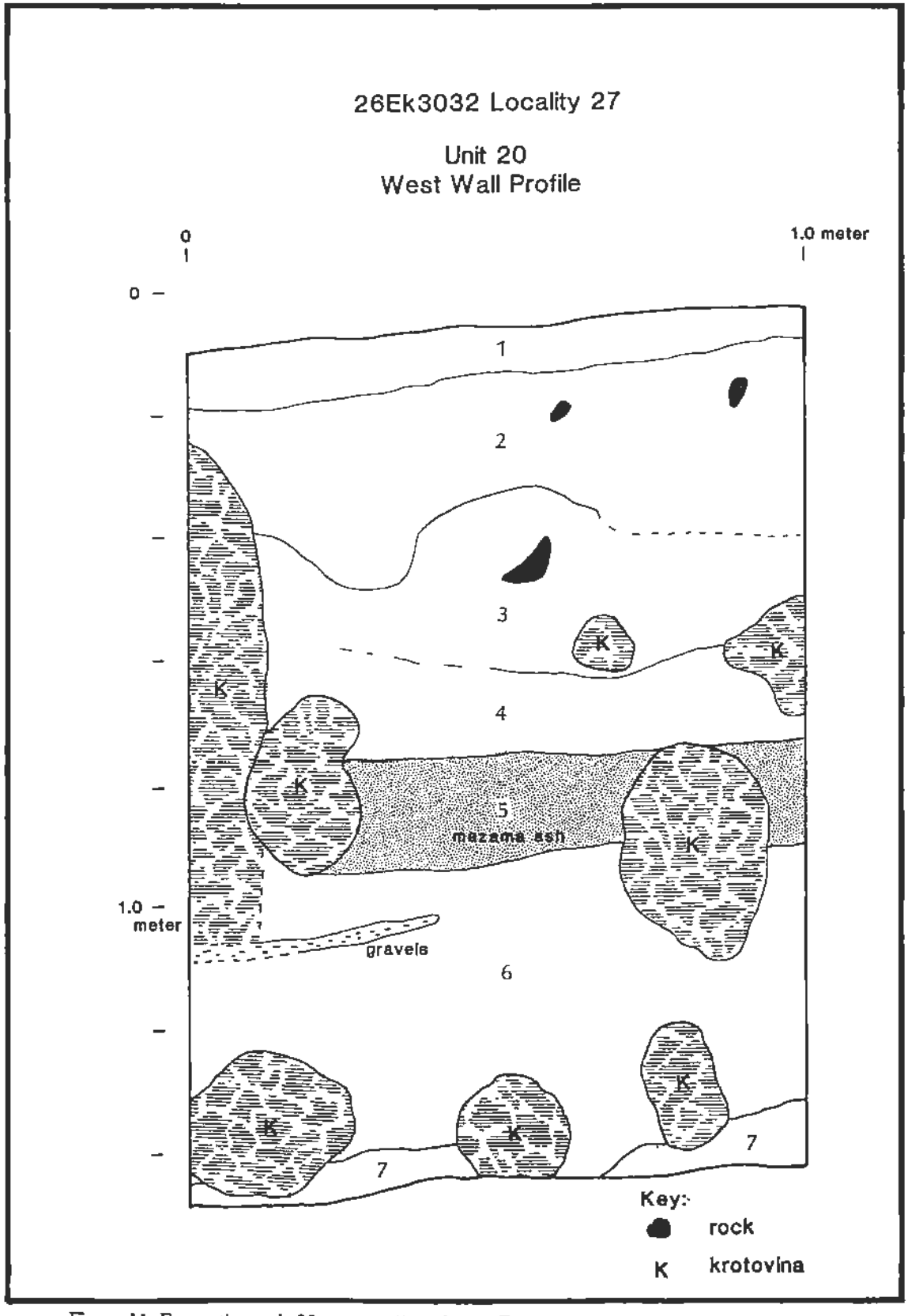


Figure 11. Excavation unit 20, west wall profile, 26Ek3032, Locality 27.

Summary of Backhoe Trench Analyses for Localities 26 and 27

Five backhoe trenches were dug at Localities 26 and 27 in order to study subsurface evidence of past geomorphic activity and cultural quarrying episodes. Three separate quarry pits were revealed in Trench 1 of Locality 26. They contained typical filling cycles of roughly alternating quarrying debris and natural slopewash sediments. Based on the superposition of Mazama tephra, one pit appears to predate 6,800 B.P., but this is contradicted by a ^{14}C date of 510 ± 80 B.P. Stratigraphic units, occurring downslope from these pits, consisted of sandy and silty clays overlain by silt loams. The silty units were a combination of slopewash and alluvial materials. The clays appeared to be strongly weathered alluvial and slopewash materials. These clays and silt loams are roughly correlated to similar sediments seen in Trench 4, Locality 27 (Table 6).

Table 6. Stratigraphic Unit Correlation by Trench, Localities 26 and 27.

Trench 1, Loc. 26	Trench 4, Loc.27	Trench 1, Loc. 27
36, 37 ?	4	4
40	5	-
41	6	-
42	7 ?	-

These sediments, which were interpreted as terrace fill insets overlying an older erosional terrace cut, occur in a blanket-like deposit running along the base of the hillslope. They are likely to be older than the quarrying activity on this hillslope, as quarry debris overlies them, and are probably of Pleistocene age. The terrace cuts in the bedrock and consolidated cobbly material within Trench 1 at Locality 26 and Trench 4 at Locality 27 may be correlated. The cut that is between 15 and 16 meters in Trench 1 is roughly correlated with the break in cobbly "bedrock" that is near 7 meters in the profile of Trench 4. The cut at about 9 meters in Trench 1 may be matched with the truncation of the calcic horizon that is at about 12 meters in Trench 4.

The profile at the northwestern end of Trench 1, Locality 26, is different from those of EU 20 and Locality 27. Here, stratigraphic unit 36 containing Mazama ash grades into unit 37. Unit 37, therefore, can be considered equivalent to unit 36 and thus correlates with unit 5 of EU 20. On the other hand, units above and below the Mazama tephra level in Locality 26, are only roughly equivalent to units in other localities. For instance, below the tephra level in Trench 1, Locality 26, there is another silt loam unit and finally two clayey units that do not match well with units 6 and 7 in the EU 20 profile. This probably is due to differences in geomorphic setting, including the presence of quarry pits upslope in Trench 1, Locality 26, and the relatively smaller scale of the hillslope. Although the quarrying debris from the pits provided abundant clasts to the slopewash sediments, the pits would have inhibited slopewash by acting as sediment traps. This may explain the fewer number of stratigraphic episodes recorded in this section of the profile compared to those seen in EU 20. In addition, there was more alluvial deposition of rounded to subrounded gravels and cobbles in the EU 20 lower elevation profile, compared to the more pedogenically weathered profile at Locality 26 where more clays and relatively fewer coarse alluvial sediments are present below the Mazama tephra level. Thus, the resulting differences between the profiles seen in EU 20 and Trench 1, Locality 26, can be explained by the varied input of alluvial, colluvial, weathering, and cultural processes.

Trench 1, Locality 27, also exhibits alluvial sediments. The most notable unit in this profile is number 3. These brown gravely, clayey sands appear to be part of a fairly consistent and extensive gravel and cobble deposit(s) that underlies much of the meadow area. The reddish color and eroded upper surface suggest this unit is fairly old. It might be correlated roughly with the clayey units that occur in Trench 1, Locality 26; Trench 4, Locality 27, and Trench 2 and 3, Locality 27.

Projectile Points and Preforms

All the projectile points (n=8) and all the preforms (n=5) in the test sample were recovered from Locality 27. The points were classified with reference to Thomas's (1981) key. Attributes recorded for comparisons are presented in Appendix D. Results reveal that only two of the specimens are attributable to the post-Mazama types considered by Thomas. One other classifiable specimen, a stemmed series point, pre-dates types encompassed by Thomas's scheme (Layton 1979; Clewlow 1968; Frison 1978).

Two points are unclassifiable according to Thomas and three specimens are too fragmentary for classification. Table 7 summarizes classification of the projectile points and photographs of select points and preforms appear in Figure 12.

Table 7. Summary Data for Projectile Points from 26Ek3032, Locality 27.

Specimen No.	Point Type	Material	Fragment Type	Use Data	Loc. of Rework
6062-2	Gatecliff Split Stem	Opalite	Complete	Reworked/Used	
01-130	Large Side-notched	Obsidian	Base Missing	Reworked/Used	Lateral
01-045	Great Basin Stemmed	Opalite	Stem/Base		
6521-1	Out of Key	Obsidian	Complete		
6401-1	Out of Key	Opalite	Stem/Base		
6122-1	Fragment	Opalite	Base Missing	Reworked	
6001-17	Fragment	Obsidian	Mid-Section		
6361-6	Fragment	Opalite	Tip	Reworked/Used	Lateral

Series Classification

Specimen 6062-2 is a Gatecliff Split Stem point (GSS). Its tip is broken and the lateral margins have been reworked. The point was produced on an opalite flake blank, with minimal modification along one margin of its ventral surface. Reworking is absent from its slightly contracting, deeply notched stem. The Gatecliff Series includes a number of stemmed and split-stemmed variants found throughout the Great Basin. The series dates between approximately 3000 and 1300 B.C. (Thomas 1981:36).

A Large Side-notched point (LSN, 01-130) also displays evidence of reworking (Figure 12a). Broken at the tip and neck, it exhibits retouch near the apices of its distal margins that produces a slight shoulder along one edge and a shallow concavity along the other. The point was made on an obsidian flake, with both surfaces reduced to form a lenticular cross-section. Although the base is missing, size and remnant distal shoulder allow classification of the point. Thomas (1981:19) argues that Large Side-notched points are poor time-markers in the Great Basin but suggests they most likely pre-date A.D. 1300.

Specimen 01-45 (Figure 12d), broken below the shoulder, appears to be the basal portion of a Great Basin Stemmed Series (GBSS) point. Basal grinding is present along two-thirds of the artifact margin. Unlike the other projectile points from Locality 27, this specimen appears to have been manufactured from a small biface preform

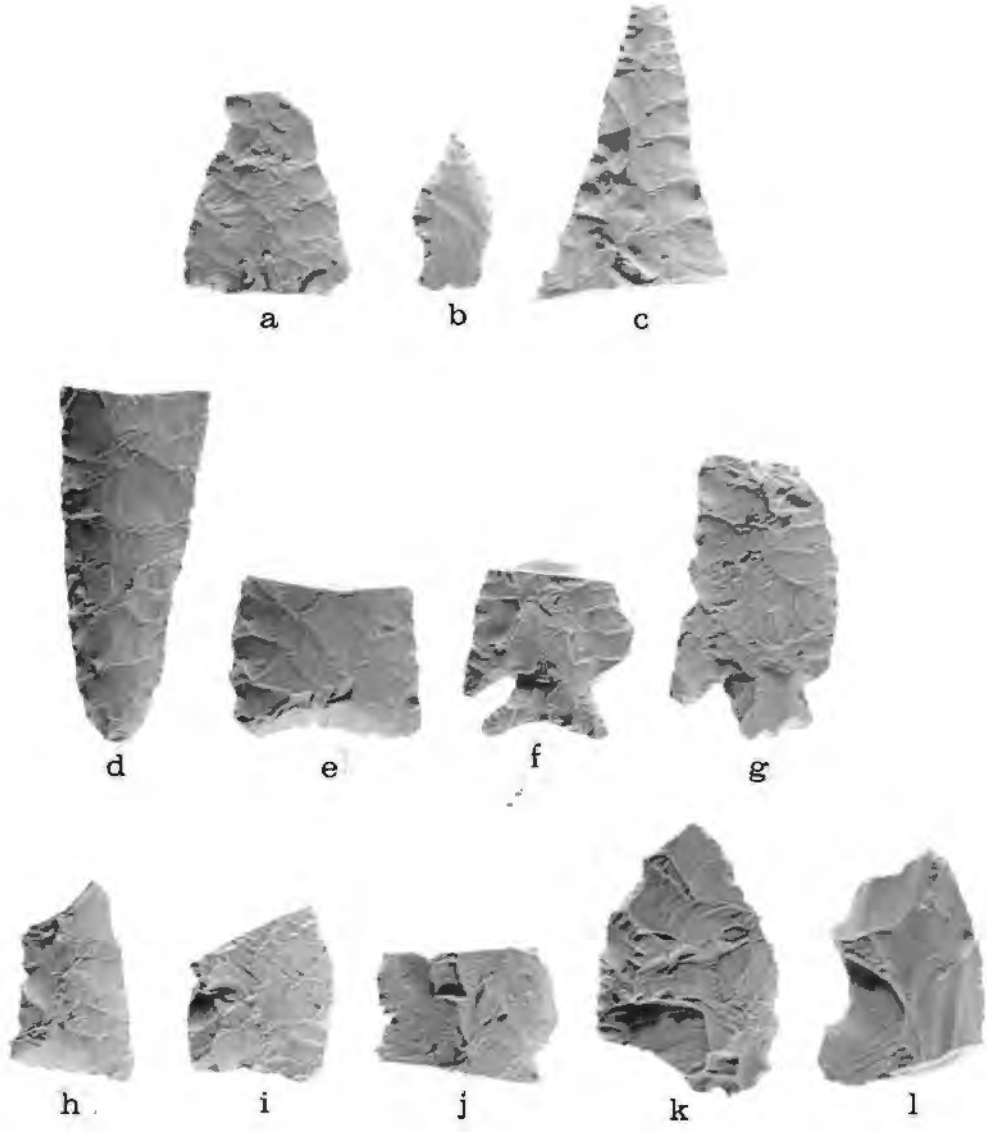


Figure 12. Selected points and preforms from 26Ek3032, Locality 27 and 26Ek3516. Points: a. L27-10-130; b. L27-6521-1; c. L27-6122-1; d. L27-01-45; e. L27-6401-1; f. 26Ek3516-01-15; g. 26Ek3516-01-9. Preforms: h. L27-6380-5; i. L27-6182-2; j. L27-6143-1; k. L27-6143-2; l. L27-6520-1.

preform rather than directly on an unworked flake. Both surfaces are fully reduced, producing a thick lenticular cross-section. The Great Basin Stemmed Series is of considerable antiquity, dating between 8,000 B.C. and 6000 B.C. (Layton 1979; Clewlow 1968; Tuohy 1968, 1974).

Other Points

Two projectile points cannot be classified by Thomas's key. Specimen 6521-1 is small and leaf-shaped in outline, with slight shoulders and a straight base (Figure 12b). Produced on a small obsidian flake, reduction scars on its dorsal surface carry across the artifact midline. Reduction is minimal along the margins of its ventral surface. A broad, shallow notch along one margin precludes its classification as a Cottonwood Triangular type.

Specimen 6401-1 (Figure 12e) is a concave based basal fragment, square in outlined and broken with a snap fracture that could have occurred during manufacture, use, or post-deposition. It is made of white opalite, exhibiting roughly parallel flaking perpendicular to the longitudinal axis of the point.

Of the three pieces too highly fragmented for typological assessment, one (6122-1) may be the tip of a large projectile point or a reworked drill. Both edges are extensively resharpened creating a slightly concave margin (Figure 12c). Specimen 6361-6 is a reworked opalite point tip with an asymmetric outline. The remaining fragment (specimen 6001-17) is an obsidian point midsection. One margin is broken, and no evidence of reworking occurs.

Preforms

Preforms are unifacially or bifacially modified flakes, reduced by pressure flaking to produce a thin cross-section and symmetrical outline. Like biface production, preform manufacture follows a reduction sequence which results in a nearly finished form that may be similar to projectile points in size, shape, and degree of reduction, but lacks final hafting elements. In addition to projectile points, preforms may be made into drills, gravers, knives or other formalized bifacial tools.

The five preforms recovered are pictured in Figure 12 h-l. In outline and cross-section, three of these (6360-5, 6182-2, 01-96) appear to have the general shape of Cottonwood or Desert Side-notched projectile points. Specimen 6360-5 (Figure 12 h) is triangular in outline with a broken tip. Bifacial thinning has resulted in a thin, lenticular cross-section. A grainy inclusion precluded further reduction of one margin. Specimen 6182-2 is also triangular in outline. An attempt to thin a small protuberance along one margin appears to have caused a diagonal fracture near the artifact midline. The entire margin of the dorsal surface and one margin of the ventral surface are reduced. Thinning along the proximal end has produced a slightly concave base. On specimen 01-96, steeply angled flake scars occur along the dorsal margins and all but a small portion along the lateral margin of the ventral surface is reduced. The artifact is roughly triangular in outline, with a rounded tip and straight base. An arris, or dorsal ridge, located near one lateral margin, creates an asymmetrical, triangular cross-section. The maker's inability to thin the arris may have caused the discard of this artifact.

Partial reduction of the remaining two (6143-2, 6520-1) suggests they are early stage preforms; their intended terminal forms are unknown. Specimen 6143-2 (Figure 12k) is broad and somewhat triangular in outline with a sinuous edge. The prehistoric knapper's inability to reduce a bulbar platform on its ventral surface may have resulted in its discard. Specimen 6520-1 (Figure 12l) is fragmentary, with only one lateral margin intact. Flake scars are present only on the ventral surface.

Chronological Implications

Comparison of the projectile point assemblage from Locality 27 with time markers recovered from other sites in the eastern periphery of the Tosawihi Quarries hints at intriguing chronological implications for the use of the locality. Although few in number, the classifiable projectile points from Locality 27 signal comparatively early occupation of the place, from the Pre-Archaic (GBSS) through the Early and Middle Archaic (GSS and LSN). The three small triangular preforms (possibly Late Archaic arrowpoint preforms) offer only equivocal evidence for more recent visitation. By contrast, projectile points (supported by radiocarbon assay and ceramics) from sites in the USX-East relate overwhelmingly to use of the area after A.D. 1300 (Elston and Drews 1991).

This, coupled with the presence of Mazama tephra, suggests that Locality 27 holds data that would allow examination of the earliest periods of use of the Tosawihi vicinity. In particular, it may contain information about the so far only minimally explored interval preceding the intensification of toolstone extraction that typifies land use during Desert times (see Chapter 5, below).

Bifaces

Bifaces are produced through the systematic removal of flakes from a piece of toolstone. Reduction is continuous, but stages can be defined on the basis of points in the reduction sequence where a flintknapper changes reduction goals or techniques (cf. Callahan 1979:33-37). Stage 1 bifaces are unmodified flake blanks, transported from a primary quarry context and intended for bifacial reduction. Stage 2 bifaces have initial margin preparation and removal of irregularities. Stage 3 bifaces have begun to be thinned and have preliminary margin shaping, while Stage 4 bifaces generally are more symmetrical, with straight edges and faces that have been further thinned. Based on the extent and intensity of reduction, these stages are subdivided in order to examine fine-grained distinctions within and between steps in biface manufacture. Stages 2 and 4 are divided into early and late sub-types. Stage 3 bifaces, the predominant forms to be found in the area, have been segregated into early, middle, and late components.

Fifty-nine bifaces were recovered from Locality 26 and 278 from Locality 27. As might be predicted from its function as a toolstone source, specimens recovered from Locality 26 represent somewhat earlier manufacturing stages than do those from Locality 27 (Table 8; cf. Bloomer, Ataman and Ingbar 1991). A large proportion (62.7%) of the biface assemblage from Locality 26 is classified as early Stage 3 and no Stage 4 bifaces are present. At Locality 27 on the other hand, 41.4% are early Stage 3 specimens. These are accompanied by a high incidence of middle and late Stage 3 pieces as well as several early and late Stage 4 bifaces.

Table 8. Biface Production Stages at 26Ek3032, Localities 26 and 27.

	STAGES									
	Stage 1	Early 2	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Indeterminate	Total
Frequencies										
L-26	-	2	8	37	10	2	-	-	-	59
L-27	1	11	23	115	44	21	10	5	48	278
Total	1	13	31	152	54	23	10	5	48	337
Proportions										
L-26	-	3.39	13.56	62.71	16.95	3.39	-	-	-	100.0
L-27	0.36	3.96	8.27	41.37	15.83	7.55	3.60	1.80	17.27	100.0

As noted in Chapter 2, the drainages that cross Locality 27 contain angular and rounded opalite cobbles. These served as an easily accessible toolstone source and were used as blanks for 8.6% of the bifaces produced at Locality 27 (Figure 13); however, none of the bifaces from Locality 26 were made on stream cobbles. Flakes detached directly from outcrops or from extracted blocks, also served as blanks for biface production. The use of flake blanks can be recognized only on early stage bifaces and the proportion of bifaces made on flake blanks is similar in the two assemblages, roughly 12%.

On the basis of the colors and textures of the opalites that comprise them, the assemblages from both localities appear to contain toolstone derived from the pits at Locality 26. The assemblage at Locality 27, however, exhibits an even wider variety of colors than that from Locality 26, suggesting that additional toolstone almost certainly was obtained from other, more distant Tosawihi sources for reduction at Locality 27.

The frequency of heat-treatment (thermal alteration to improve flaking quality) in the two biface assemblages also differs (Table 9). In the Locality 26 biface assemblage, 3.3% of the pieces are heat-treated, while 30.5% of the Locality 27 assemblage was heat-treated. Later stages of bifaces tend to be heat-treated more often than do early stages. In the Locality 27 assemblage, a small number of bifaces were heat-treated as blanks before reduction was initiated, but the vast majority of heat-treated pieces were heat-treated after some reduction had taken place. No bifaces were made on blanks that had been detached from heat-treated cores.

Table 9. Heat-Treatment of Bifaces from 26Ek3032, Localities 26 and 27.

	STAGE									
	Stage 1	Early 2	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Indeterminate	Total
Locality 26										
Heat-Treated	-	-	-	1	1	-	-	-	-	2
Possibly HT	-	1	-	2	3	1	-	-	-	7
Not Heat-Treated	-	1	8	34	6	1	-	-	-	50
Total	0	2	8	37	10	2	-	-	-	59
Locality 27										
Heat-Treated	-	1	1	23	20	14	6	5	15	66
Possibly HT	-	1	1	12	4	4	-	-	12	30
Not Heat-Treated	1	9	21	80	20	3	4	-	21	59
Total	1	11	23	115	44	21	10	5	48	278

The differences between the reduction stages and the incidence and nature of heat-treatment in the Locality 26 and 27 biface assemblages are distinct and correspond to patterns observed in the rest of the Tosawihi vicinity (cf. Bloomer, Ataman and Ingbar 1991). Reduction of bifaces at sites immediately adjacent quarries tends to be early with few pieces heat-treated. At sites more distant from toolstone sources (and especially at places that exhibit residential qualities) biface production tends to be carried further through the reduction sequence and a greater proportion of specimens were subjected to heat-treatment.

Flake Tools

Thirty-eight flake tools (excluding projectile points) were recovered from Locality 27. Of these, 34 are made of opalite and 4 are obsidian (Table 10; Figure 14). Tool types in the collection include scrapers, pointed tools (drills, perforators, or gravers), notched flakes and bifacially-worked pieces (knives, percussion tools, etc.). The most elaborately formed tools, scrapers and pointed tools, make up a considerable portion of the assemblage. None of the pieces is clearly temporally diagnostic, but one, a crescent-shaped scraper (Figure 14j) is similar to specimens attributed to Paleoindian assemblages in the Great Basin (Willig 1988; Hutchinson 1988).

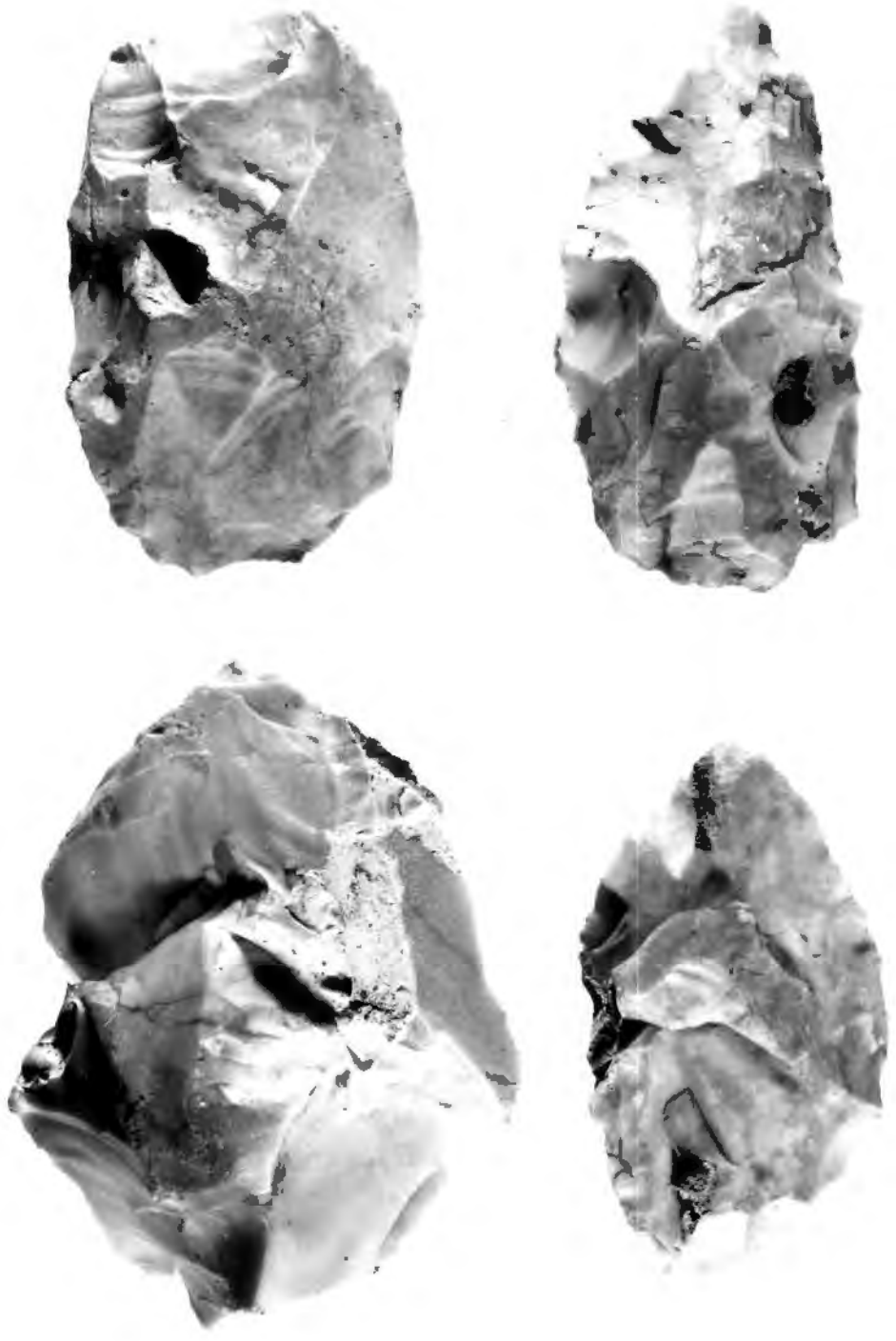


Figure 13. Selected cobble bifaces from 26Ek3032, Locality 27.

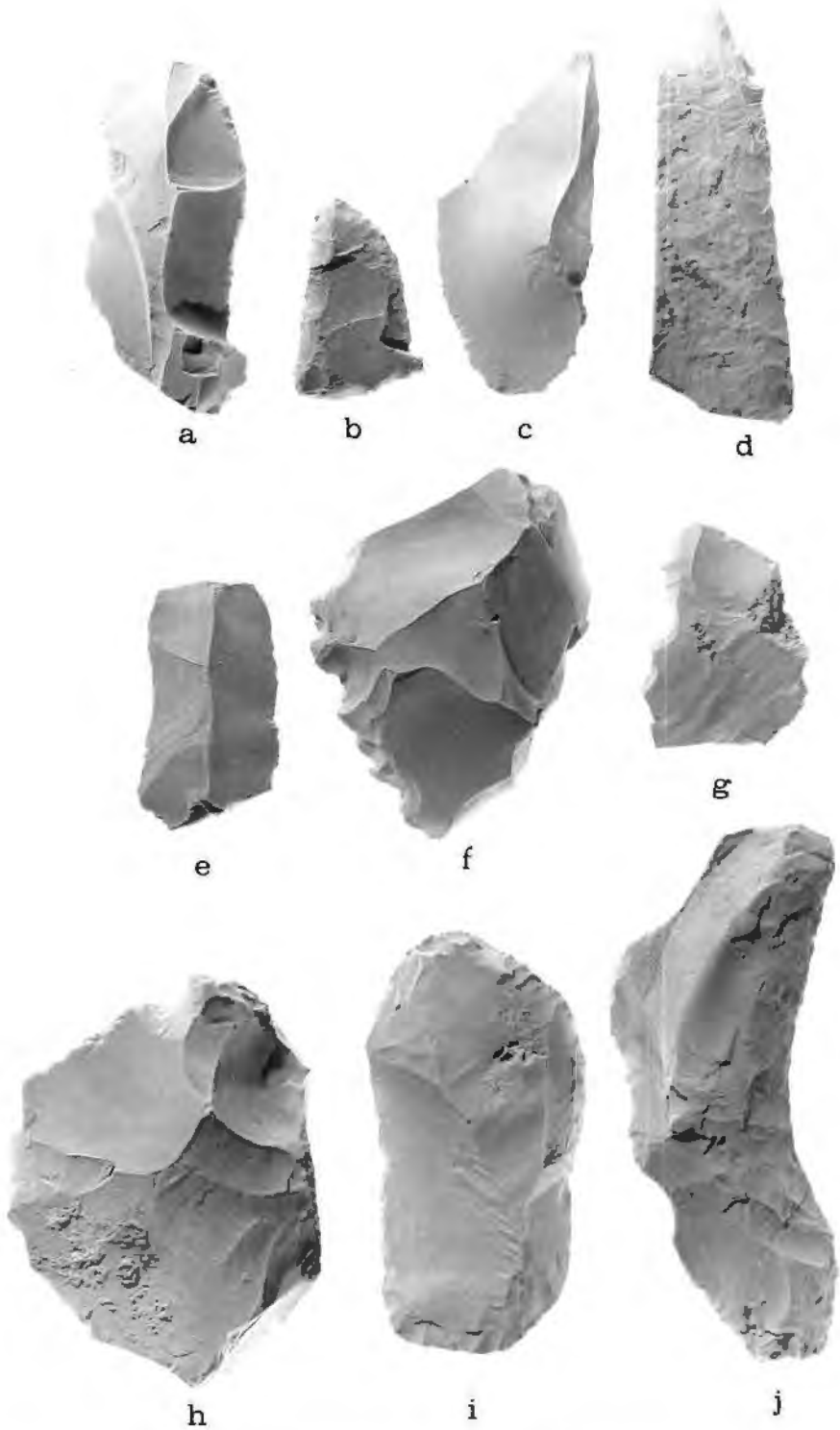


Figure 14. Selected flake tools from 26Ek3032, Locality 27. a. retouched flake; b-d. pointed tools (c. is obsidian); e. obsidian retouched flake; f. denticulate; g. notch; h-j. scrapers.

Table 10. Flake Tools from 26Ek3032, Locality 27.

TOOL TYPE	RAW MATERIAL Opalite	Obsidian	Total n	%
Side Scraper	1	-	1	2.63
End Scraper	4	-	4	10.53
Misc. Scraper or Fragment	5	-	5	13.16
Symmetrically Pointed - Elongate	-	1	1	2.63
Symmetrically Pointed - Short	3	-	3	7.89
Asymmetrically Pointed	1	-	1	2.63
Notch/Denticulate	5	-	5	13.16
Microdenticulate	1	-	1	2.63
Bifacially Retouched Irregular Flake/Chunk	3	-	3	7.89
Pressure-Flaked Tool Fragment	2	1	3	7.89
Flake w/Continuous Unifacial Retouch, 1 Edge & Fragment	5	1	6	15.79
Flake w/Continuous Unifacial Retouch, Multiple Edges	1	1	2	5.26
Flake w/Variable Retouch Pattern, Multiple Edges	2	-	2	5.26
Unifacially Retouched Crude Flake/Chunk	1	-	1	2.63
TOTAL	34	4	38	100.00

Flake tools from Locality 27 are made on several types of blanks, including biface thinning flakes (62.5%), blade-like flakes, simple flakes, and large chunky flakes. Retouch was produced by both percussion and pressure techniques, as well as by use. The variety of colors and textures of opalite from which the flake tools were made exceeds the range of materials observed in both the Locality 26 and 27 biface and debitage assemblages. Thirty-nine percent of the flake tools are of colors other than white, beige or grey.

The functions represented by these flake tools are diverse. Nineteen pieces were examined microscopically for use wear traces using magnifications between 50x and 200x. Details of the methods employed using this technique are described elsewhere (Ataman 1991). Evidence of use is clear on 14 pieces. The range of activities represented by the tools found at Locality 27 includes scraping, cutting, perforating, grooving, chopping and whittling. At Tosawihi, such diversity of flake tool function is common only among sites situated close to water sources and exhibiting other evidence of residential activity, such as pottery and groundstone (Ataman 1991; Leach 1991).

Only one flake tool was recovered from Locality 26. It is a bifacially worked white opalite flake with heavy battering along one edge (Figure 15a). Like similar tools recovered from other quarry pit contexts, it may have served as a quarrying implement (cf. Schmitt 1989).

Cores

Five opalite cores were recovered from Locality 26, while thirteen opalite cores and one obsidian core were recovered from Locality 27. Two of the cores from Locality 27 were made on opalite stream cobbles. All cores appear to have resulted from the production of relatively small flakes. Their shapes vary, but all were classified as blocky, spheroidal, bifacial, conical, or fragmentary. Selected flakes removed from these cores probably were directed toward the production of flake tools rather than bifaces. One core is made on a small obsidian nodule (41.1 mm x 30.8 mm x 21.1 mm) with remnant cortex covering a small portion of its surface.

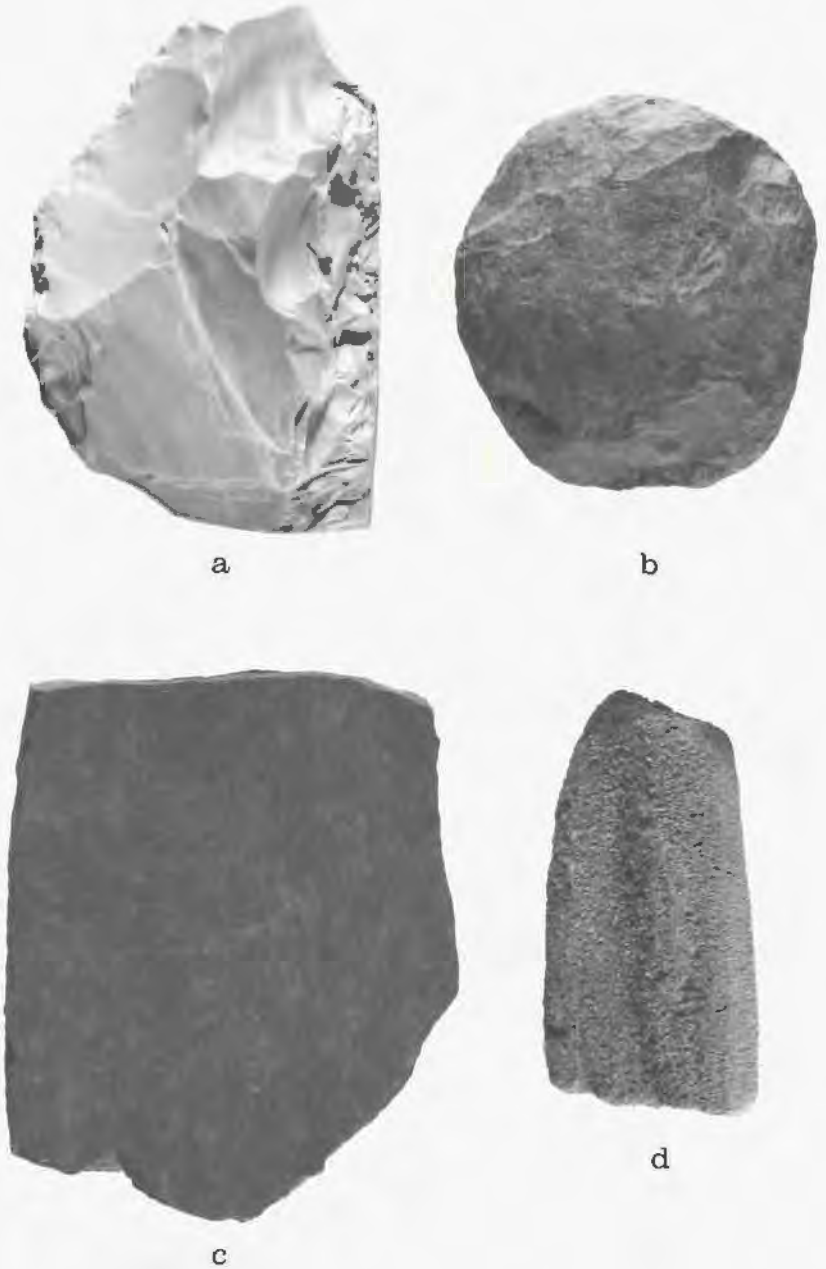


Figure 15. Miscellaneous artifacts from 26Ek3032, Localities 26 and 27. a. flake tool, Locality 26; b. hammerstone, Locality 27; c. metate fragment, Locality 27; d. grooved abrader, Locality 26.

Modified Chunks

Modified chunks are angular fragments with no clear detachment surface and with complete negative flake scars on one or more surfaces. Each of these pieces has undergone reduction, and they probably are by-products of core reduction or very early stage biface production. The end-product of reduction, however, cannot be determined. Nineteen opalite modified chunks were collected from Locality 27 and two from Locality 26. Five Locality 27 specimens exhibit remnants of cobble cortex and may represent assay of easily collected, on-site, raw material.

Percussion Tools

Surface collection and test excavation at Locality 27 returned nine hammerstones. Most (n=6) are small, fist-sized cobbles that can be wielded with one hand (Figures 15b, 16). Although probably employed in the reduction of toolstone (e.g. quarrying or biface manufacturing), specimen 6165-4 displays a relatively large rectangular (4 cm x 3 cm) battered surface, suggesting it may have been used to pulverize foodstuffs (e.g. roots, tubers, rodents).

Surface reconnaissance at Locality 26 recovered ten hammerstones and two choppers (Figure 16, Table 11). The assemblage contains both large hammerstones exhibiting compound spalling and edge-crushing and smaller fist-sized percussion tools. The former probably were used for toolstone extraction while the latter possess often restricted battered margins and probably were used in biface reduction.

Table 11. Attributes of Hammerstones and Choppers from 26Ek3032, Localities 26 and 27.

ALL MEASUREMENTS ARE IN CENTIMETERS

Specimen No.	Material	Length	Width	Thickness	Weight (gms)	Type	Shaped	Complete
Locality 26								
01-11	RH	13.7	9.1	6.1	1173.0	HM	-	-
01-14	QZ	14.7	8.7	6.5	1170.5	HM	-	+
01-21	QZ	10.2	9.1	5.4	518.8	HM	?	+
01-22	QZ	9.6	7.2	5.1	364.2	HM	-	-
01-28	RH	11.2	9.2	4.4	573.9	HM	-	+
01-30	QZ	10.9	9.6	5.3	686.7	HM	-	+
01-35	QZ	11.3	8.8	6.2	704.1	HM	-	+
01-39	QZ	6.8	5.2	3.8	176.4	HM	-	+
01-40	QZ	15.2	10.5	7.1	1303.1	HM	-	+
01-44	OP	10.6	9.1	7.7	848.7	HM	-	-
01-60	RH	11.0	7.4	3.6	336.7	CH	+	+
01-79	OP	9.4	6.3	2.1	155.8	CH	+	+
Locality 27								
01-62	QZ	13.3	11.17	7.7	1434.9	HM	-	+
6167-03	CH	7.5	5.2	4.2	209.2	HM	-	-
01-118	OP	9.6	6.5	4.4	350.9	HM	+	-
01-25	QZ	8.3	6.2	6.9	414.6	HM	-	+
01-150	QZ	5.7	5.8	3.3	172.0	HM	-	+
01-72	OP	7.9	7.0	5.2	352.1	HM	+	+
6061-04	BA	6.7	6.2	4.6	271.1	HM	-	+
6165-04	QZ	7.0	6.1	4.8	393.3	HM	-	+
01-148	RH	13.3	8.7	7.4	1046.3	HM	-	+

Material

RH = Rhyolite
QZ = Quartzite
OP = Opalite
CH = Chert
BA = Basalt

Type

HM = Hammerstone
CH = Chopper



Figure 16. Selected hammerstones from 26Ek3032, Localities 26 and 27.

Like hammerstone assemblages collected elsewhere in the USX-East project area, selection of raw material for hammerstones at Localities 26 and 27 focused on stone obtainable in the immediate vicinity. Most of the hammerstones are made on quartzite stream cobbles; these are available in abundance in the beds of Undine Gorge and Little Antelope Creek (cf. Schmitt 1989).

The margins of the two choppers recovered from Locality 26 are bifacially flaked and battered. Both pieces are complete, specimen 01-60 is of rhyolite and specimen 01-79 is made on a thick opalite flake.

Groundstone

Three manos, four metate fragments, and two abrader/shaft straighteners comprise the ground stone assemblages at Localities 26 and 27. All the millingstones were recovered from Locality 27. Three metate fragments were manufactured on tabular basalt, each displaying superficial use-wear on one surface (Figure 15c), while the other was made on a large piece of abraded tuff. The manos are fist-sized rhyolitic cobbles possessing unifacial use-wear (Figure 17). One of the Locality 26 abrader/shaft straighteners is made on an elongated cube of porous tuff. Grooves have been ground into two of its opposing faces (Figure 15d). One groove is broad and shallow and could have functioned in shaft straightening, but the function of the more narrow groove (width = 3.5 mm) is ambiguous. Its small size suggests that it was employed in the manufacture of bone tools (e.g. needles or awls), or that it was used to prepare the edges of bifaces or points for pressure flaking. A second tuff abrader was also recovered from Locality 26, but it displays only superficial wear and could have been used as a platform abrader in biface production.

Ceramics and Beads

Eleven ceramic sherds were recovered from Locality 27. From differences in wall thickness, temper constituency, and provenience, we infer that they represent at least three different vessels. Excavations in level 1 of EU 4 recovered a single Grayware sherd. In this piece, temper consists largely of angular and subangular quartz grains and possible feldspar. Color, temper qualities, and wall thickness suggest the specimen represents either Promontory or Snake Valley Gray, both dating between ca. A.D. 900 and A.D. 1300 (Madsen 1977). Grayware has been discovered elsewhere in the Tosawihi Quarries vicinity, including nearby sites 26Ek3171 and 26Ek3198 in the USX-East project area (Schmitt and Juell 1989; Schmitt 1991).

Ten Shoshone Brownware sherds were recovered; six were collected in EU 9, and four in EU 19. Shoshone Brownware is poorly dated, but most likely postdates A.D. 1300 in Northern Nevada (Madsen 1986:214). The occurrence of Shoshone Brownware is widespread in the central and eastern Great Basin (cf. Fowler 1968); sherds of this material were recovered from four other sites adjacent the Tosawihi Quarries (Schmitt and Juell 1989).

An elaborately incised stone (tuff?) bead was recovered from the northern portion of Locality 27 in level 3 of EU 2 (Figure 18a). The bead is cylindrical in overall shape, rectangular in cross-section (mean thickness = 13mm), and circular in plan (diameter = 20mm). A biconically-produced hole perforates the center of the piece. A series of decorative striations, parallel to the central perforation, encompass its outer margin, and these are bisected by a single groove around its circumference.



Figure 17. Manos from 26Ek3032, Locality 27 and 26Ek3516.

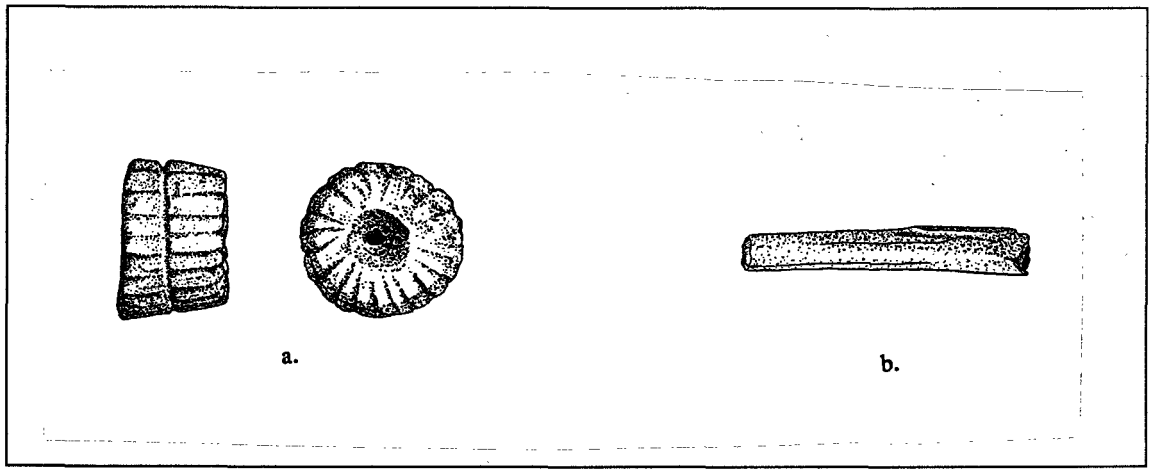


Figure 18. Beads from 26Ek3032, Locality 27. a. tuff bead; b. bone bead or bead preform.

Excavations in level 2 of EU 5 yielded a rabbit-sized tibia fragment with a scored surface just distal the fibula-tibia junction (Figure 18b). Based on the location of scoring and lack of use-wear (e.g. polish along the cut margin), the artifact represents bone debitage produced during the on-site manufacture of bone beads (see discussions in Schmitt 1990).

Faunal Remains

Seventy bones were recovered from test excavations at Locality 27. Most (n=45) are small mammal remains represented largely by complete, undamaged elements (often clustered in excavation unit/levels) suggesting on-site natural mortality (e.g. burrow deaths). Identified small mammals include ground squirrel (*Spermophilus* sp.) and pocket gopher (*Thomomys* sp.). Additional taxa include the remains of marmot (*Marmota flaviventris*), jackrabbit (*Lepus* sp.), and pronghorn (*Antilocapra americana*). Although much of the taphonomic history of these latter specimens remains ambiguous, a fractured pronghorn distal tibia recovered from level 6 of unit 5 and a charred jackrabbit longbone fragment from unit 9 probably represent human subsistence refuse.

Due to excellent faunal preservation in the meadow, further excavation and detailed analysis of animal bones retrieved from Locality 27 may offer a unique opportunity to explore human subsistence in association with quarrying activities.

Historic Artifacts

Excavators recovered a small assemblage (n=133) of recent era artifacts from the north area of Locality 27. The metal, glass, and plastic fragments represent at least 33 individual objects. Artifacts of a personal nature include a clothing zipper part, an iron hobnail, glass mirror fragments, and aluminum-top beer or soda cans, with ring-type pull tabs. Domestic, architectural, and draft animal activities are reflected by one all-aluminum sardine can, five wire nails of 8d to 20d size, a carriage bolt, and a copper rivet used for leather harnesses. Hunting or plinking is suggested by 14 cartridge parts, 12 of them .22 caliber casings with various headstamps. One specialized tin can, four colorless glass bottles, and a white plastic rod are included, though exact functions are unknown.

All historic artifacts from Locality 27 were recovered from the upper 10 cm of several excavation units. Together, they paint a picture of temporary, probably "day-use only" occupation. Identifiable food and beverage containers held ready-to-consume commodities, such as one might take along for working, hiking, horseback-riding, or practice shooting. No cooking gear is represented. Recovered clothing and shoe parts reflect work/outdoor articles. Day-users may have included cowboys stopping to water their herds, drillers and geologists involved in mineral exploration, hunters, or recreationists.

Appendix C illustrates the known time ranges for artifacts recovered from Locality 27. All but one of the datable artifacts, regardless of their initial years of development, are currently manufactured, suggesting 1) that all the recovered artifacts were deposited after 1970 (the earliest manufacture date of the artifact with the most recent time range), or 2) that several short occupations occurred at the site, reflected by a cluster of initial manufacturing dates occurring every 50 years. Since seasonal water is available here, a rarity for the project area, one would expect it to have attracted people and animals through the years.

Technological Analysis of Lithic Samples: Locality 26

The specific objective in analyzing the 33 lithic samples collected from the Locality 26 quarry pit was identification of reduction debris types associated with each stratigraphic unit, thus allowing inferences as to the locations of different biface reduction stages relative to quarrying. Ethnographic work among Australian Aborigines provides a record of quarrying behavior which we have used to model the expected patterning of archaeological remains resulting from quarrying and toolstone reduction (Binford and O'Connell 1984). When quarrying, the Alyawara reduce large cores to manageable size in the bottom of their quarry pit, then move out of the pit to continue the reduction process. Experimental flint knappers at Tosawihi followed a similar pattern (personal observation by B. Bloomer, 1989). If prehistoric quarriers at Locality 26 engaged in this pattern of moving to another location to accomplish later stage reduction, the behavior might become evident through technological analysis of their reduction debris.

Quarrying and processing toolstone is a continuous process which can be divided into several stages for analytical purposes: quarrying (toolstone extraction), core reduction to produce flake blanks (Stage 1), biface edge preparation (Stage 2), primary biface thinning (Stage 3), and secondary biface thinning (Stage 4). Quarrying often produces fragments of unsilicified tuff, shattered toolstone, and nondiagnostic flake fragments. Stage 1 reduction produces shatter and interior flakes which result from removing surface irregularities in preparation for the removal of a flake blank. Stage 2 reduction is indicated by the presence of edge preparation flakes. Stage 3 and Stage 4 reduction produce early and late stage biface thinning flakes, respectively. The presence, absence, and relative quantity of each flake type was considered in the interpretation of the general reduction activities that produced the sample debitage.

A reduction event includes all the reduction activities occurring in one place at one time, and is marked by the debitage produced and discarded there. If material is processed through more than one reduction stage at a particular location, the debitage will reflect more than one stage. Changing locations at any point along the reduction continuum essentially ends that reduction event and begins another, even if the stage of reduction does not change.

The relationship between the archaeological location of debitage and its place of production is not necessarily direct. Geological processes, as well as human behavior, can affect the archaeological record. Fortunately, stratigraphic analysis allows us to interpret the integrity of the archaeological remains in each stratigraphic sample (see Figure 8 and Table 2).

Technological analysis indicates that the reduction of toolstone ranged from bedrock quarrying through the production of Stage 1 biface blanks and Stage 2 margin preparation to Stage 3 primary biface thinning (Table 12). There was no indication of Stage 4 reduction, an observation compatible with the high frequencies of Stage 2 and 3 bifaces collected from the surface of Locality 26.

All stratigraphic units in the three quarry pits (parts of units 2, 4, 7, and 10; units 6, 9, 12, 14, 25-28, 30, and 32) contain debitage from *only* quarrying, and Stage 1 reduction and/or Stage 2 reduction (see Table 12 and Figure 8). Although most of these units represent primary deposition, unit 6 in pit 2 (see Figure 8) appears to be a secondary deposit of reworked backfill from pit 1, and unit 2 appears to be a combination of slopewash and reworked quarrying and reduction debris.

In contrast, Stage 3 biface reduction debitage occurs primarily in units near the surface, deposited well after the quarry pits had been filled. Debitage from quarrying, Stage 1 reduction, and Stage 2 biface reduction often occur in association with Stage 3 biface reduction debitage in these upper lenses. This indicates that Stage 3 biface reduction usually did not occur within open quarry pits, but was performed on the level surface provided by a filled or partially filled quarry pit. This general use of space conforms to that observed ethnographically among Australian Aborigines working at quarries (Binford and O'Connell 1984).

Table 12. Technological Characterizations of Reduction Present in Backhoe Trench 1, 26Ek3032, Locality 26.

Stratigraphic Unit	Sample No.	Stages Represented
1	2599-600	1,2
1	2599-610	1,2,3
2	2599-603	2,3
2	2599-602	1,2
4	2599-604/5	Q,1
5	2599-606	Q
6	2599-611	1
7	2599-607	1,2
9	2599-608	1
10	2599-609	1
10	2599-612	2,3,1
12	2599-613	1
13	2599-615	1,2
14	2599-614	1,2
16	2599-616	2,1,3
17	2599-617	2,3
21	2599-618	1,2,3
21	2599-631	1,2,3
21	2599-601	1,2,3
23	2599-619	1,2,3
25	2599-625	1
26	2599-620	Q
26	2599-621	Q
26	2599-626	1,Q
26/27	2599-628	1,Q
27	2599-627	Q,1
27	2599-622	Q,1
28	2599-623	1
30	2599-624	Q
30	2599-629	Q
32	2599-630	Q,1
33	2599-632	1,2,3

Q = Quarrying Debris
1 = Initial Core Reduction
2 = Edge Preparation
3 = Primary Thinning

Note: Manufacturing stages are listed in order of greatest frequency in the sample.

Stratigraphic unit 10 (quarry pit 2) explicitly reveals this expected pattern of quarry locality biface reduction. In this unit, early stage biface reduction debitage (for example, sample 2599-609) is found in the bottom of the quarry pit, and Stage 1-3 reduction debris (sample 2599-612) is found on the berm away from quarrying activity. The reduction assemblages in these two samples indicate the reduction of material extracted in a single quarrying episode, segregated into at least two reduction events. These samples each contain debitage produced through the reduction of one or more pink opalite cores and/or flake blanks, probably extracted at the same time. Our model suggests that the Stage 1 debitage in both samples could have resulted from core reduction in the bottom of the pit and the subsequent removal of the same core or a large irregular flake blank to the berm for further reduction.

The stage analysis of the debitage samples, and a consideration of their spatial relationships, indicates that only early stage reduction occurred within quarry pits, while all stages of reduction occurred outside their immediate vicinity. This allowed quarrying activity to continue concurrently with Stage 1, 2, and 3 reduction. Additionally, toolstone probably was quarried a short distance east or west of quarry pits 1-3, some time after the pits were filled. The quarried stone then was moved to the area bisected by the backhoe trench and reduced through the continuum to produce Stage 3 bifaces.

The technological analysis of these backhoe trench samples demonstrates that the samples are technologically distinct from one another and that they can be used to interpret depositional patterns which result from quarrying and reduction activities.

Debitage Analyses: Locality 27

Debitage is by far the dominant artifact class at Locality 27. Testing recovered 26,632 platform-bearing flakes (henceforth abbreviated as PRB flakes) and marginal fragments of flakes without platforms (henceforth called flake fragments). All told, flake fragments and PRB flakes weigh 51.4kg. An additional 19.2kg of angular debris were also collected. In total, the debitage sample consisted of 209 samples from 20 test EUs and 3 surface collections. All samples from the 20 test EUs were screened through 1/4 in. or finer (1/8 in.) mesh. Only samples from the excavation units are discussed here. The few additional flakes collected from non-EU surfaces are not useful analytically since mass analysis requires a consistent size minimum.

The goal of analysis for the Locality 27 debitage sample was a relatively simple one: we wished to assess the potential information present in the debitage sample. Strategies for reaching this goal can be phrased as a series of questions:

(1) Is artifactual material largely confined to the surface, with diminishing densities below surface indicating post-depositional creation of a subsurface record?

(2) Is the debitage assemblage homogeneous across test EUs and levels, and thus uninformative?

(3) If negative answers accrue to the above queries, are debitage studies worth pursuing further at Locality 27?

Laboratory and Interpretive Methods

The primary method of debitage study was mass analysis (see Ahler 1989a, 1989b; Bloomer and Ingbar 1991). After separating opalite from other material types, samples were sorted into three categories: flakes or flake fragments with platforms (PRB flakes), flakes without platforms (flake fragments), and angular debris

which shows no orientable scar morphology or platform attributes. Both the PRB and flake fragment portions of all samples were then shaken through a nested sieve set of 2 in., 1 in., 1/2 in., and 1/4 in. square mesh. Samples were poured into the largest size grade sieve, and then shaken for 15-20 seconds using a mechanical agitator. Counts and weights within each size grade then were tabulated.

The resulting frequency and mass data then were summed for all samples of the same material type from the same EU and level. These summed samples were interpreted using statistical mass analysis discriminant models developed by Bloomer and Ingbar (1991) from experimental reduction of Tosawihi opalite and other experiments reported by Ahler (1989a). Samples are classified into one of five categories: core reduction; marginal retouch; early stage biface reduction (Callahan [1979] Stages 1 to middle Stage 3); late stage biface reduction (Callahan [1979] middle Stage 3 and later); and mixed biface reduction (both early and late stage biface reduction, i.e., spanning the mid-Stage 3 period of biface reduction).

An important limitation of the mass analysis discriminant procedure is its dependence upon a sample larger than fifty items that also contains at least one item in the 1/4 in. screen (see Bloomer and Ingbar 1991). Samples smaller than fifty items are not reliably classified under this technique. Although not all the debitage samples could be characterized because of this limitation, ancillary uses for the separation of PRB flakes, flake fragments, and angular debris are illustrated below.

PRB flakes, flake fragments, and angular debris were kept separate during laboratory data collection so that they could be analyzed further. The ratio of PRB flakes to flake fragments provides a measure of flake breakage. Flake breakage models are not well developed in the literature (e.g. Amick and Mauldin 1989; Prentiss and Romanski 1989; Sullivan and Rozen 1985), perhaps because flake breakage can result from numerous factors: trampling and fragility of flake form are the most obvious of these. Trampling of flake assemblages should increase the frequency of flake fragments, resulting in a lower mean flake weight. Different reduction techniques can produce this same signature. If flakes break more frequently when they are thin, as in late bifacial reduction, then mean flake weight will decrease as the number of flake fragments rises. We use flake fragmentation frequencies (comparison of flake fragment to PRB flake frequency) as a rough measure in vertical comparisons between levels within the same EU to assess either possibility. Thus, variation in flake fragmentation proportions are indicative of *some* difference between levels, but its cause is not specified.

Mean flake weights can be useful in assessing different kinds of reduction. Variation in mean flake weights can result from differential fragmentation. Without separate tabulation of complete flakes (with intact margins and platforms), the effects of fragmentation cannot be separated from those of differential reduction technique (or core size). Consequently, we use mean flake weight to assess variation vertically. Again, when variation is found, further examination is indicated to determine whether it reflects differential breakage or reduction technique.

In addition to these measures, a sample of debitage collected from EUs at Locality 27 was scanned for technological attributes indicative of the types and stages of reduction evident in the flake sample (Bloomer and Ingbar 1991). This typological analysis permits comparison of the mass analysis results to educated estimates of the range of reduction activities resulting in debitage.

Mass Analysis Results

Mass analysis results are not highly variable for most of the interpretable samples (Appendix F), which are interpreted as early stage biface reduction. A few levels are interpreted as mixed biface reduction (in EUs 3, 9, 12, 20, 21, 23, 27).

Compared to other settings close to the main Tosawihi toolstone sources (Bloomer and Ingbar 1991), the results are unexpected. A majority of samples from other localities within Ek3032 analyzed using the same techniques were dominated by Core Reduction characterizations. Thus, given the proximity of Locality 27 to the toolstone source at Locality 26, it is surprising that no samples were characterized as Core Reduction. The *relatively* "late" characterization of the Locality 27 samples indicates something quite different at this locality than at Ek3032 localities reported by Bloomer and Ingbar (1991).

Variation in Flake Densities and Fragmentation

Variation in flake densities is marked both across EUs and vertically within units at Locality 27 (Figure 19; Appendix G). There appear to be two patterns in overall flake density: some EUs have the highest densities of items within 2cm of the ground surface, with consistently diminishing densities below the 10cm level (EUs 1, 2, 4, 6, 10, 13, 21; see Appendix F and Appendix G). The consistent decrease in density may be the result of upward transport of flakes from a buried surface, or downward transport from surface. However, it also can result from a steady rate of natural deposition and from an increasing intensity of debitage generation by human actions.

Other EUs have decreasing debitage densities below surface, punctuated by one or more steep increases in flake density (EUs 3, 5, 7, 8, 9, 11, 12, 18, 19, 20, 23, 27; see Appendix G). These are most parsimoniously interpreted as showing episodes of stability-instability in sediment deposition under a constant rate of debitage discard or steady deposition rates punctuated by episodes of higher debitage discard. In any case, they indicate substantial subsurface variation that is relevant to understanding both prehistoric use of the Locality 27 area and local geomorphic environments.

EU 25 differs from both density profile patterns discussed above. Debitage density in EU 25 increases consistently with depth below surface (Appendix G). The test unit may have hit a buried surface or diffuse buried horizon of occupation, while mantled in its upper 10 to 20 cm by redeposited material.

Flake fragmentation can be measured roughly by comparison of frequencies of all flakes to PRB flakes by level for each EU (Appendix G). In general, the number of fragmented flakes is greater than that of PRB flakes, but trends between the two closely parallel each other within any given EU. This result suggests that little trampling has occurred. This should only be considered a suggestion, however, since differential fragmentation may be more subtle than this examination can reveal.

Mean Flake Weights

Mean flake weights can provide some information on the sizes of items reduced and the flaking techniques employed in doing so. As well, the mass of a flake, when considered as a sedimentary particle may affect its potential for subsurface movement through turbation, wet-dry sediment changes, and freeze-thaw cycles. For this examination, the total weight of flakes (PRB and flake fragments) was summed and divided into the total count of flakes. Several general patterns are present. Decrease in flake weight with increasing distance below surface, followed by a sharp increase (usually 40cm or further below surface) in mean flake weight is one general profile. EUs 1, 2, 3, 4, 5, 7, 8, 9, 18, 20, and 23 follow this pattern. General diminution in mean flake weight is present in several other EU profiles: EUs 6, 10, 11, 13, 21, 23, 25, and 27 all share this pattern. The three remaining EUs have various profiles. EU 12 increases greatly in flake weight between 2 and 10cm below

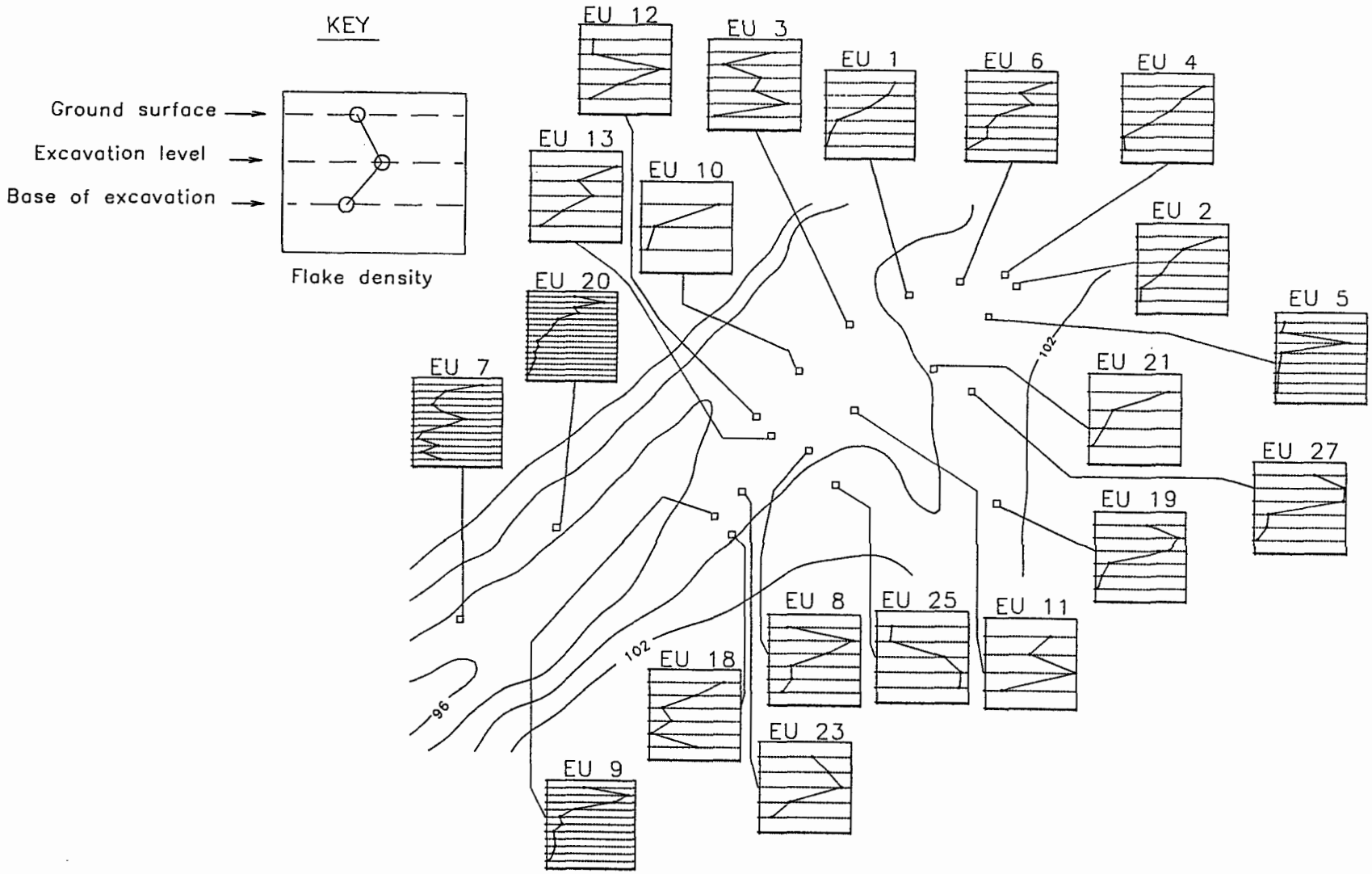


Figure 19. 26Ek3032, Locality 27, flake densities by level.

below surface, and then diminishes again. Interestingly, the greatest frequency of flakes lies just under this increase in mean flake weight—perhaps indicating upward movement of large items by frost heaving from a buried deposit of debitage. EU 19, on the other hand, shows a rough increase in mean flake weight with increasing depth. This trend parallels a decrease in flake frequency: a few large items are present in the lower reaches of EU 19, but not many small ones.

Use of Toolstone Other Than Opalite

Very few flakes of toolstone were recovered that were not opalite (n=153). None of the non-opalite flakes was sufficiently common to effect characterization using mass analysis. Almost all of the non-opalite flakes are jasper (n=103). Obsidian flakes, useful for both dating and sourcing, are infrequent (n=38). The obsidian debitage indicates in-situ production of flakes and early stage bifaces, while the presence of a single pressure flake suggests the possibility of in situ point manufacture. A single basalt flake and two flakes of non-local chert were also present in the debitage.

Typological Debitage Analysis

Thirty debitage samples from individual excavation levels were scanned for indicators of core reduction, biface reduction stage, heat treatment, and other technological variation. Scan analyses were performed on all excavation level debitage from EU 9, and every 10th sample from all remaining EUs. Interpretations of reduction type and stage follow the observations made above concerning analysis of the Locality 26 debitage. Results of the Locality 27 scan analysis are summarized briefly here.

First, it is apparent that the mass analysis characterizations, which are predominantly "early stage biface", mask considerable variation within most of the thirty samples examined. While early stage biface reduction flakes were present in most of the samples, they cooccur with late biface reduction debris and middle (Callahan [1979] Stage 3) biface reduction debris. Thus, the mass analysis characterization is less detailed than the characterization resulting from scan analysis. In general, most samples characterized as early stage biface reduction are more likely Stage 3 biface reduction with some early biface reduction debris intermingled. Moreover, there appears a fairly high frequency of late (late Stage 3, Stage 4) biface reduction within almost every sample. Many of the samples scanned that were classified as mixed stage biface reduction by mass analysis are middle and late stage biface reduction, with virtually no pre-Stage 3 flakes at all.

Second, in half the samples scanned, there were very large relatively late (late Stage 3) biface production flakes. This indicates the production of large bifaces, probably greater than 15cm in length, at Locality 27. These are larger than many of the bifaces known from the Tosawihi Quarries vicinity (Bloomer, Ataman, and Ingbar 1991).

Third, heat treatment is relatively common in the scanned samples. Approximately 10 to 20% of each sample showed obvious evidence of heat alteration. This proportion is high relative to other sites in the vicinity (Bloomer and Ingbar 1991; Bloomer, Ataman, and Ingbar 1991).

Fourth, the debitage samples scanned show considerable variation in opalite material color. This suggests a heterogeneous pool of sources for the opalite, despite the proximity of toolstone at Locality 26. Many of the large *early* biface reduction flakes also showed remnant cortex, indicating use of local opalite stream cobbles for tool manufacture, a finding reinforced by similar findings in the analysis of the bifaces from Locality 27 (see above).

Summary of Debitage Analyses, Localities 26 and 27

Debitage from the quarry pits trenched at Locality 26 clearly is dominated by early stage toolstone reduction; that is, quarried stone processed into forms suitable for further reduction into bifaces. Early stage reduction is the sole lithic production activity within the quarry pits themselves. However, around the quarry pits—on outer berm slopes and even just a few meters from the berms—all stages of reduction were present, including late stage biface reduction.

Within 40m of Locality 26, at Locality 27, there is ample evidence of late stage reduction. It is, in fact, the dominant form of reduction in the locality as a whole. Despite the predominance of early stage biface reduction as the outcome of mass analysis, the scan analysis showed that considerably more late bifacial reduction is present in most of the Locality 27 debitage samples. The disjuncture between these two analytical techniques is not unexpected, and is exacerbated by the very large bifaces that seem to have been produced at Locality 27 (cf. Bloomer and Ingbar 1991).

There appears to be a wider range of toolstone sources represented in the Locality 27 debitage than in the Locality 26 debitage. Our scan analyses suggest that this is the case, since range of flake color and texture exceeds those of the bedrock at Locality 26. The scan analysis also revealed a wide range of material sources and reduction of local cobbles. Heat treatment is relatively high in the Locality 27 sample and low in the Locality 26 sample. The differences in raw material source utilization is especially interesting, for under any cost-minimizing model of prehistoric behavior, we would predict that Locality 26 should have been most heavily used by occupants of Locality 27. That this is not the case suggests these are distinctly different economic settings. They may nonetheless be linked to each other in some fashion or during some intervals of time. If they are, then the movement of quarried products from their place of procurement (a context of production) to their place of reduction into transport forms (a context of use) occurs over a very short distance at these two localities.

Debitage from Locality 27 is differentially distributed both horizontally on the surface, and in terms of subsurface frequencies within any given EU (see Figure 19). Artifactual material is not confined to the surface of this locality, nor does it necessarily diminish in frequency vertically.

Technological differences among samples are suggested by several of the results above: the debitage samples are far from homogeneous in composition. Nor are the debitage assemblages easily understood in terms of prehistoric toolstone exploitation strategies, as the contrast with other analyses of the Tosawihi vicinity shows. Rather, it is apparent that debitage variation at Locality 27 may have two causes, which are not mutually exclusive: (1) variation in the rate of deposition and subsurface processes that may have created peaks and valleys in debitage density and also winnowed the assemblage through movement; (2) variation in prehistoric flintknapping strategies in any given location.

The latter topic speaks to the heart of an important research question concerning the Tosawihi quarries (cf. Elston et al. 1991)—whether prehistoric use of the quarries was consistent or changeable through time. For example, variation within an EU by level could be due simply to minor shifts in where reduction occurred. So, at Time A, EU X was the center of a reduction action, but at Time B (10cm of deposition later), a prehistoric flintknapper left large debris 2m away, and only small-sized pieces of debitage were deposited on the (Time B) surface of EU X. Alternatively, flintknapping strategies may have changed through time, as prehistoric knappers sought and used toolstone in different ways. Obviously, neither of these scenarios can be evaluated on the basis of our present knowledge of Locality 27. Nonetheless, Locality 27 has important information in its debitage assemblage of relevance to both formation processes (with concomitant paleoenvironmental parameters) and prehistoric human behavior.

Chapter 5

RESEARCH POTENTIAL AT 26Ek3032, LOCALITIES 26 AND 27

Localities 26 and 27 of site 26Ek3032 offer avenues for future research as outlined in this chapter. Our discussion of research opportunities springs from the test excavations at these localities, but draws upon prior work at the Tosawihi Quarries (Elston 1989, Elston and Raven 1991). What follows is not a data recovery plan for Localities 26 and 27 (cf. IMR 1988e); rather, it is a general discussion of their research *value* given present knowledge of the Tosawihi archaeological record. Suggestions made concerning procedures to implement a particular line of inquiry are intended as ideas, not prescriptions.

The research potential of Localities 26 and 27 can be divided arbitrarily into two domains of inquiry. The first of these is the natural setting of the localities and its change through time. Paleoenvironmental studies are possible at both locations, and undoubtedly would be fruitful. Integrated paleoenvironmental studies are wholly lacking for the Tosawihi area; our knowledge of past climatic, vegetative, and faunal change comes solely from archaeological inquiry and some geomorphological research (Elston and Raven 1991; Dugas 1991). A second research domain is the understanding of prehistoric activity on and around the two localities, and their relationship to the cultural processes of which they were a part. We discuss each domain separately, merely for ease of presentation since we see no clear boundary between them.

Paleoenvironmental Research

Locality 27 occupies a rare depositional setting in the Tosawihi vicinity. Few other places there contain a combination of deep sediments and essentially depositional environments (Dugas 1991). It is far more common to find a shallow archaeological record at Tosawihi, in which little deposition or erosion occurred. Locality 27 also contains a sedimentary record with a long time span. The presence of Mazama tephra in primary fluvial sediments, in stratigraphic context (although not the primary eolian depositional context of the tephra), clearly indicates a lengthy span of deposition. Thus, unlike most places on the Tosawihi landscape, Locality 27 contains an extensive Holocene sediment pile that well may contain important paleoenvironmental information along with stratigraphically separable archaeological horizons. The terrace sequence itself, described in Chapter 4, is a record of environmental change. For example, the large basal gravels and the erosional terrace surface found in Trench 4 at Locality 27 may be indicators of a generally wetter or more seasonally intense precipitation pattern. Detailed geomorphological study could increase present knowledge of paleoclimates in the Tosawihi uplands by an order of magnitude.

More direct indicators of paleoenvironments may also be present in the sediments of Locality 27. Pollen and opal phytoliths provide primary data on local and extralocal vegetation. If present, these should be sampled intensively and scrutinized, for few other locations in the area offer any hope of stratigraphic separation of these materials.

As noted in Chapter 4, the preservation of bone is relatively good in Locality 27 deposits. Many of the bones recovered in testing may be the waste of human meals: but this too provides information on paleoenvironments. Local and extralocal faunal remains provide a sort of "human's-eye" view of the landscape. Natural death faunas (burrow deaths, natural mortality carcasses) augment this record at the local level. Good bone preservation at Locality 27 suggests the probability of preservation of other organic materials. Charred seeds and partly burned or carbonized wood fragments often can be identified to the species level and yield evidence of prehistoric diet as well as provide chronological controls on stratigraphy through radiocarbon dating. As well, organic artifacts can testify to resources now vanished from the local landscape.

Locality 26 also provides a deep stratigraphic record, although we do not know the range of time represented in it. Most of the stratigraphy is anthropic, created by quarry pit excavation and opalite processing, thus the likelihood that it contains a significant paleoenvironmental record may be less than at Locality 27. Nevertheless the rarity of deep stratification at Tosawihi renders it a potentially important research opportunity. As at Locality 27, pollen and phytolith sampling can be undertaken here.

Intriguing at Locality 26 is the presence of Mazama tephra in a discrete stratum. The single ^{14}C date from this stratum (510±80 years B.P.; Beta-35573) does not match the age of the Mazama tephra (6800 years B.P., see Appendix A), yet this does not necessarily place the Mazama tephra in secondary depositional context. Radiocarbon dates can be wrong, and further dating would easily assess this. Even if the Mazama tephra is in a secondary depositional context, one must still account for its redeposition. From where did it erode? Is it an eolian deposit, perhaps trapped in the pit matrix during a drier interval in the past? Is it a slopewash or colluvial deposit? If so, there must have been soft sediment above the Locality 26 quarry pits which later eroded. Answers to these questions are not obvious, but clearly they have implications for the reconstruction of general climatic events in the past.

In sum, paleoenvironmental inquiry can be undertaken effectively at Localities 26 and 27. Through geomorphological studies of sediment erosion and deposition, pedological studies of stability and surficial sediment weathering regimes, and studies of plant macrofossils with palynological and phytological investigations, a picture of local and regional paleoenvironmental change can be built.

Archaeological Research

A second research domain at Localities 26 and 27 is the study of past human actions. A series of hierarchical topics are envisioned for this investigation. We wish first to know what actions took place at each locality and at what time(s) in the past. Are the two localities contemporaneous? Were products quarried from Locality 26 reduced at Locality 27? What additional functions can be ascribed to Locality 27? Was it used for the same purpose throughout prehistory? The answers to these questions are not obvious at present, though the results of testing indicate that the two localities contain important information with which to address them.

A basic investigative strategy is to seek chronological control. Temporal controls can be built through stratigraphy, radiocarbon dating, and obsidian hydration studies. While several important temporal patterns already have emerged (see Chapter 4), the Mazama tephra uncertainty discussed above shows chronology building cannot be done without concomitant geological investigation. In any case, the presence of Mazama tephra in both localities makes these potentially the oldest subsurface deposits at Tosawihi.

Human use of the confluence of Undine Creek and Little Antelope Creek predates 6800 years B.P. in at least part of Locality 27, and possibly in the oldest pit at Locality 26. The ages of projectile points recovered at Locality 27 do not include Late Archaic forms younger than 1000 years old (although some of the preforms *could* have been used to produce these more recent projectile point types). In contrast, the available dates and time-sensitive artifacts from other parts of the Tosawihi vicinity suggest late use of the area east of the main quarries (Elston and Drews 1991).

Better definition of the ages of materials buried in Localities 26 and 27 would have two great benefits. First, if the Locality 26 quarry pits are contemporary with much of the Locality 27 subsurface materials, then they constitute some of the oldest quarry features yet known at Tosawihi and, as such, will provide an opportunity to contrast quarrying techniques and products of toolstone procurement with the more common, younger quarry pits at Tosawihi. Second, if the Locality 26 quarry pits are younger than much of the Locality

27 archaeological record, then they constitute further evidence of late intensification in quarry use (cf. Elston and Drews 1991). This possibility raises a question about activities undertaken by prehistoric people at Tosawihi prior to the late intensification: what did the pre-quarry pit groups do at Tosawihi? In either case, the importance of the lower, older, archaeological materials at Locality 27 cannot be overstressed, since they can provide important information on change through time in the prehistoric use of the Tosawihi landscape.

Locality 27 contains abundant archaeological data in geological context sufficient to address these questions. The preservation of organic materials, the long stratigraphic record, and the differential vertical and horizontal distribution of debitage and stone tools indicate the potential of this locality to provide data about site function changes through time. Excavations could reveal sequential uses of the locality, revealing many occupations and their associated activities (sorted through time) in a single place.

Beyond addressing "what" and "when" queries, we need to link the actions performed prehistorically at these localities to more general prehistoric use of the Tosawihi uplands (Raven 1991; Elston et al. 1991). Prehistoric use of Tosawihi appears to have been most intense during the past 1000 years. Most of the larger sites studied so far contain abundant evidence of this late use (Elston and Drews 1991). In this regard, it is interesting that no time diagnostic artifacts from Locality 27 unequivocally date to the past 1000 years suggesting that Locality 27 could be more restricted temporally than most other places in the Tosawihi vicinity.

Additionally, previous research in the Tosawihi vicinity indicates that sites close to water or toolstone sources are fundamentally different from sites away from these resources (Elston and Raven 1991). Sites within 250m of water tend to have a full range of tools on them; sites close to toolstone may have a full range of tools as well, but are dominated by the tools and byproducts of opalite extraction and processing. Since Locality 27 is close to both water and toolstone, we then expect the full suite of prehistoric activities to have occurred at this location. However, if the use of the Tosawihi uplands changed through time, then activities at Locality 27 also may have changed. Because of the long stratigraphic record, Locality 27 presents an ideal location to evaluate these propositions.

Chapter 6

TEST RESULTS, SITE 26EK3516

Site 26Ek3516 lies immediately adjacent the northwestern boundary of the Tosawihi Quarries site 26Ek3032, where it is defined by a light density lithic scatter punctuated by two reduction features (Figure 20; see Figure 2). It was discovered during reconnaissance of a proposed realignment of the Main Access Road to the Ivanhoe Gold Company's Hollister Mine (cf. Drews 1988; IMR 1988c, 1988d).

Cursory perusal of the site surface during survey revealed the bulk of its cultural content to be derived from opalite toolstone processing and thereby implied origins for 26Ek3516 comparable to those responsible for the creation of many other sites recorded in the vicinity (cf. Budy 1988). The additional discovery of projectile points and groundstone at this time, however, suggested that the site had witnessed a broader range of behaviors than those of lithic production alone. Coupled with the potential for buried remains offered by depositional contexts, these observations hinted that the place might contain information pertinent to several research issues developed for the Tosawihi Quarries vicinity by Elston (1988). This potential rendered assessment of the National Register eligibility status of the site unclear on the basis of survey level data alone (IMR/BLM correspondence 11/11/88). As a result, the site was tested in order to evaluate its significance vis-à-vis the National Register of Historic Places and to arrive at a determination of the effect road construction would have upon it.

The present evaluation concludes that 26Ek3516 is ineligible for nomination to the National Register.

Site Description

Spanning elevations between 6100 feet (1859 m) and 6050 feet (1844 m) amsl, 26Ek3516 occupies some 8800 m^2 of the flat crest and gentle southern slopes of Mary's Ridge immediately north of Deer Pass, a low saddle that links the central portion of Mary's Ridge with the western end of Twin Butte and serves as the divide between the watershed of Spring Canyon on the east and that of Basalt Canyon on the west (Figure 20).

General site contexts are characterized by a light to moderate density scatter of opalite debitage. Within this occur two cultural features, both of them defined by more dense accumulations of reduction debris (Figure 21). The formed artifact assemblage is small but varied. In addition to the opalite bifaces and other items directly referable to toolstone processing that dominates the collection, implements indicative of maintenance/subsistence tasks are present as well. These include several flake tools, a pair of projectile points, and a mano (Table 13).

Table 13. Artifacts Recovered from Feature and Nonfeature Contexts, Site 26Ek3516.

		DEBITAGE		FORMED ARTIFACTS					
Feature	Area (m^2)	n	wt. (gm)	Proj. Points	Bifaces	Flake Tools	Hammer-Stones	Ground Stone	Total
1	9	-	-	-	-	1	-	-	1
*	2	5	879	2967.7	-	5	2	-	7
Surface Isolates	N/A	-	-	2	11	-	1	1	15
Other Nonfeature	N/A	92	97.2	-	1	1	-	-	2

*Sample Feature

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

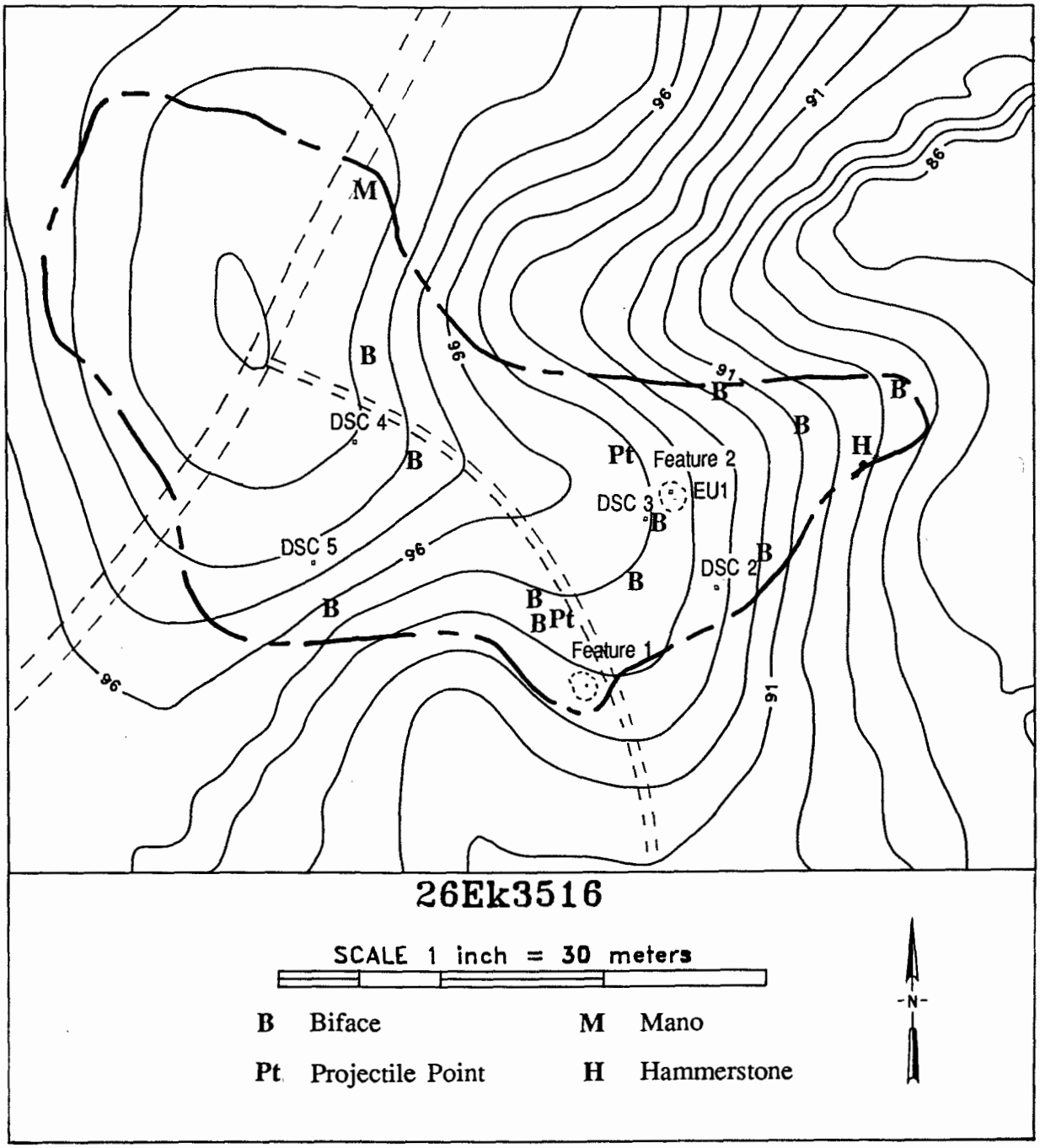


Figure 21. 26Ek3516, site map.

No primary opalite toolstone sources occur within site precincts. Instead, local geology is mapped as platy basaltic andesite (Cornucopia 1987). Site soils are shallow sandy gravelly silts, the product of inplace weathering of the bedrock and contributions of eolian silts. Over most of the site these soils support an open growth of tall sagebrush, low sagebrush, and phlox. Where recent brush fires swept the ridgecrest, nearly half of the site now supports a sparse cover of cheat grass, rabbitbrush, and lupine. Under current conditions, the site lies far from persistent water sources. The nearest perennial supply occurs at Tosawihi Spring, located some 1.5 km to the east and, although water is available seasonally from seeps within upper Basalt Canyon, they are attainable only by means of negotiating several hundred meters of relatively steep slopes.

At the time of fieldwork, the site remained relatively well preserved. The main dirt road linking the Butte, Silver Cloud, and Governor Mines crosses the site from east to west along the ridgecrest and has obliterated a 5 m wide swath through the upper portion of the site. A faint two-track jeep road has inflicted superficial damage where it transits the southern half of the site. Beyond this, the site has been subjected to post-depositional disturbances comparable to those encountered throughout the Tosawihi vicinity (cf. Elston and Dugas 1991). Rodent burrowing is common and has churned deposits extensively while solifluction and colluvial actions, particularly on the steepest site slopes, undoubtedly have translocated artifacts and altered original depositional contexts.

Research Methods

The theoretical approach developed for Tosawihi research by Elston (1988) guided all aspects of the investigation. Field and laboratory methods employed for the collection and analysis of cultural remains were comparable to those applied during the USX testing program in 1988 (Elston 1989:37-46) and were designed to recover data appropriate to the address of specific Tosawihi research questions (Intermountain Research 1988a). Undertaken between April 10 and April 12, 1990, fieldwork at 26Ek3516 included intensive surface reconnaissance, boundary determination, and controlled surface collection and mapping. Minimal controlled subsurface probing was conducted in order to assess the potential for buried remains. Table 14 summarizes collection procedures.

Table 14. Summary of Collection Procedures, Site 26Ek3516.

FEATURES RECORDED		FEATURE CONTEXT		NONFEATURE CONTEXT	
		Surface	Subsurface	Surface	Subsurface
Total (n)	Sampled (n)	Scrape (m^2)	Excavation (m^2)	Scrape (m^2)	Excavation (m^2)
2	1	1	0.25	4	-

Fieldwork commenced with a close interval (two meter) transect survey of the site surface. By this means formed artifacts and cultural features were isolated and site boundaries were established and mapped. Formed artifacts found in nonfeature contexts were point plotted and collected.

Five discretionary surface collection (DSC) units were employed for the purpose of obtaining a volumetrically controlled sample of the cultural content of the lithic scatter visible on the ground surface and

deposits lying immediately out of view just below it. This was accomplished by shovel skimming the upper 2 cm of soil in each unit and passing them through 1/4 inch mesh screen. All cultural material retained by the sieves was collected. Four of the DSC units (Units 2-5) were placed judgmentally throughout non-feature contexts in order to sample the full range of topographic settings offered by the site. The fifth unit (Unit 1) was centered on the densest portion of the surface of Feature 2.

The contents of both cultural features were inventoried, described, drawn in plan, and the formed artifacts on their surfaces were collected. Additional, more invasive sampling focused on Feature 2. The surface scrape unit within it was continued as an excavation unit (EU) in order to assess the vertical dimension of the site. Material was segregated by 10 cm arbitrary stratigraphic levels. A 50 cm x 50 cm quarter of the unit served as a 1/8 inch mesh control quadrant and the remainder of the unit contents were passed through 1/4 inch mesh.

In the laboratory, the recovered artifact assemblage was subjected to data collection and analyses comparable to those undertaken for sites in the USX project areas (Elston 1989:41-45). Standard analytical procedures consistently applied throughout the Great Basin were followed for projectile points (Thomas 1981) and for groundstone (Juell 1990). For bifaces, flake tools, percussion tools, and debitage, procedures modified for specific application to Tosawihi research were employed (Elston and Raven 1991).

Analytical results were incorporated into the Tosawihi Project electronic data bases. Permanent curation of the artifact collection and field documentation for Ek3516 will be undertaken by the Nevada State Museum in Carson City, Nevada.

Test Results

As elsewhere in areas immediately peripheral to the Tosawihi Quarries, "noise" contributed by a ubiquitous background scatter of opalite debitage rendered identification of site boundaries somewhat problematical. Following conventions established for testing of other sites in the area, surface artifact density and shared topographic context were used to isolate 26Ek3516 from amid the general background of debris and to distinguish it from other sites nearby.

Reduced artifact density along the brink of Mary's Ridge defines the boundary over the northern half of the site. Minor drainage channels accompanied by little detectable concomitant change in artifact density were adopted as boundaries on the southwest and northeast and they served to differentiate the site in these quarters from reduction stations of 26Ek3223 and 26Ek3515, respectively. On the south, subtle diminution of flake densities and a change in slope gradient arbitrarily distinguish the site from reduction station 26Ek3224 in Deer Pass. At its eastern limit, gradually decreasing artifact density of 26Ek3516 blends into the sparse lithic scatter that characterizes inter-locality areas in this portion of the Tosawihi Quarries (see Figure 21).

In non-feature contexts, close interval inspection and discretionary surface collection revealed formed artifacts to occur diffusely throughout the site within a light debitage scatter of between 15 and 35 flakes/m^2. Toolstone processing debris constitutes the bulk of the assemblage recovered, here, represented by twelve opalite bifaces, a basalt hammerstone, and a collection of opalite waste. Several implements indicative of maintenance/subsistence chores were encountered here as well, including two projectile points, a flake tool, and a mano. Table 13 summarized the cultural content of non-feature contexts and Table 15 presents the yields from DSC units.

Table 15. Discretionary Surface Collection from Nonfeature Contexts, Site 26Ek3516.

Unit No.	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces	FORMED ARTIFACTS Flake Tools	FORMED ARTIFACTS Total
*2	0.02	24	15.7	-	-	0
3	0.02	35	38.5	-	-	1
4	0.02	15	14.5	-	1	1
5	0.02	18	28.5	1	-	1
Totals	0.08	92	97.2	1	1	2

*DSC Unit 1 served as surface scrape in Feature 2 (cf. Table 6.4)

South-facing ridgeslopes host the two cultural features at 26Ek3516 (see Figure 21). Both are reduction stations manifest by concentrations of opalite processing by-products created by spatially distinct episodes of biface manufacture. Feature 1, the larger, least dense of the features, occurs at the southern edge of the site immediately above Deer Pass. Known only from inventory procedures, it is defined by a 9 m^2 moderate density patch of opalite debitage. Only one formed artifact, a flake tool, was found on its surface (see Table 13). The smaller reduction station, Feature 2, occupies a slight flattening on the ridgeslope located about 35 m to the northeast. It is defined by a high density accumulation of opalite debitage and biface fragments scattered over 5 m^2. Our 1 m x 1 m surface scrape and congruent excavation unit returned an abundance of debitage accompanied by several bifaces and a pair of flake tools. All lithic spoils are opalite; no faunal remains, charcoal, or other cultural residues were returned. Subsurface work penetrated soils that are shallow, turbated, and lack cultural stratigraphy. Although artifactual remains occur throughout unit depths, excavation revealed that Feature 2 is confined almost exclusively to the upper 10 cm of the deposit. Below this only scant remains were encountered until andesitic basalt bedrock halted digging at a depth of ca. 25 cm (Table 16).

Table 16. Artifacts Recovered from Surface Scrapes and Excavation Unit 1, Feature 1, Site 26Ek3516.

Level/Depth (cm B.S.)	Volume Excav. (m^3)	DEBITAGE Flakes n	DEBITAGE Flakes wt. (gm)	DEBITAGE Shatter n	DEBITAGE Shatter wt. (gm)	FORMED ARTIFACTS Bifaces	FORMED ARTIFACTS Flake Tools	FORMED ARTIFACTS Total
5 (0-2)	0.02	237	705.0	12	25.3	3	-	3
1 (2-10)	0.08	414	1658.4	15	274.7	1	-	1
2 (10-20)	0.10	195	303.6	-	-	1	1	2
3 (20-25)	0.05	5	0.7	-	-	-	1	1
Total	0.25	852	2667.7	27	300.0	5	2	7

The bulk of cultural material recovered by test samples from 26Ek3516, regardless of provenience, are referable directly to opalite processing. The reduction assemblage recovered from general site contexts is, save for its dispersed state, comparable to that which constitutes the cultural features (see Table 13). Analysis of the biface assemblage (n=17) coupled with cursory technological characterization of the debitage suggest that the place hosted nearly the full extent of the toolstone processing trajectory recorded for the Tosawihi vicinity: from

blank preparation through late stage biface production (Bloomer and Ataman 1991). Of the 11 specimens for which reduction stage could be identified, most are the product of middle and late stage processing (mid Stage 3 and Stage 4; n=5 and n=2, respectively), two have undergone only initial primary thinning (early Stage 3), and one piece, a large flake, most likely represents a biface blank. Only two of the specimens are complete; the remainder are fragmentary results of manufacturing failures. Most of the bifaces (n=11) have been heat-treated.

Comprised as such, the processing component at 26Ek3516 is essentially identical to assemblages recovered from sites peripheral to the Tosawihi Quarries. It is noteworthy, however, for the uncommon variety of colorful, high quality opalites that comprise it. Differences in material color and texture suggest that contributions from as many as eight separate toolstone sources are represented in the collection. Most of these are of the distinctive polychrome cherts that are available from the quarry pit complexes of the Butterscotch Ridge Archaeological Neighborhood of 26Ek3032.

The scant remainder of the assemblage (weapons, groundstone, and flake tools) imply use of the site for purposes beyond the strict address of toolstone. The two projectile points recovered, one of obsidian and one of opalite, are both referable to Elko Corner-notched types on the basis of Thomas's (1981) key (see Figure 12). Their presence is plausibly attributable to an episode of hunters' re-tooling at the site . Both are fragmentary; their distal ends are truncated by impact fractures. The opalite specimen (01-9) was reworked and reused prior to its ultimate discard. All four of the flake tools in the collection are minimally used implements. Made on small opalite flakes, each displays minor unifacial retouch and they likely were selected from amid the lithic scatter for some expedient cutting, scraping, or graving task. The mano is complete (see Figure 17). It is made on an andesite cobble that, by means of intentional shaping and use, has been rendered oval in plan and biconvex in section. The full extent of both faces is ground and its margins are battered.

Implications

Tests at 26Ek3516 disclose site contents dominated by prolific waste products of opalite processing. These remains are augmented by a small number of maintenance/subsistence tools that may reflect activities ancillary to, but supportive of, toolstone production. Diversity of the assemblage aside, the diffuse distribution of cultural material coupled with the small size and depauperate formed artifact components of the two reduction features there suggest that the place saw comparatively ephemeral, less intensive use than did many more favorably provisioned sites in the vicinity (cf. Leach 1991).

Given its lack of primary toolstone supplies, great distance from water, and non-nutritious vegetation, factors conditioning aboriginal use of 26Ek3516 would appear to stem from its position relative resources lying beyond its limits rather than from any special offering available within the site itself. Indeed, the location of 26Ek3516 next to Deer Pass places it central to several off-site resources. Importantly, Deer Pass forms a natural causeway that joins the high quality toolstone prospects of the Tosawihi Quarries to the east with the opalite-scarce but bitterroot-rich uplands to the west (cf. Raven 1991a). The abundance of distinctively colorful cherts in the assemblage almost certainly originated from the quarries of Butterscotch Ridge. As well, deer are commonly seen in the immediate vicinity and have likely traversed the Pass for millennia when moving between the relatively abundant browse available in the riparian habitats that flank it. The projectile points at the site suggest that someone may have taken advantage of their passage sometime during the Middle Archaic. That the calories sought by these hunters and seed processors were destined to fuel efforts of opalite extraction and reduction is unknowable with certainty. Given the minimal attraction of Tosawihi for anything but stone however, we suspect that this was the case (cf. Raven 1991a).

In this light we suspect that the site's provision of commodious workspace, its location relative to toolstone resources nearby, and perhaps a seasonal opportunity to collect plant foods and take large game, inspired prehistoric visitation of the place.

National Register Evaluation

Testing of 26Ek3516 served as the basis for clarifying issues of its National Register eligibility. Upon completion of fieldwork and laboratory analyses, data garnered by testing were reviewed as a means of evaluating the NRHP significance of the site. The significance of the site resided in the degree to which test results promised that it contained information pertinent to the address of explicit research issues relevant to Tosawihi Quarries prehistory (Intermountain Research 1988a; Budy, Elston, and Raven 1989:13-37).

From this perspective, evaluations conclude that 26Ek3516 does not contain additional data that would contribute productively to the larger context of Tosawihi research. Although of minimal extent, testing seems assuredly to have recovered the full information content of the site. As such, 26Ek3516 is determined to be ineligible for nomination to the National Register. To wit, construction of the Main Access Road to Ivanhoe Gold Company's Hollister Mine will have no adverse effect on the site.

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APPENDIX A

Tephra Analysis

DESERT RESEARCH INSTITUTE
University of Nevada System

Quaternary Sciences Center

7010 Dandini Blvd.
Reno, Nevada 89512

P.O. Box 60220
Reno, Nevada 89506
(702) 673-7303

26 Sept., 1989

Dr. Robert Elston
Intermountain Research
Drawer D
Silver City NV 89428

Dear Bob,

I have examined the sediment samples (2599–128 and 2599–19, and the bag labelled 26EK3032–LOC. 26 –T1– 20) you gave me from the Tosawihi Quarry area and I conclude that they all contain Mazama tephra, from the 6800 yr B.P. eruption at Crater Lake, Oregon.

I took a few grams of each specimen and wetted them with dilute HCl; there was no reaction. I immersed the samples in an ultrasonic cleaner and decanted them repeatedly until the supernatant was fairly clear, to remove coatings and fine particles. I then dried the samples and examined a pinch of each in refractive index oil (n = 1.508) under a cover slip in transmitted light at magnifications of 100 to 400 X.

Sample –128 was about 50% clean glass and mineral fragments, the remainder being aggregates and coated grains. Sample –197 was about 10% clean glass and mineral fragments. Sample –20 was less than 5% glass, but several glass fragments were clearly visible. Each sample contained phytoliths. However, the clean glass and mineral fragments were essentially identical in the three specimens and the following description refers to all three.

Glass morphology was vesicular with vesicles predominantly stretched into spindle shapes. Fine glass was platy, or bubble–wall, in shape. The refractive index of the hydrated glass was very slightly less than 1.508, perhaps 1.5075, and hydration rinds about 3.5 micrometers thick were distinctly visible on thin particles. Green to brown hornblende with adhering glass was present in both –197 and –128.

Although these techniques are cursory, the combination of stratigraphic and geographic setting, and the limited number of possible tephra layers in the area allow me to conclude that the glass in these samples represents the Mazama tephra. Tephra more than 10,000 or 15,000 years old would be completely hydrated and would not display hydration rinds (this applies to ash derived from the Tertiary bedrock, as well). No tephra between 6,800 and 19,000 years old are known from northern Nevada, except the Mazama tephra. Younger tephra would have thinner rinds and the possible candidates (Newberry and Mono Craters) have distinctly lower refractive indices than the samples you provided.

Sincerely,

Dr. Jonathan O. Davis
Research Professor

APPENDIX B

Provenience of Cultural Materials 26Ek3032, Locality 27

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
Surface													
0	2	0	127	14	3	6		9	6				167
EU1													
0												1	1
1	1		6	2								1	10
2			12	1	2								15
3			5		1								6
4			2										2
5													0
subtotal	1	0	25	3	3	0	0	0	0	0	0	2	34
EU2													
0			1									11	12
1			5										5
2			7		2								9
3			4		1						bead		6
4													0
5													0
subtotal	0	0	17	0	3	0	0	0	0	0	1	11	32
EU3													
0													0
1													0

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
2													0
3													0
4													0
5													0
subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0
EU4													
0			2	1								11	14
1			2		1					1		7	11
2	1		1										2
3			7	1									8
4													0
5					1								1
subtotal	1	0	12	2	2	0	0	0	0	1	0	18	36
EU4 1/8"													
0			2	1								16	19
1			1	1	1							1	4
2			3		1								4
3			1										1
4													0
5													0
subtotal	0	0	7	2	2	0	0	0	0	0	0	17	28
EU5													
0												35	35

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
1												7	7
2			10	3	1						bone bead		15
3			2										2
4			2										2
5			3										3
6													0
7			2										2
subtotal	0	0	19	3	1	0	0	0	0	0	1	42	66
EU6													
0			1										1
1				1								1	2
2			1		1								2
3			3										3
4			1	1				1					3
5			1										1
6													0
subtotal	0	0	7	2	1	0	0	1	0	0	0	1	12
EU7													
0			1										1
1			2										2
2	1												1
3													0
4													0
5													0
6													0

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
7													0
8													0
9			2		1								3
10													0
11													0
subtotal	1	0	5	0	1	0	0	0	0	0	0	0	7
EU8													
0													0
1													0
2			1										1
3		2											2
4													0
5			1										1
6													0
subtotal	0	2	2	0	0	0	0	0	0	0	0	0	4
EU8 1/8"													
0													0
1													0
2													0
3													0
4													0
5													0
6													0
subtotal	0	0	0	0	0	0	0	0	0	0	0	0	0

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
EU9													
0			2										2
1			2										2
2			3	1						5			9
3			2	1				1		1			5
4													0
5				1		1							2
6			1										1
7				1		1							2
8													0
9													0
10													0
subtotal	0	0	10	4	0	2	0	1	0	6	0	0	23
EU 10													
0													0
1								1					1
2		1											1
subtotal	0	1	0	0	0	0	0	1	0	0	0	0	2
EU 11													
0				1									1
1			1										1
2			5	1									6
3			1										1
subtotal	0	0	7	2	0	0	0	0	0	0	0	0	9

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
EU 12													
0													0
1			2										2
2			3		1								4
3													0
4													0
subtotal	0	0	5	0	1	0	0	0	0	0	0	0	6
EU 13													
0			1									1	2
1			1										1
2			1										1
3			2										2
4			1		1								2
subtotal	0	0	6	0	1	0	0	0	0	0	0	1	8
EU 18													
0													0
1													0
2													0
3			1.										1
4													0
5													0
subtotal	0	0	1	0	0	0	0	0	0	0	0	0	1

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
EU 19													
0		1	1							1			3
1	1			1						3			5
2			3										3
3			1										1
4													0
5			1										1
subtotal	1	1	6	1	0	0	0	0	0	4	0	0	13
EU 20													
0													0
1									1				1
2			1		1	1							3
3			1										1
4													0
5													0
6													0
7			2										2
8				1									1
9			1										1
10													0
11								1					1
12													0
13													0
14													0
subtotal	0	0	5	1	1	1	0	1	1	0	0	0	10

(cont.)

Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
EU 21													
0													0
1	1												1
2													0
3													0
subtotal	1	0	0	0	0	0	0	0	0	0	0	0	1
EU 23													
0													0
1													0
2			2	1									3
3													0
4													0
subtotal	0	0	2	1	0	0	0	0	0	0	0	0	3
EU 25													
0													0
1			2										2
2				1									1
3			3					1					4
4			1										1
subtotal	0	0	6	1	0	0	0	1	0	0	0	0	8
EU 27													
0		1											1
1	1		4	1									6

(cont.)

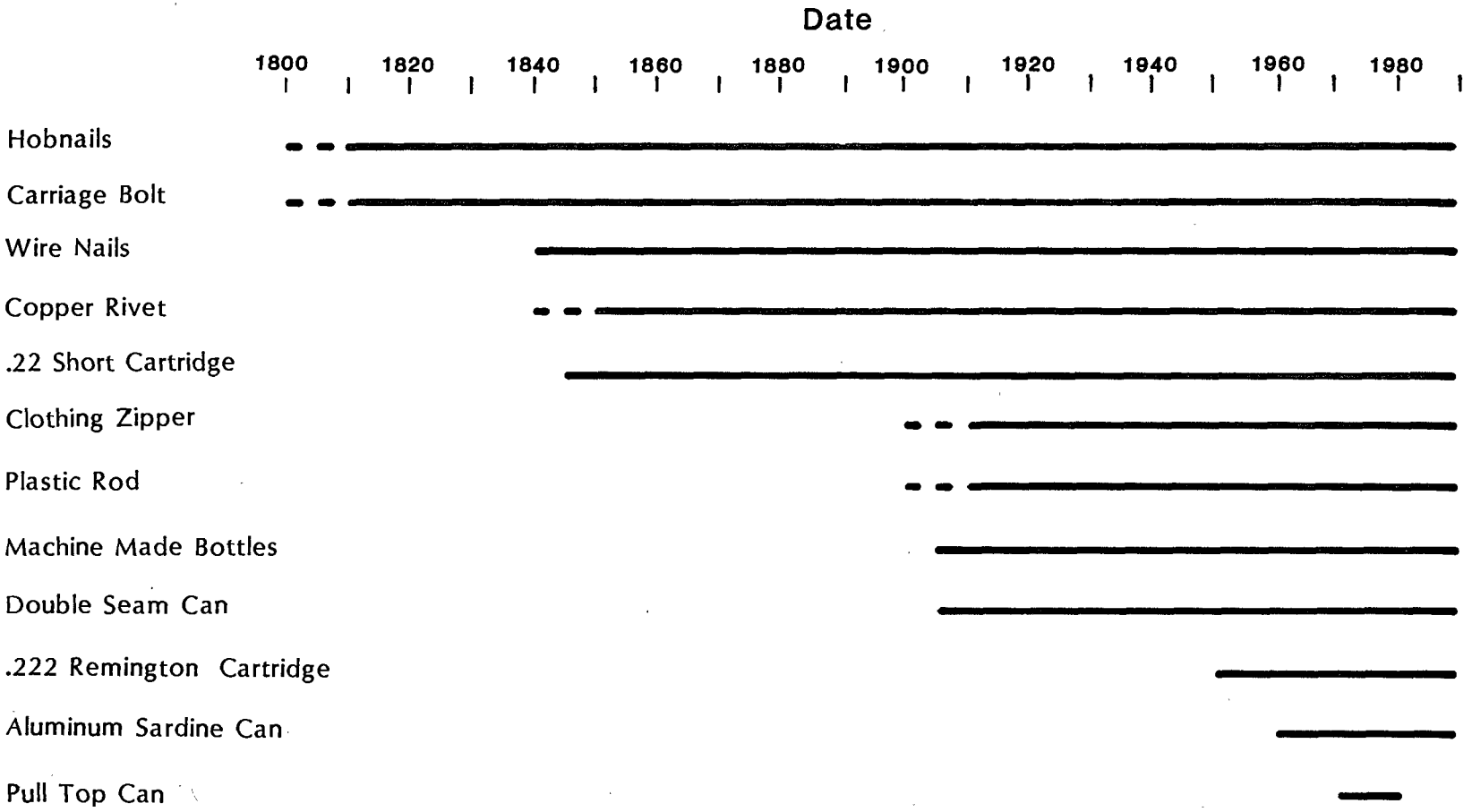
Provenience of Cultural Materials, 26Ek3032, Locality 27

LEVEL	PROJ. PTS.	PREFORMS	BIFACES	FLAKE TOOLS	MOD. CHUNK	HAMMERS	CHOPPERS	CORES	GROUNDSTONE	POTTERY	MISC.	HISTORICAL	TOTAL
2			5										5
3													0
4				1									1
5													0
subtotal	1	1	9	2	0	0	0	0	0	0	0	0	13
TOTAL	8	5	278	38	19	9	0	14	7	11	2	92	483

APPENDIX C

Temporal Span of Historic Artifacts 26Ek3032, Locality 27

26Ek3032 Locality 27



APPENDIX D

Morphological Attributes of Projectile Points and Preforms, 26Ek3032, Locality 27

Morphological Attributes of Projectile Points and Preforms.

Ref. #	Type	Locality	Unit	Level	Depth	Material	Lt	La	Lm	Wm	Wb	NW	Th	Act Wt	Est Wt	DSA	PSA	NOI	La/Lt	Lt/Wm	Wb/Wm	Comp
6062-2	GSS	27	Eu4	2	10-20	Opalite	(34.6)	(30.4)	9.5	26.2	12.4	12.2	3.7	2.7	3.0	140	94	44	.88	1.32	.43	-
01-130	LSN	27	1a	Surf		Obsidian	(44.0)	(44.0)		(19.5)	(19.5)	10.0	4.1	2.0	2.5	190	(162)	(28)	1.00	2.26	1.00	-
6521-1	OOK (Cottonwood)	27	Eu27	1	2-10	Obsidian	18.6	18.6	8.5	9.6	7.2	6.5	2.0	.4	.4	227	103	124	1.00	1.94	.75	+
01-45	OOK (Stemmed)	27	1a	Surf		Opalite	41.3			17.5			5.2	3.9								-
6401-1	OOK	27	Eu21	1	2-10	Opalite	45.1	43.4	5.1	22.4	21.9		4.5	2.4	5.0				.96	2.01	.98	-
6122-1	Fragment	27	Eu7	2	10-20	Opalite	33.2			22.8			3.5	2.2								
6143-1	Fragment	27	Eu8	3	20-30	Opalite	16.0			21.5			4.3	2.1								
6361-6	Fragment	27	Eu19	1	2-10	Opalite	11.9			7.9			1.4	.2								
6143-2	Preform	27	Eu8	3	20-30	Opalite	31.6			21.5			4.0	2.6								-
6520-1	Preform	27	Eu27	Surf	0-2	Opalite	26.4			19.1			4.5	2.4								-
6360-5	Preform	27	Eu19	Surf	0-2	Opalite	22.7			14.8			2.7	.8								-
6182-2	Preform	27	Eu10	2	10-20	Opalite	20.4			17.2			3.2	1.3								-
01-96	Preform	27	1a	Surf		Obsidian	24.8			15.0			3.6	1.4								+

Key:

GSS = Gatecliff Split Stem
LSN = Large Side-Notch
OOK = Out of Key

Lt = Total Length
La = Axial Length
Lm = Length Max. Width
Wm = Maximum Width
Wb = Basal Width
NW = Neck Width
Th = Thickness

Act Wt = Actual Weight
Est Wt = Estimated Weight
DSA = Distal Shoulder Angle
PSA = Proximal Shoulder Angle
NOI = Notch Opening Index
La/Lt = Basal Indentation Ration (BIR)
Lt/Wm = Length-Width Ratio
Wb/Wm = Basal Width-Maximum Width Ratio

Comp = Completeness
+ Complete
- Fragment

APPENDIX E

Radiocarbon Results, 26Ek3032, Locality 26

BETA ANALYTIC INC.

RADIOCARBON DATING, STABLE ISOTOPE RATIOS
P.O. BOX 248113 CORAL GABLES, FLORIDA 33124 - (305) 667-5167
BITNET XNRBET22@SERVAX

March 5, 1990

Mr. Steven G. Botkin
Intemountain Research
Drawer A
Silver City, Nevada 89428

Dear Mr. Botkin:

Please find enclosed the result on the charcoal sample recently submitted for radiocarbon dating analysis. We hope this date will be useful in your research.

Your charcoal was pretreated by first examining for rootlets. The sample was then given a hot acid wash to eliminate carbonates. It was repeatedly rinsed to neutrality and subsequently given a hot alkali soaking to take out humic acids. After rinsing to neutrality, another acid wash followed and another rinsing to neutrality. The following benzene synthesis and counting proceeded normally.

The sample was small, as indicated on the date report sheet. It was given extended counting time (four times the normal amount) to reduce the statistical error as much as practical.

We are enclosing our invoice. If there are any questions or if you would like to confer on the date, my direct telephone number is listed above. Both my partner and I have over thirty years experience in radiocarbon dating. Please don't hesitate to call us if we can be of help.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

P.S. I'm including some data sheets for future samples and a copy of our new brochure for your files.

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Steven G. Botkin
Intermountain Research

DATE RECEIVED: February 7, 1990
DATE REPORTED: March 5, 1990

SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	
Beta-35573	26EK3032 Loc 26 2599-196 (0.35 gram carbon)	510 +/- 80 BP	(charcoal)

Note: the small sample was given extended counting time.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

APPENDIX F

Mass Analysis Results, by Excavation Unit, 26Ek3032, Locality 27

Debitage Summary, 26EK3032, Locality 27

EU Number	Depth B.S. (cm)	Cubic meters excavated	Raw material type	Total flakes recovered count	Total flakes recovered weight (g)	Flakes w/platfm count	Flakes w/platfm weight (g)	Flake fragments count	Flake fragments weight (g)	Mass Analysis Classification
1	0-2	0.02	Opalite	248	324.9	76	182.9	172	142.0	Early Biface
1	0-2	0.02	Jasper	2	0.6	0	0.0	2	0.6	Not classified
1	2-10	0.08	Opalite	886	1300.2	292	673.7	594	626.5	Early Biface
1	2-10	0.08	Jasper	1	0.1	0	0.0	1	0.1	Not classified
1	10-20	0.10	Opalite	758	1739.8	271	991.2	487	748.6	Early Biface
1	10-20	0.10	Obsidian	1	0.2	0	0.0	1	0.2	Not classified
1	20-30	0.10	Opalite	202	785.4	69	431.9	133	353.5	Early Biface
1	20-30	0.10	Other	1	77.9	1	77.9	0	0.0	Not classified
1	30-40	0.10	Opalite	83	349.2	30	236.6	53	112.6	Early Biface
1	30-40	0.10	Jasper	2	118.6	1	117.2	1	1.4	Not classified
1	40-50	0.10	Opalite	17	32.3	9	25.1	8	7.2	Not classified
2	0-2	0.02	Opalite	292	321.2	201	141.0	91	180.2	Early Biface
2	2-10	0.08	Opalite	644	952.6	223	461.9	421	490.7	Early Biface
2	2-10	0.08	Jasper	9	7.4	5	5.8	4	1.6	Not classified
2	10-20	0.10	Opalite	556	1179.2	210	299.4	346	879.8	Early Biface
2	10-20	0.10	Jasper	6	21.8	2	2.1	4	19.7	Not classified
2	20-30	0.10	Opalite	399	1530.1	80	871.3	319	658.8	Early Biface
2	20-30	0.10	Jasper	3	1.2	0	0.0	3	1.2	Not classified
2	30-40	0.10	Opalite	68	180.1	26	74.8	42	105.3	Early Biface
2	40-50	0.10	Opalite	64	69.1	28	47.5	36	21.6	Early Biface
3	0-2	0.02	Opalite	10	20.9	2	17.5	8	3.4	Not classified
3	2-10	0.08	Opalite	9	9.7	3	4.4	6	5.3	Not classified
3	10-20	0.10	Opalite	40	101.9	20	77.3	20	24.6	Not classified
3	20-30	0.10	Opalite	34	82.6	13	68.3	21	14.3	Not classified
3	30-40	0.10	Opalite	60	59.4	12	17.5	48	41.9	Mixed Biface
3	40-50	0.10	Opalite	5	19.2	1	16.9	4	2.3	Not classified
4	0-2	0.02	Opalite	254	189.3	137	106.9	117	82.4	Early Biface
4	2-10	0.08	Opalite	801	1455.4	253	655.4	548	800.0	Early Biface
4	2-10	0.08	Jasper	9	7.3	3	1.9	6	5.4	Not classified
4	10-20	0.10	Opalite	825	2388.2	310	1553.8	515	834.4	Early Biface
4	10-20	0.10	Jasper	0	0.0	0	0.0	0	0.0	Not classified
4	20-30	0.10	Opalite	528	589.8	234	321.8	294	268.0	Early Biface
4	20-30	0.10	Obsidian	1	0.1	0	0.0	1	0.1	Not classified
4	30-40	0.10	Opalite	222	203.1	72	63.1	150	140.0	Early Biface

(cont.)

Debitage Summary, 26EK3032, Locality 27

EU Number	Depth B.S. (cm)	Cubic meters excavated	Raw material type	Total flakes recovered count	Total flakes recovered weight (g)	Flakes w/platfm count	Flakes w/platfm weight (g)	Flake fragments count	Flake fragments weight (g)	Mass Analysis Classification
4	40-50	0.07	Opalite	174	269.4	49	130.5	125	138.9	Early Biface
5	0-2	0.02	Opalite	161	208.2	45	80.3	116	127.9	Early Biface
5	0-2	0.02	Jasper	1	0.4	0	0.0	1	0.4	Not classified
5	2-10	0.08	Opalite	351	456.8	138	283.5	213	173.3	Early Biface
5	10-20	0.02	Opalite	1295	3924.3	430	1802.8	865	2121.5	Early Biface
5	10-20	0.02	Jasper	17	7.2	8	3.8	9	3.4	Not classified
5	20-30	0.08	Opalite	388	918.7	140	577.0	248	341.7	Early Biface
5	20-30	0.08	Jasper	5	2.3	0	0.0	5	2.3	Not classified
5	20-30	0.08	Other	1	0.3	1	0.3	0	0.0	Not classified
5	30-40	0.10	Opalite	371	1182.6	164	972.8	207	209.8	Early Biface
5	30-40	0.10	Jasper	3	0.6	3	0.6	0	0.0	Not classified
5	40-50	0.10	Opalite	218	763.1	80	258.5	138	504.6	Early Biface
5	40-50	0.10	Jasper	4	3.8	1	0.8	3	3.0	Not classified
5	50-60	0.10	Opalite	259	340.0	94	210.9	165	129.1	Early Biface
5	50-60	0.10	Jasper	3	1.9	1	0.2	2	1.7	Not classified
5	60-70	0.10	Opalite	170	192.6	72	73.9	98	118.7	Early Biface
6	0-2	0.02	Opalite	132	124.7	33	37.0	99	87.7	Early Biface
6	0-2	0.02	Jasper	3	3.1	1	2.6	2	0.5	Not classified
6	2-10	0.08	Opalite	362	362.8	86	119.3	276	243.5	Early Biface
6	2-10	0.08	Jasper	2	1.5	2	1.5	0	0.0	Not classified
6	10-20	0.10	Opalite	535	651.9	120	220.3	415	431.6	Early Biface
6	10-20	0.10	Jasper	5	1.5	1	0.3	4	1.2	Not classified
6	10-20	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
6	20-30	0.10	Opalite	299	483.4	60	152.7	239	330.7	Early Biface
6	30-40	0.10	Opalite	236	345.0	70	158.0	166	187.0	Early Biface
6	30-40	0.10	Jasper	2	0.9	2	0.9	0	0.0	Not classified
6	40-50	0.10	Opalite	236	405.1	79	221.9	157	183.2	Early Biface
6	40-50	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
6	50-60	0.10	Opalite	106	219.7	21	16.2	85	203.5	Early Biface
6	50-60	0.10	Jasper	2	2.3	1	2.0	1	0.3	Not classified
7	0-2	0.02	Opalite	41	46.3	10	15.6	31	30.7	Not classified
7	2-10	0.08	Opalite	98	183.3	51	111.2	47	72.1	Early Biface
7	10-20	0.10	Opalite	103	195.2	40	109.8	63	85.4	Early Biface
7	10-20	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified

(cont.)

Debitage Summary, 26EK3032, Locality 27

EU Number	Depth B.S. (cm)	Cubic meters excavated	Raw material type	Total flakes recovered count	Total flakes recovered weight (g)	Flakes w/platfm count	Flakes w/platfm weight (g)	Flake fragments count	Flake fragments weight (g)	Mass Analysis Classification
7	20-30	0.10	Opalite	92	175.1	25	43.4	67	131.7	Early Biface
7	20-30	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
7	30-40	0.10	Opalite	116	342.8	35	266.1	81	76.7	Early Biface
7	30-40	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
7	40-50	0.10	Opalite	166	372.7	51	188.1	115	184.6	Early Biface
7	50-60	0.10	Opalite	128	239.0	35	99.8	93	139.2	Early Biface
7	50-60	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
7	60-70	0.10	Opalite	71	80.7	29	55.1	42	25.6	Early Biface
7	60-70	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
7	70-80	0.10	Opalite	60	180.9	22	134.6	38	46.3	Early Biface
7	80-90	0.10	Opalite	108	296.5	44	187.6	64	108.9	Early Biface
7	90-100	0.10	Opalite	70	136.3	17	76.7	53	59.6	Early Biface
7	100-110	0.09	Opalite	102	134.4	34	66.5	68	67.9	Early Biface
8	2-10	0.08	Opalite	96	121.0	28	65.1	68	55.9	Early Biface
8	10-20	0.10	Opalite	372	560.4	89	292.6	283	267.8	Early Biface
8	20-30	0.10	Opalite	274	1006.8	103	583.0	171	423.8	Early Biface
8	30-40	0.10	Opalite	133	280.2	49	106.3	84	173.9	Early Biface
8	40-50	0.10	Opalite	138	157.1	52	64.2	86	92.9	Early Biface
8	50-60	0.10	Opalite	99	297.7	35	206.1	64	91.6	Early Biface
9	0-2	0.02	Opalite	101	220.1	36	37.2	65	182.9	Early Biface
9	2-10	0.08	Opalite	881	781.2	172	358.0	709	423.2	Early Biface
9	10-20	0.10	Opalite	908	881.4	248	404.1	660	477.3	Early Biface
9	10-20	0.10	Jasper	2	2.2	1	0.4	1	1.8	Not classified
9	10-20	0.10	Basalt	1	0.4	0	0.0	1	0.4	Not classified
9	20-30	0.10	Opalite	384	762.2	130	523.9	254	238.3	Early Biface
9	30-40	0.10	Opalite	178	267.3	62	115.3	116	152.0	Early Biface
9	40-50	0.10	Opalite	217	288.2	78	137.1	139	151.1	Early Biface
9	50-60	0.10	Opalite	97	90.3	34	26.7	63	63.6	Early Biface
9	60-70	0.10	Opalite	112	186.5	38	113.6	74	72.9	Early Biface
9	70-80	0.10	Opalite	119	328.3	35	131.9	84	196.4	Early Biface
9	80-90	0.10	Opalite	84	101.0	31	63.9	53	37.1	Mixed Biface
9	90-100	0.10	Opalite	34	81.3	17	69.4	17	11.9	Not classified
10	0-2	0.02	Opalite	21	34.9	3	4.6	18	30.3	Not classified
10	2-10	0.08	Opalite	28	108.9	15	101.8	13	7.1	Not classified

(cont.)

Debitage Summary, 26EK3032, Locality 27

EU Number	Depth B.S. (cm)	Cubic meters excavated	Raw material type	Total flakes recovered count	Total flakes recovered weight (g)	Flakes w/platfm count	Flakes w/platfm weight (g)	Flake fragments count	Flake fragments weight (g)	Mass Analysis Classification
10	10-20	0.10	Opalite	27	113.7	17	108.0	10	5.7	Not classified
11	0-2	0.02	Opalite	57	62.7	20	23.7	37	39.0	Early Biface
11	2-10	0.08	Opalite	155	201.0	0	0.0	155	201.0	Early Biface
11	10-20	0.10	Opalite	398	795.5	172	461.4	226	334.1	Early Biface
11	20-30	0.10	Opalite	73	184.5	50	97.8	23	86.7	Early Biface
12	0-2	0.02	Opalite	19	69.3	4	31.1	15	38.2	Not classified
12	2-10	0.08	Opalite	74	75.8	40	56.7	34	19.1	Mixed Biface
12	10-20	0.10	Opalite	325	452.7	139	337.3	186	115.4	Early Biface
12	10-20	0.10	Jasper	1	24.2	1	24.2	0	0.0	Not classified
12	20-30	0.10	Opalite	181	304.2	80	239.4	101	64.8	Early Biface
12	30-40	0.10	Opalite	88	253.3	41	225.7	47	27.6	Early Biface
13	0-2	0.02	Opalite	94	79.2	16	21.6	78	57.6	Mixed Biface
13	0-2	0.02	Jasper	1	0.9	1	0.9	0	0.0	Not classified
13	2-10	0.08	Opalite	206	334.1	67	161.8	139	172.3	Early Biface
13	10-20	0.10	Opalite	341	451.1	154	265.8	187	185.3	Early Biface
13	20-30	0.10	Opalite	176	262.9	62	172.6	114	90.3	Early Biface
13	20-30	0.10	Jasper	0	0.0	0	0.0	0	0.0	Not classified
13	30-40	0.10	Opalite	58	565.7	28	523.7	30	42.0	Early Biface
18	0-2	0.02	Opalite	34	61.2	5	32.4	29	28.8	Not classified
18	2-10	0.08	Opalite	97	136.5	22	40.1	75	96.4	Early Biface
18	10-20	0.10	Opalite	62	94.8	11	15.6	51	79.2	Early Biface
18	20-30	0.10	Opalite	79	150.1	10	28.0	69	122.1	Early Biface
18	30-40	0.10	Opalite	44	168.6	8	66.7	36	101.9	Not classified
18	40-50	0.04	Opalite	49	97.9	6	4.3	43	93.6	Not classified
19	0-2	0.02	Opalite	114	214.9	28	43.2	86	171.7	Early Biface
19	2-10	0.08	Opalite	731	1581.2	273	1022.8	458	558.4	Early Biface
19	10-20	0.10	Opalite	806	2297.8	317	1535.0	489	762.8	Early Biface
19	20-30	0.10	Opalite	147	197.7	74	124.5	73	73.2	Early Biface
19	30-40	0.10	Opalite	72	82.8	28	34.9	44	47.9	Early Biface
19	40-50	0.10	Opalite	29	28.2	8	13.6	21	14.6	Not classified
20	0-2	0.02	Opalite	63	118.4	26	38.6	37	79.8	Early Biface

(cont.)

Debitage Summary, 26EK3032, Locality 27

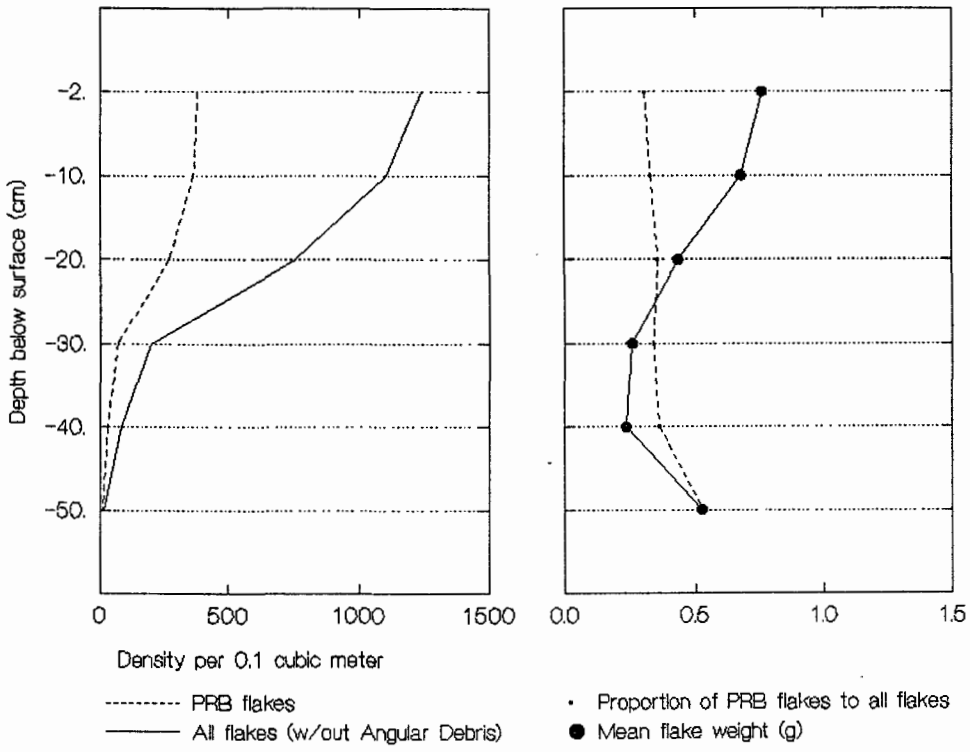
EU Number	Depth B.S. (cm)	Cubic meters excavated	Raw material type	Total flakes recovered count	Total flakes recovered weight (g)	Flakes w/platfm count	Flakes w/platfm weight (g)	Flake fragments count	Flake fragments weight (g)	Mass Analysis Classification
20	2-10	0.08	Opalite	409	524.0	106	183.6	303	340.4	Early Biface
20	2-10	0.08	Jasper	0	0.0	0	0.0	0	0.0	Not classified
20	10-20	0.10	Opalite	312	452.5	103	291.1	209	161.4	Early Biface
20	10-20	0.10	Jasper	0	0.0	0	0.0	0	0.0	Not classified
20	20-30	0.10	Opalite	342	616.0	132	381.9	210	234.1	Early Biface
20	20-30	0.10	Jasper	0	0.0	0	0.0	0	0.0	Not classified
20	30-40	0.10	Opalite	204	456.8	77	321.8	127	135.0	Early Biface
20	40-50	0.10	Opalite	172	644.2	67	512.1	105	132.1	Early Biface
20	50-60	0.10	Opalite	150	375.0	54	223.2	96	151.8	Early Biface
20	60-70	0.10	Opalite	117	106.1	28	24.2	89	81.9	Mixed Biface
20	60-70	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
20	70-80	0.10	Opalite	66	420.0	29	364.7	37	55.3	Early Biface
20	80-90	0.10	Opalite	75	148.6	15	70.6	60	78.0	Early Biface
20	90-100	0.10	Opalite	46	170.6	22	143.3	24	27.3	Not classified
20	100-110	0.10	Opalite	59	64.5	25	42.1	34	22.4	Early Biface
20	110-120	0.10	Opalite	40	140.7	25	116.6	15	24.1	Not classified
20	120-130	0.10	Opalite	26	46.0	4	4.5	22	41.5	Not classified
20	130-140	0.10	Opalite	8	62.5	7	47.9	1	14.6	Not classified
21	0-2	0.02	Opalite	121	104.6	30	31.9	91	72.7	Mixed Biface
21	2-10	0.08	Opalite	141	102.4	42	26.8	99	75.6	Early Biface
21	2-10	0.08	Jasper	3	2.6	2	2.2	1	0.4	Not classified
21	10-20	0.10	Opalite	110	130.5	27	46.1	83	84.4	Early Biface
21	10-20	0.10	Jasper	1	0.4	1	0.4	0	0.0	Not classified
21	20-30	0.10	Opalite	28	202.4	9	171.3	19	31.1	Not classified
23	0-2	0.02	Opalite	23	21.8	19	20.0	4	1.8	Not classified
23	2-10	0.08	Opalite	120	96.4	29	30.9	91	65.5	Mixed Biface
23	2-10	0.08	Jasper	1	0.2	0	0.0	1	0.2	Not classified
23	10-20	0.10	Opalite	179	264.1	62	162.8	117	101.3	Early Biface
23	10-20	0.10	Jasper	1	0.4	0	0.0	1	0.4	Not classified
23	20-30	0.10	Opalite	66	74.1	20	40.8	46	33.3	Early Biface
23	20-30	0.10	Jasper	1	0.2	1	0.2	0	0.0	Not classified
23	30-40	0.10	Opalite	27	32.1	9	24.7	18	7.4	Not classified
23	30-40	0.10	Jasper	1	0.4	1	0.4	0	0.0	Not classified
25	0-2	0.02	Opalite	6	1.7	1	0.2	5	1.5	Not classified

(cont.)

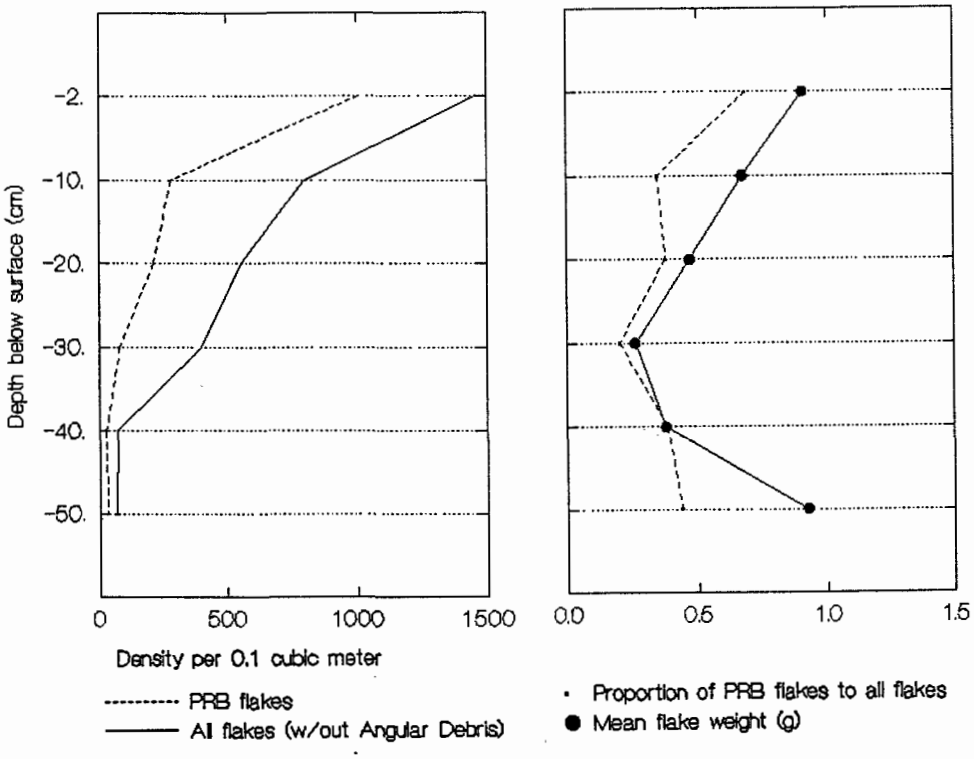
Debitage Summary, 26EK3032, Locality 27

EU Number	Depth B.S. (cm)	Cubic meters excavated	Raw material type	Total flakes recovered count	Total flakes recovered weight (g)	Flakes w/platfm count	Flakes w/platfm weight (g)	Flake fragments count	Flake fragments weight (g)	Mass Analysis Classification
25	2-10	0.08	Opalite	23	34.8	10	21.3	13	13.5	Not classified
25	10-20	0.10	Opalite	64	260.8	18	145.9	46	114.9	Early Biface
25	20-30	0.10	Opalite	75	402.2	23	210.6	52	191.6	Early Biface
25	20-30	0.10	Jasper	1	0.4	1	0.4	0	0.0	Not classified
25	30-40	0.10	Opalite	74	534.1	25	457.8	49	76.3	Early Biface
27	0-2	0.02	Opalite	65	38.4	20	17.2	45	21.2	Mixed Biface
27	2-10	0.08	Opalite	394	519.7	125	167.1	269	352.6	Early Biface
27	2-10	0.08	Jasper	3	5.3	1	4.5	2	0.8	Not classified
27	10-20	0.10	Opalite	484	465.9	158	240.4	326	225.5	Early Biface
27	10-20	0.10	Jasper	8	4.4	5	2.7	3	1.7	Not classified
27	10-20	0.10	Other	0	0.0	0	0.0	0	0.0	Not classified
27	20-30	0.10	Opalite	77	96.3	19	21.8	58	74.5	Early Biface
27	30-40	0.10	Opalite	70	87.2	18	37.8	52	49.4	Mixed Biface
27	40-50	0.10	Opalite	18	30.9	9	17.2	9	13.7	Not classified

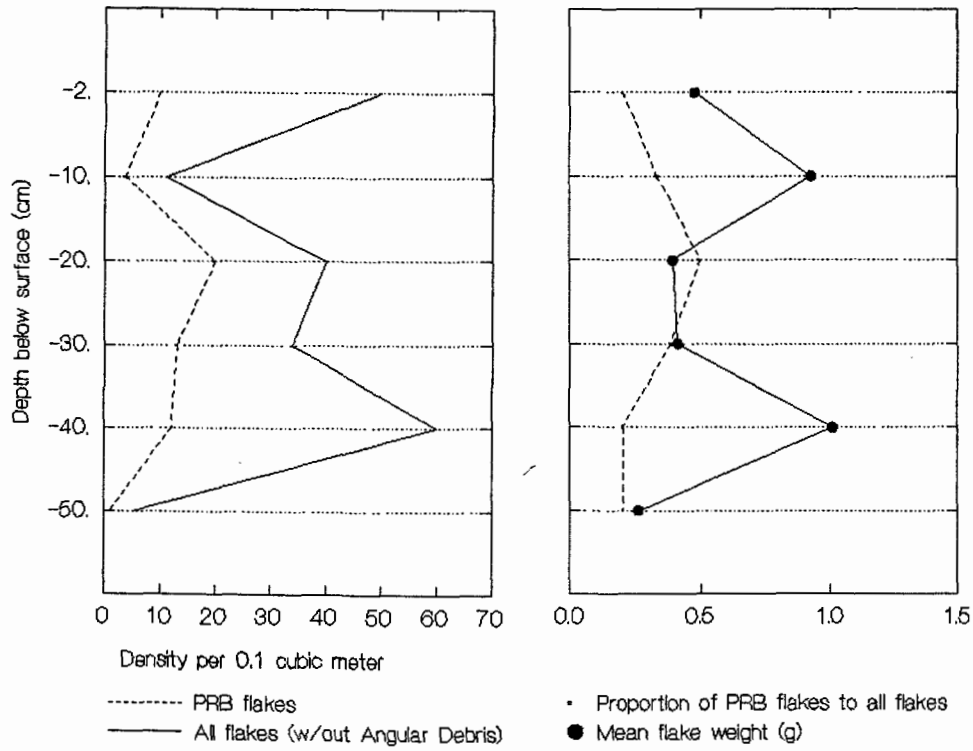
Unit 1 -- Opalite debitage



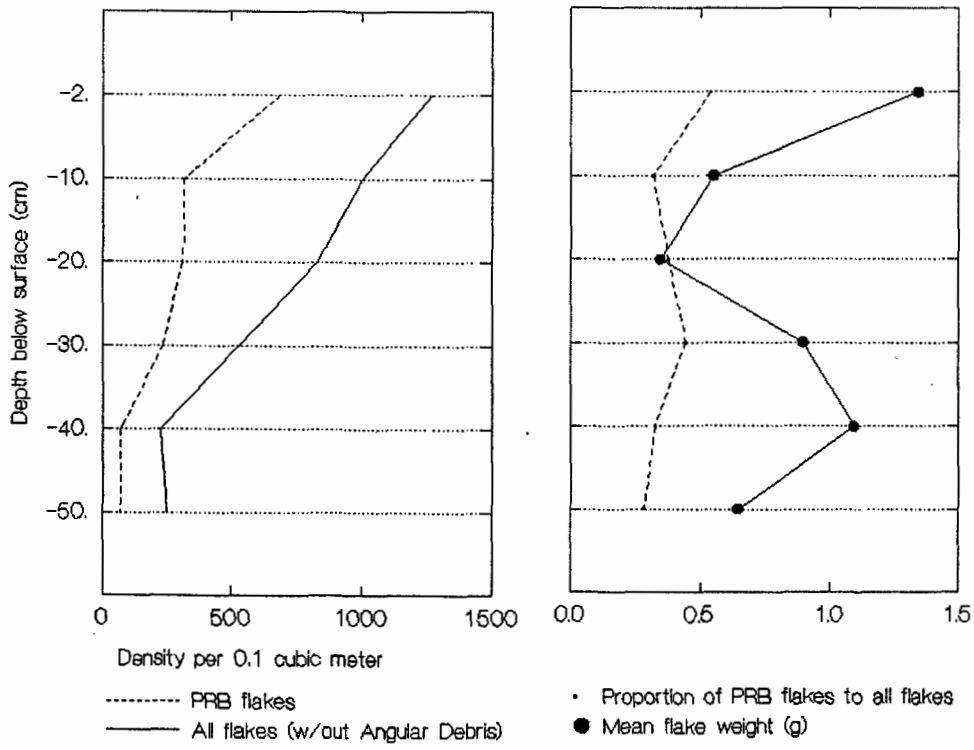
Unit 2 -- Opalite debitage



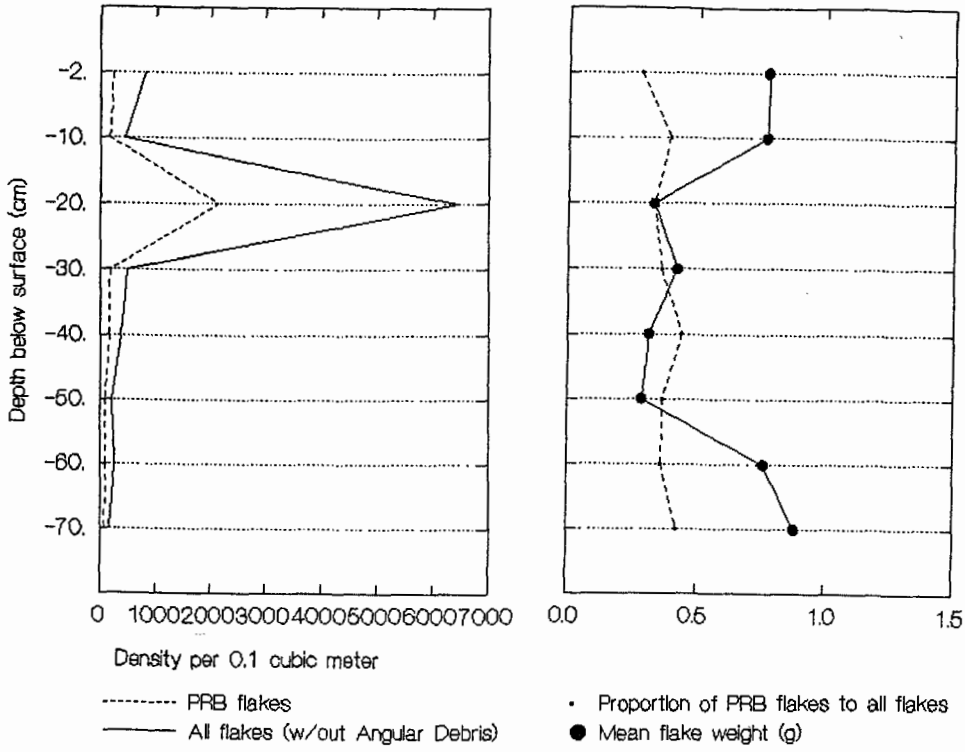
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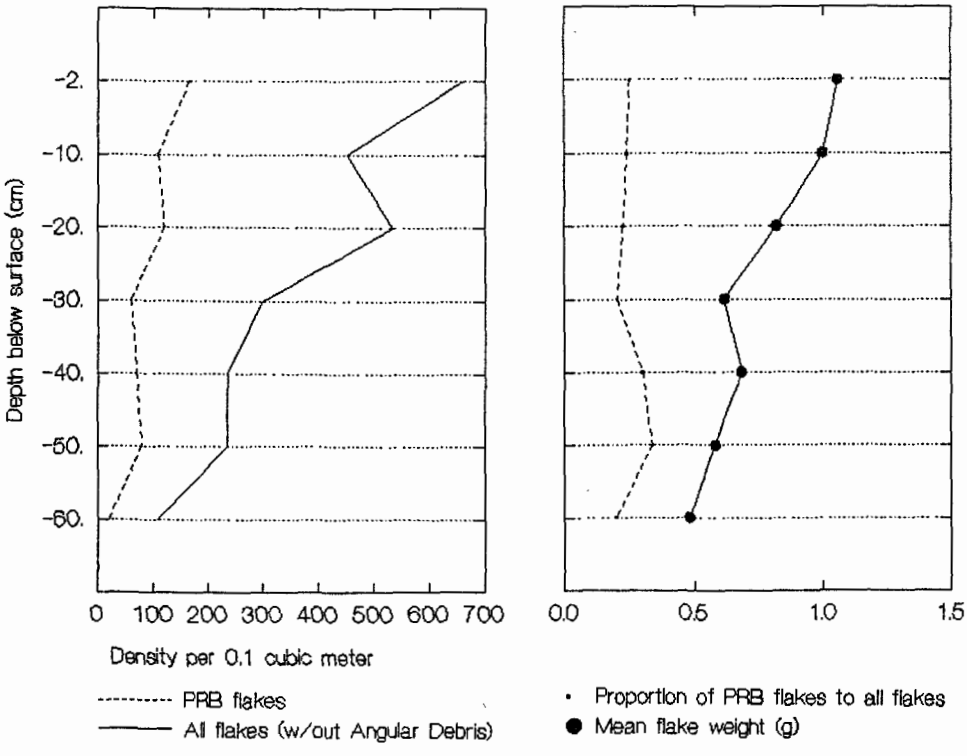
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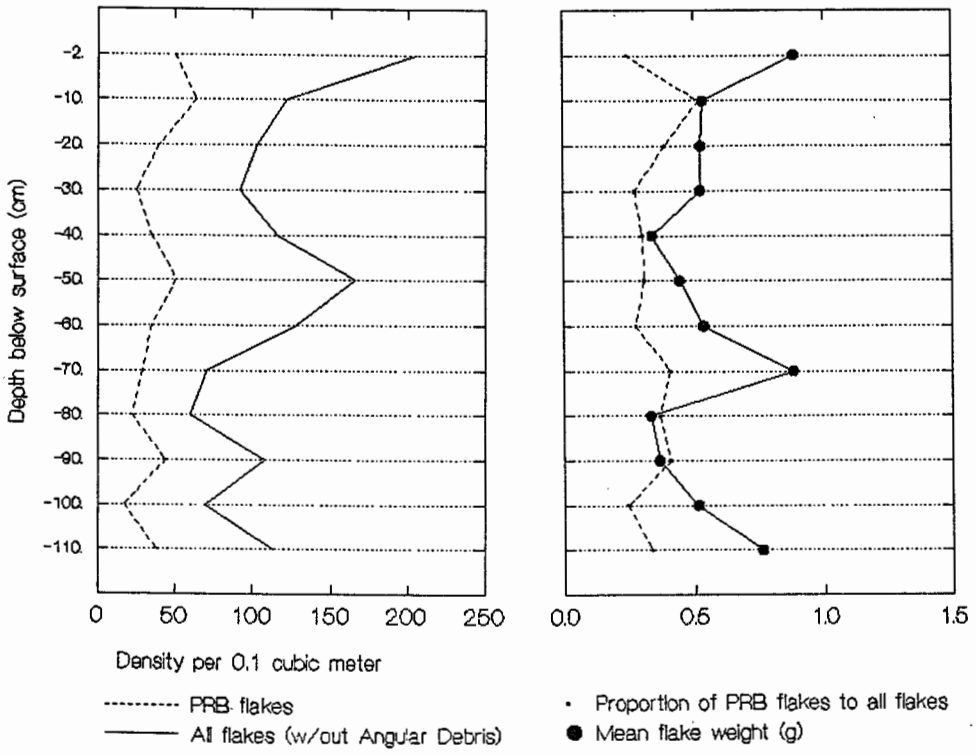
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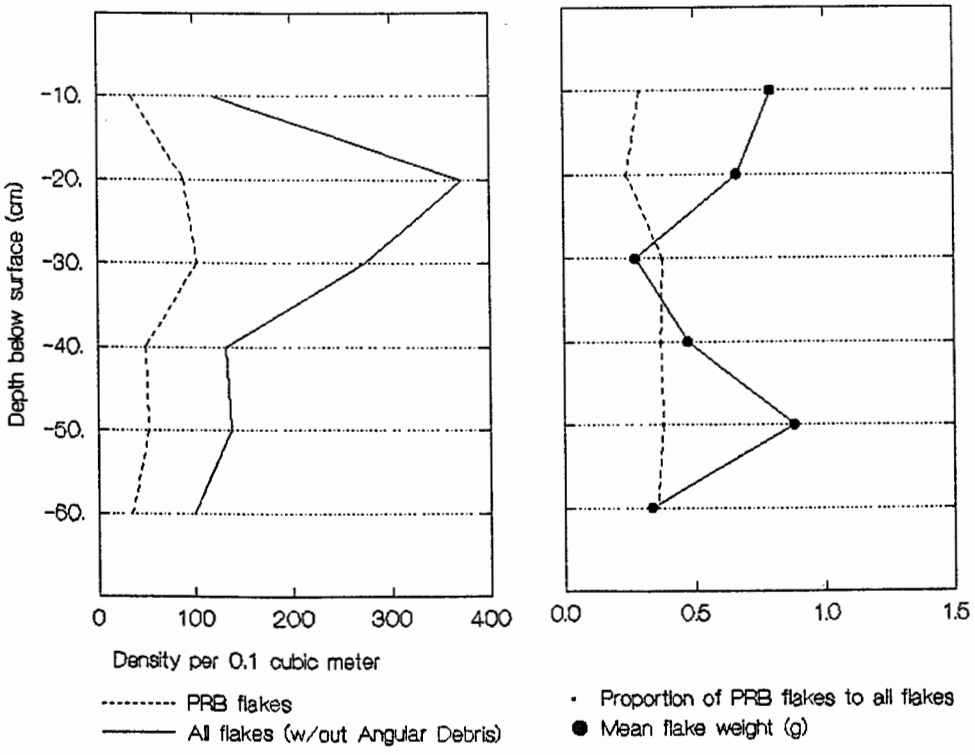
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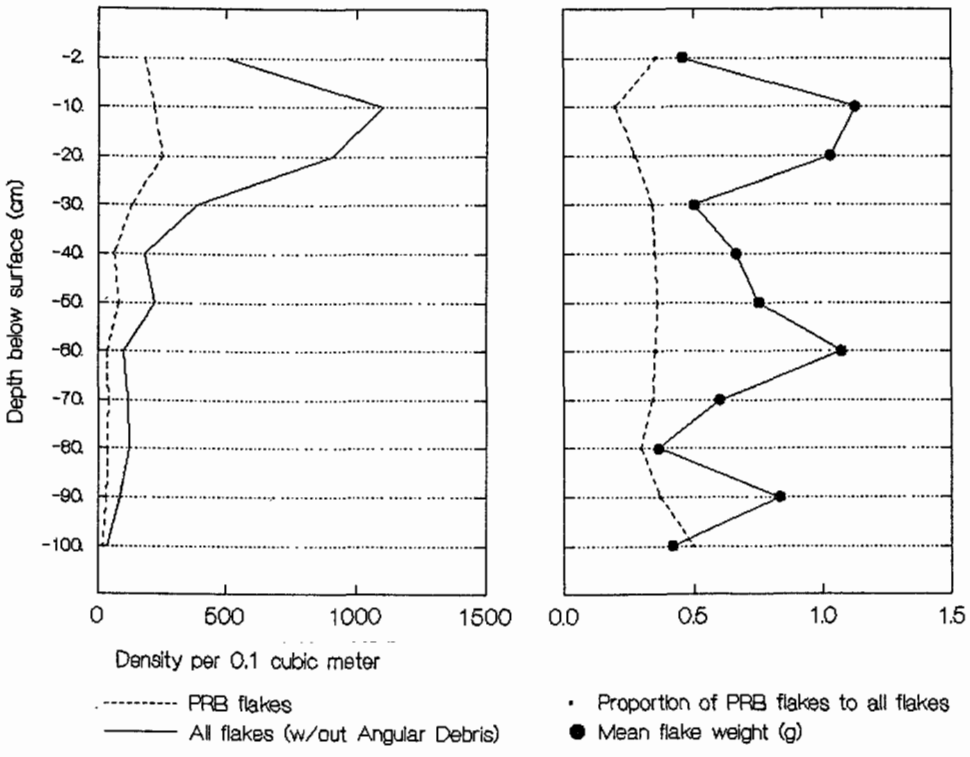
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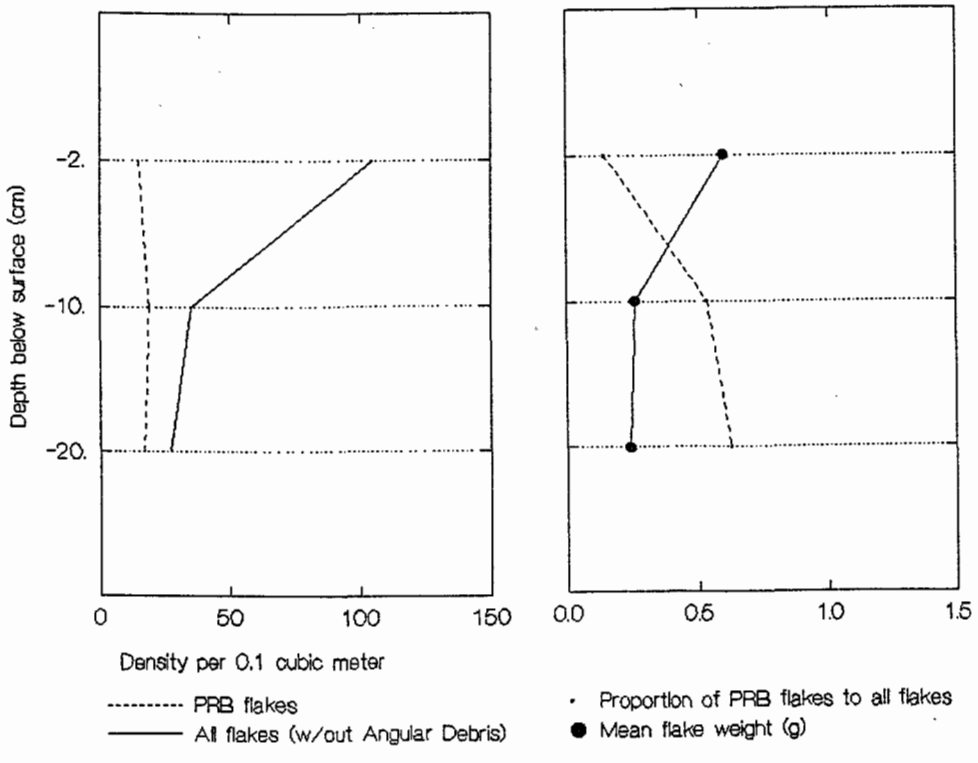
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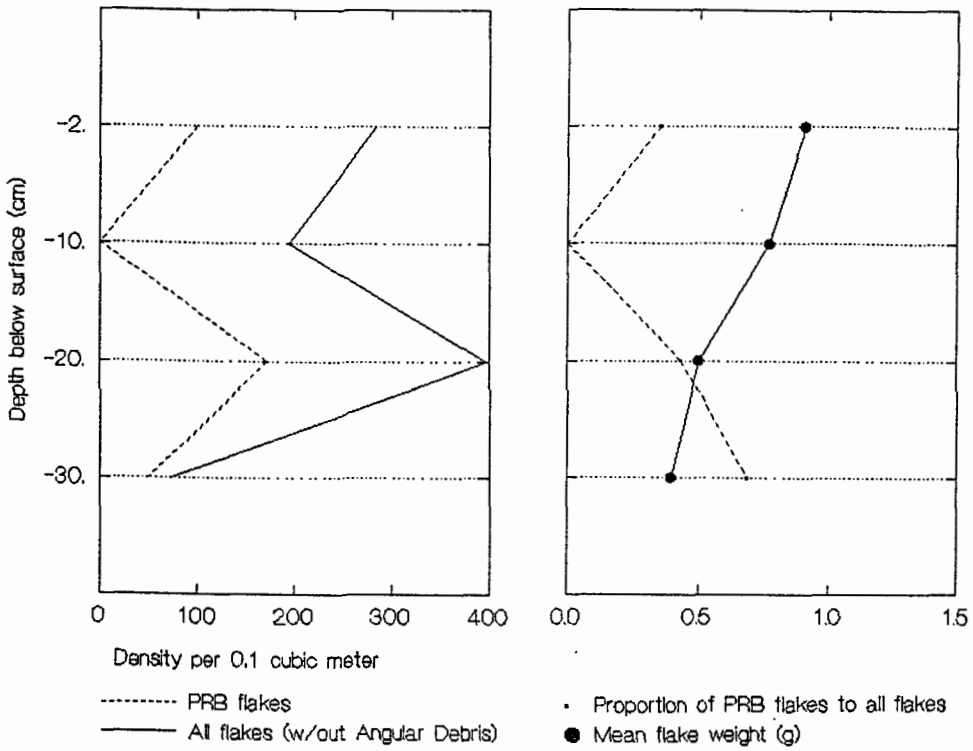
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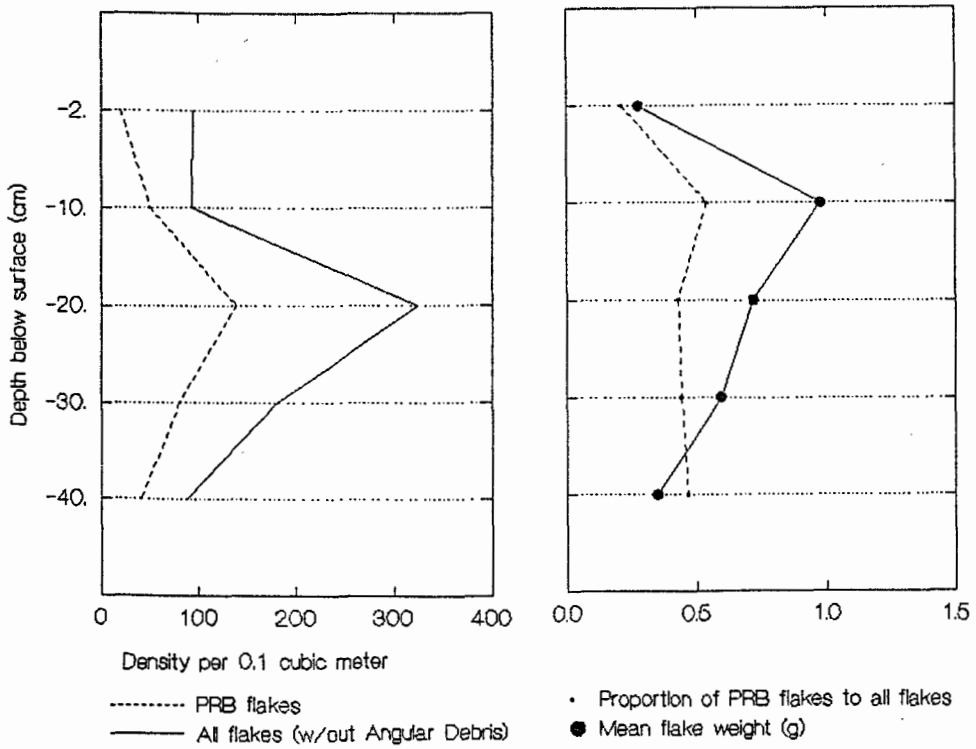
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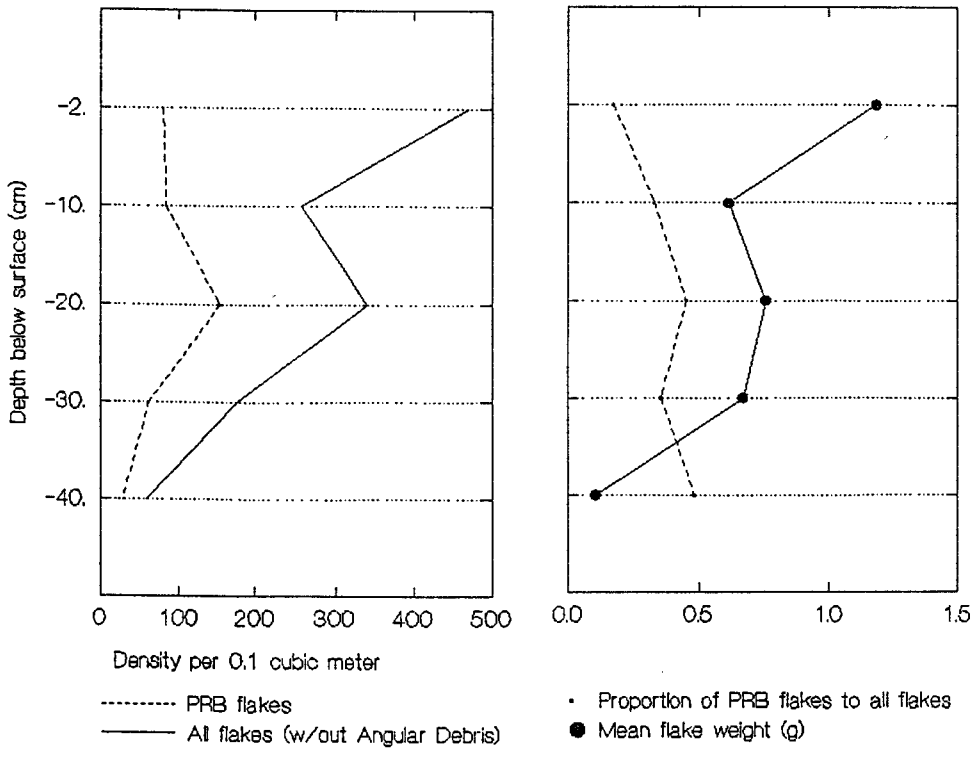
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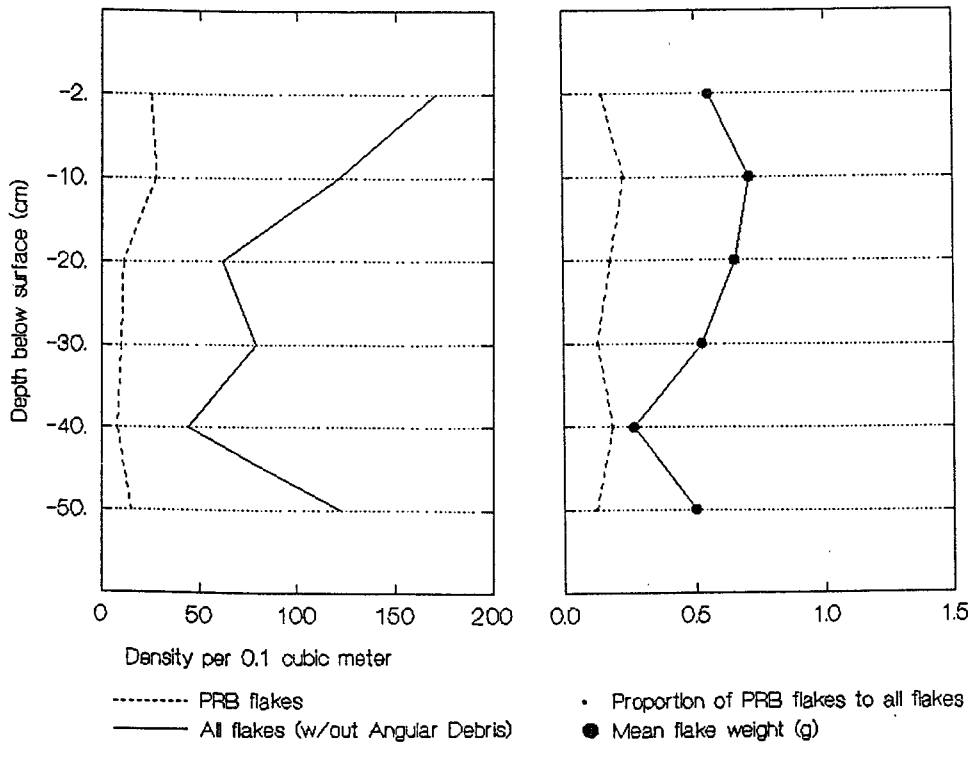
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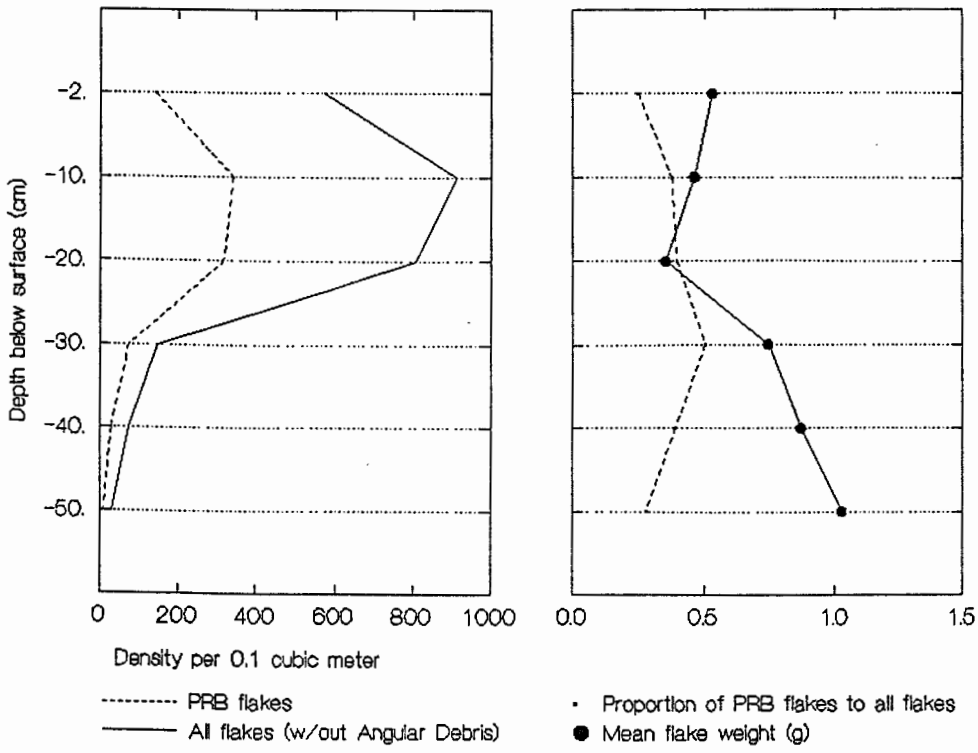
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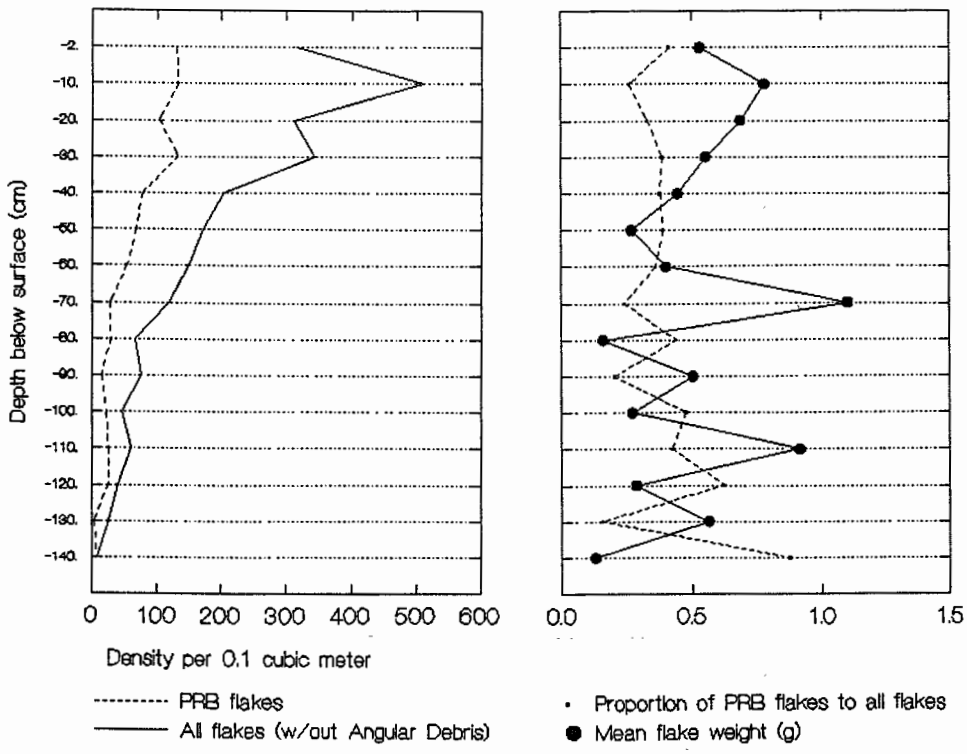
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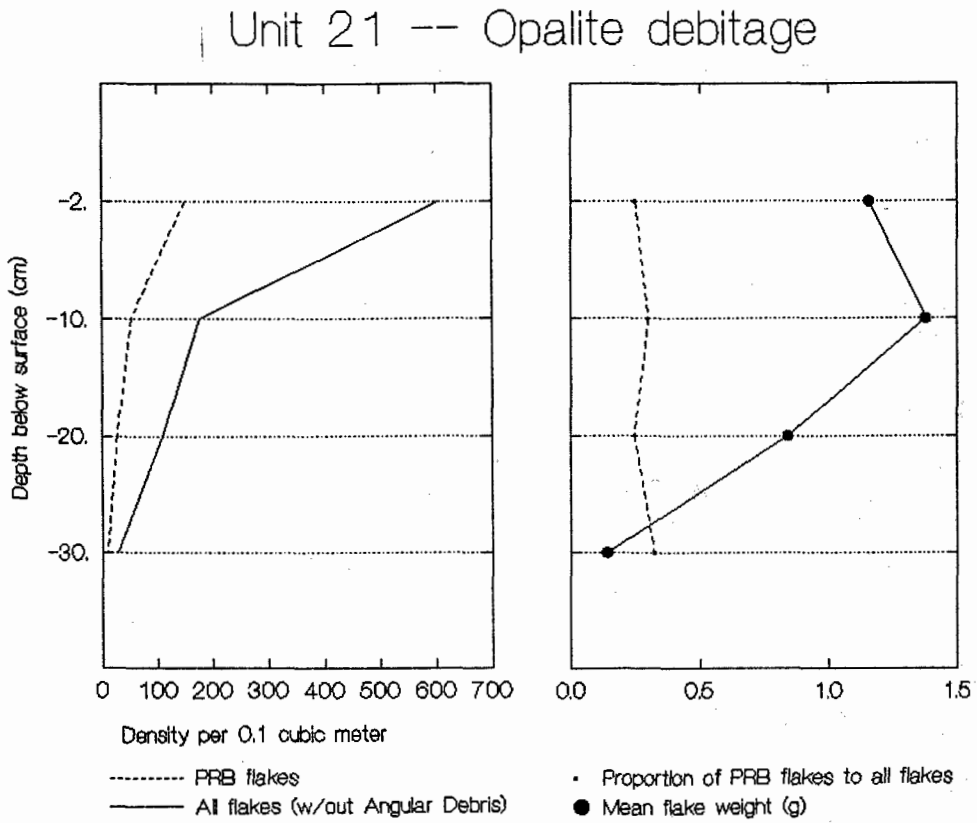


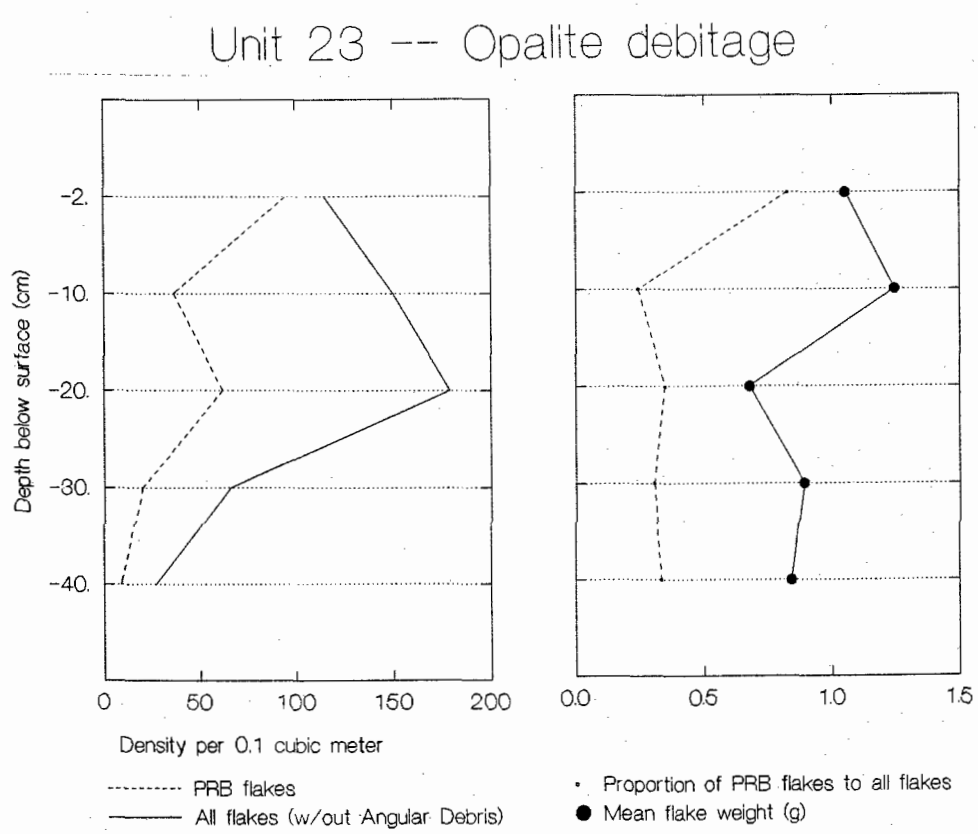
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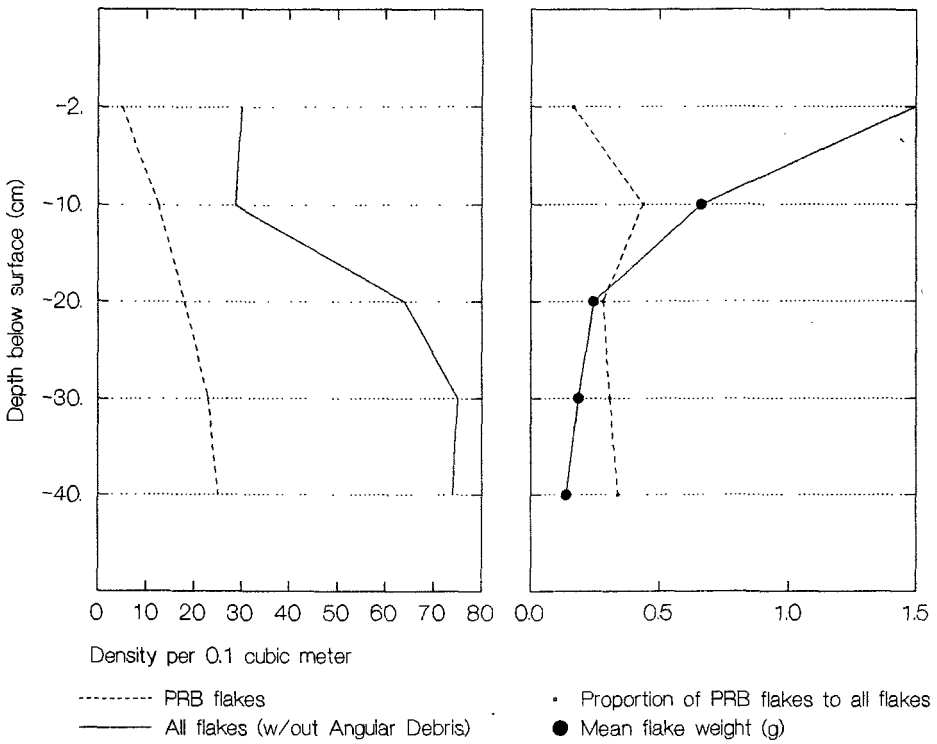
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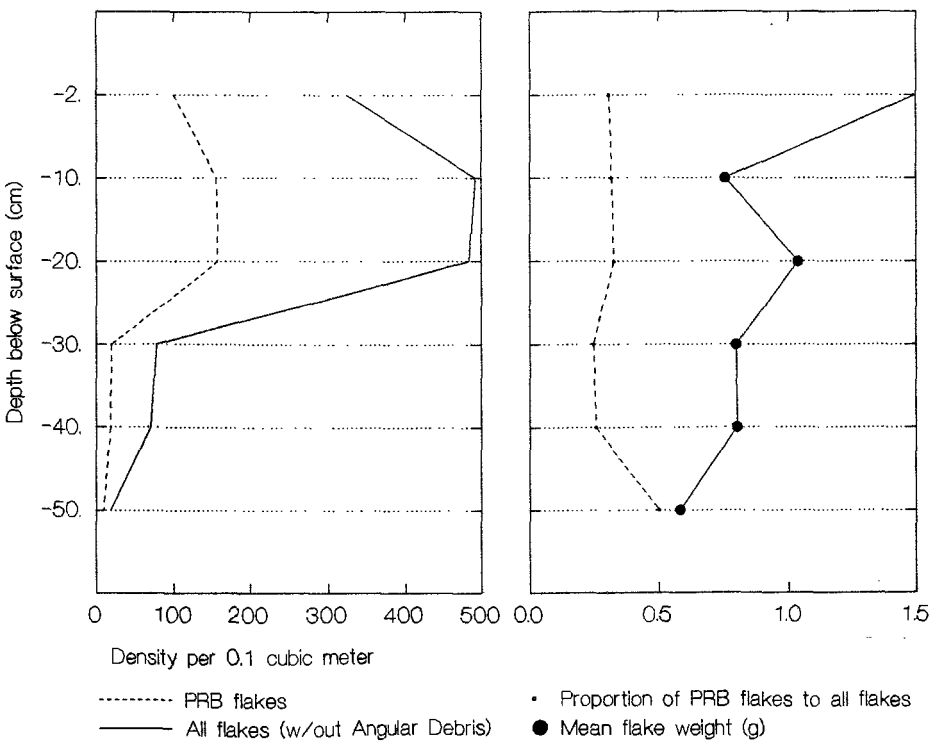

Unit 21 -- Opalite debitage
Depth below surface (cm)
-2.
-10.
-20.
-30.
0 100 200 300 400 500 600 700
Density per 0.1 cubic meter
0.0 0.5 1.0 1.5
PRB flakes
All flakes (w/out Angular Debris)
Proportion of PRB flakes to all flakes
Mean flake weight (g)


Unit 23 -- Opalite debitage
Depth below surface (cm)
-2.
-10.
-20.
-30.
-40.
0 50 100 150 200
Density per 0.1 cubic meter
0.0 0.5 1.0 1.5
PRB flakes
All flakes (w/out Angular Debris)
Proportion of PRB flakes to all flakes
Mean flake weight (g)

Unit 25 -- Opalite debitage



Unit 27 -- Opalite debitage



ARCHAEOLOGICAL INVESTIGATIONS AT TOSAWIHI, A GREAT BASIN QUARRY

Part 1: The Periphery

Volume 1

Robert G. Elston and Christopher Raven
Editors

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January 1992

ARCHAEOLOGICAL INVESTIGATIONS AT TOSAWIHI, A GREAT BASIN QUARRY

Part 1: The Periphery

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January 1992

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CULTURAL RESOURCES MANAGEMENT SUMMARY

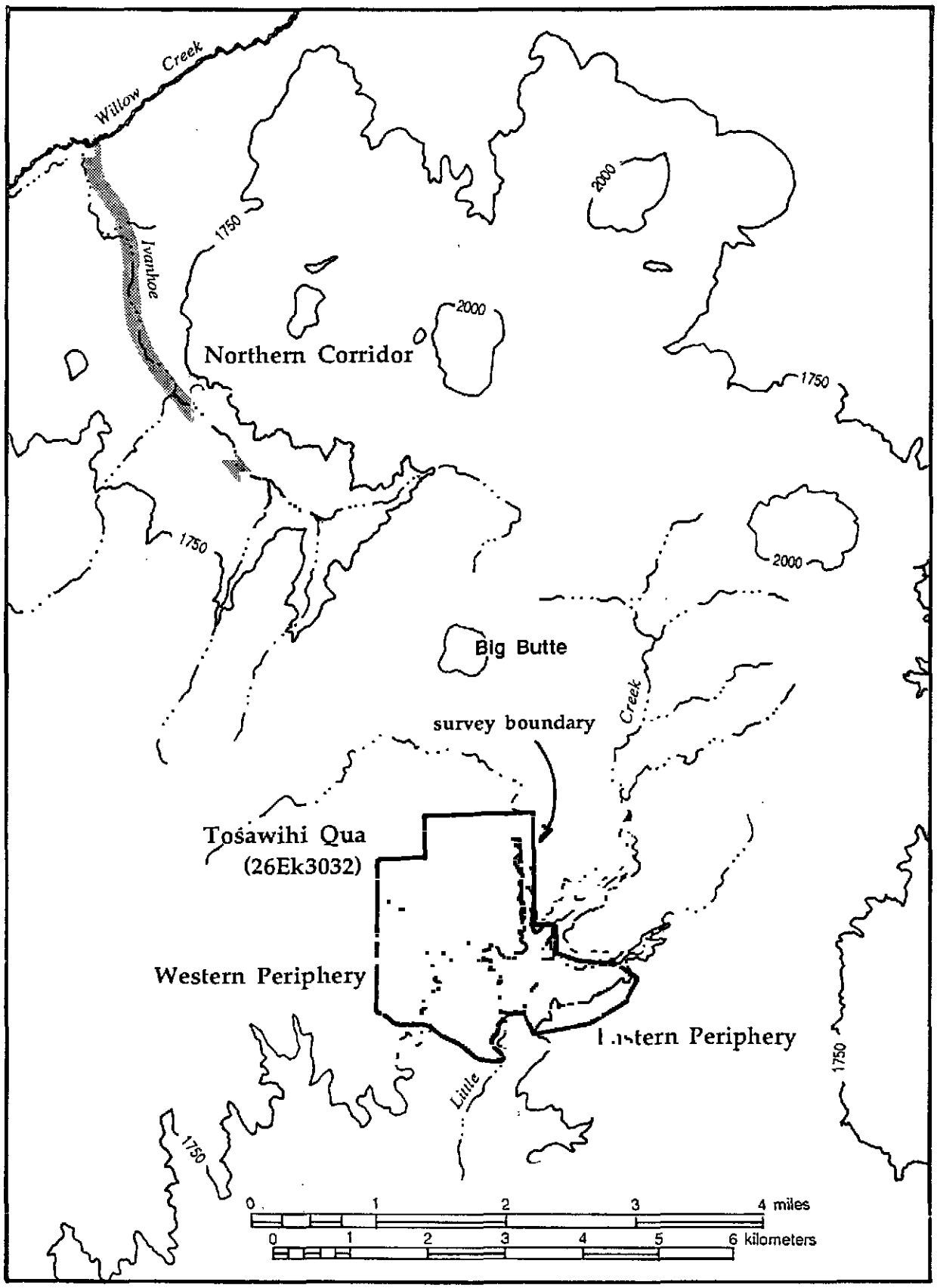
Minerals exploration, extraction, processing, and transport comprise the Ivanhoe Project, a gold development in the Ivanhoe Mining District, Elko County, Nevada. The Ivanhoe Project is located entirely on public lands administered by the Elko Resource Area of the Bureau of Land Management. An archaeological district, not yet formally defined but known regionally as the Tosawihi Quarries, is areally coincidental with the Ivanhoe Project.

A program of archaeological survey, testing, and mitigation has been in progress since 1987, prompted by the Ivanhoe Project. Funded by Ivanhoe Gold Company, the program addresses BLM obligations to Section 106 of the National Historic Preservation Act of 1966, in light of Ivanhoe Project development (Elston, Raven, and Budy 1987; Intermountain Research 1987, 1988a-d; Zeier 1987; Budy 1988; Drews 1988; Elston 1988a-b, 1989; Raven 1988). The work to which this summary refers, *Archaeological Investigations at Tosawihi, a Great Basin Quarry, Part 1: The Periphery* (Elston and Raven, eds. 1991), reports data recovery at twenty-five sites and localities determined eligible for nomination to the National Register of Historic Places (Elston, ed. 1989) and subject to impacts by elements of the Ivanhoe Project.

Data recovery plans for the twenty-five sites (Intermountain Research 1988a-d) were drafted and approved in 1988-89; field work began May 1, 1989 and continued through August 16, 1989, utilizing a crew that fluctuated in size between 16 and 32, augmented by supervisory personnel, camp staff, experimental lithics workshop personnel, and the occasional volunteer. The crew worked a ten-day on, four-day off schedule devoting, ultimately, 1771 person days to the field campaign. In the process, the crew profiled more than 350 meters of mechanically excavated trench and 12 meters of hand-excavated trench, shovel-skimmed 435 square meters of site area, and hand-excavated in excess of 110 cubic meters of fill, collecting along the way 973,000 artifacts, artifact lots, and cultural and noncultural samples. Post-field efforts—collections processing, sorting and cataloging, laboratory data collection and analysis, analysis of stratigraphic data, technical report development, project management and administration, and collections management and curation preparation—have consumed about 4000 person days. Commencing in November, 1989, analysis and draft final report preparation were completed in July, 1991; the final report, revised in light of comments received from the Bureau of Land Management, was produced in January, 1992. Seventeen of the twenty-five sites had been tested in 1988 (Elston, ed. 1989), and test data and assemblages were incorporated into post-field data recovery analysis and reporting. Selected assemblages (e.g., bifaces) and data from other previously studied sites have been incorporated into technological analyses undertaken for the present mitigation program.

The following discussion compares field procedures proposed (Intermountain Research 1988a-d) for each site with those actually executed; where discrepancies occur, details of alternative actions are offered. In all cases, the goals and objectives of data recovery plans were met by the field and post-field procedures selected and executed.

For reporting purposes, the study area is divided into three subareas known as the Eastern Periphery, the Western Periphery, and the Northern Corridor (cf. map). All refer to elements of the Ivanhoe Project which comprise the USX Mine: the Northern Corridor follows the alignment of an overland route accessing the mine from State Route 18 to the north; the Eastern Periphery encompasses ore processing facilities and a causeway; the Western Periphery encompasses USX mine pits, dumps, soil stockpiles, office compound, and the like. Table A lists mitigated sites and their Ivanhoe Project associations.



Principal study areas of the Tosawihi vicinity.

Table A. Investigated Sites and Localities.

Site/Locality	Elevation (ft. amsl)	Site Area (sq. m)	East	West	North
26Ek3170	5,620	31,000	x		
26Ek3171	5,670	7,540	x		
26Ek3184	5,640	11,309	x		
26Ek3192	5,660	3,190	x		
26Ek3195	5,700	9,425	x		
26Ek3198	5,740	12,724	x		
26Ek3200	5,760	242	x		
26Ek3204	5,680	60	x		
26Ek3032					
Loc 19	5,600	10	x		
Loc 20	5,630	200	x		
Loc 21	5,600	100	x		
Loc 22	5,580	5	x		
Loc 23	5,640	30	x		
Loc 25	5,700	2,250	x		
Loc 93	5,600		x		
Loc 98	5,600	900	x		
26Ek3084	5,775	300		x	
26Ek3085/3208	5,740-5,750	13,316		x	
26Ek3092	5,625	4,800		x	
26Ek3095	5,750	1,875		x	
26Ek3160	5,575	46,000		x	
26Ek3165	5,670	4,500		x	
26Ek3237	5,560	42,000			x
26Ek3251	5,215	15,000			x

Data were recovered from sixteen sites and localities in the Eastern Periphery. Table B summarizes selected procedures proposed and executed at each. Note that procedures were executed as proposed, or in excess of propositions, at half the sites, but that alternative actions resulting in modified efforts were undertaken at the other half.

26Ek3192 data recovery plans called for 100 soil probes. Only 88 probes were undertaken absent any need to probe those areas of the site which had been trenched.

26Ek3200 data recovery plans called for one 1 x 1 meter excavation unit to be placed in Feature 1, but the plan was abandoned due to the instability of quarry pit deposits. (Previously excavation had been attempted in similar deposits as a methodological experiment at site 26Ek3171, Feature 2, without success.)

26Ek3032, Locality 19 data recovery plans called for one 1 x 1 meter unit which was not excavated because surface scrapes demonstrated that cultural remains are confined to the upper 2 cm of the deposit.

26Ek3032, Locality 20 data recovery plans called for a backhoe trench of unspecified length to transect the quarry pit that was thought (during survey in 1987) to comprise the locality. However, 1989 review of the site could identify no quarry pit.

26Ek3032, Localities 21 and 22 data recovery plans called for "about 20" surface scrapes at each locality. Two were skimmed at the former and six at the latter because close interval reconnaissance during data recovery revealed the density of cultural remains outside the confines of features to be very sparse and because low bedrock outcrops and stream boulders occupy most of the ground surface within site precincts, making surface scraping virtually impossible.

Table B. Selected Data Recovery Procedures Executed in the Eastern Periphery.
(Proposed procedures are given in italics.)

Site No. (26Ek-)	Mechanical Trenching (no. m)	Hand Trenching (no. m)	Total Excavation Units (m^2)	Total Reserve Excavation Units (m^2)	Total Fill Excavated (m^3)	Total Surface Scrapes (m^2)	Mapping/ Description		Total Debitage Recovered (no. items)	Total Formed Artifacts Recovered Recovered (no. items)
3170	*1x8* / 1x8		*42* / 42	*4* / 2	6.77	*30-50* / 33	√	√	42,014	300
3171	*(2)1x8* / (2)1x8	½ x 5	*15* / 15	*4* / 0	5.91		√	√	30,870	151
3184		½ x 7		*10* / 5	.58	*80.5* / 189	√	√	56,011	397
3192*	*1x20* / 1x20		*26* /26	*10* / 19.5	11.13		√	√	39,246	444
3195	*(5)1x8* / (1)1x19.5 (2)1x12.5					5	√	√	44,888	56
3198	*1x15* / 1x15		*10* / 10	*4* / 30	5.57	*15* / 3	√	√	8,230	135
3200	*1x10* / 1x10		*1* / 0				√	√	240	15
3204	*1x9* / 1x9		*3* / 3		.4		√	√	123,915	140
3032										
Loc 19			*1* / 0			*30* / 32	√	√	14,673	96
Loc 20	*1x?* / 0					3	√	√	9,587	32
Loc 21			*1* / 1		.3	*ca. 20* / 2	√	√	1,794	21
Loc 22			*1* / 1		.2	*ca. 20* / 6	√	√	2,067	10
Loc 23	*1x?* / 1x8					7	√	√	38,487	119
Loc 25							√	√	25,716	129
Loc 93	(isolate)						√	√		1
Loc 98		*possible* / not done				10	√	√	1,287	11

*Soil Probes, site 3192: *100* / 88

26Ek3032, Locality 25 data recovery plans called for mapping and description of "30 discrete features," features that were apparent to 1987 surveyors but not to 1989 data recovery crews, who observed only seven features on the site. The discrepancy is attributable to inter-observer error—differences in the way individual field workers define features (lumpers versus splitters), and to differences between how reduction features are seen today as opposed to how they were seen four years ago.

26Ek3032, Locality 98 data recovery plans called for the possibility of hand trenching, but none was undertaken because surface scrapes demonstrated that cultural remains are confined to the upper 2 cm of the deposit.

Table C summarizes selected proposed and executed field procedures at seven sites in the Western Periphery. Work went as planned at five and in accordance with revised plans at two, as described below. Note that 26Ek3085 and 26Ek3208 are treated as a single site.

26Ek3084 data recovery plans called for two hand excavated 1 x 5 meter trenches and excavation of one 1 x 1 meter unit (with an additional unit held in reserve). One trench, to extend a test trench in Feature 1, was excavated mechanically rather than by hand because hand excavation was found too time consuming and too detailed simply to remove overburden and expose stratigraphy. The other trench, intended for Feature 2, was not excavated because it became apparent that the Feature 2 debris consisted only of colluvium from Feature 1, with no subsurface cultural component. The 1 x 1 m excavation unit to have been placed off Trench 1 could not be undertaken due to unstable side walls; instead, strata-based lithic samples were obtained from the trench walls.

In the Northern Corridor, data recovery was undertaken at two sites; procedures are summarized in Table D.

Table C. Selected Data Recovery Procedures Executed in the Western Periphery.
(Proposed procedures are given in italics.)

Site No. (26Ek-)	Mechanical Trenching (no. m)	Hand Trenching (no. m)	Total Excavation Units (m^2)	Total Reserve Excavation Units (m^2)	Total Fill Excavated (m^3)	Total Surface Scrapes (m^2)	Mapping/ Description		Total Debitage Recovered (no. items)	Total Formed Artifacts Recovered Recovered (no. items)
3084	(1)1x4	*(2)1x5*	*1* / 0	*1* / 0		.5	√	√	8,476	10
3085/ 3208	*(2)1x?* / (2)1x6 *(1)1x5* / 1x11 *(1)1x10* / (1)1x10	2 / 4					√	√	175,455	15
3092	*4 ext.* / 4 ext. 4 new trenches		*41* / 42		24.26		√	√	132,194	858
3095			*67* / 67	*10* / .5	11.23		√	√	82,493	646
3160			*36* / 36	*8* / 12	11.46	*66* / 57	√	√	47,034	1,047
3165			*33* / 33	*15* / 2	4.34	*40* / 40	√	√	13,067	96

ext. = extensions

Table D. Selected Data Recovery Procedures Executed in the Northern Corridor.
(Proposed procedures are given in italics.)

Site No. (26Ek-)	Mechanical Trenching (no. m)	Hand Trenching (no. m)	Total Excavation Units (m^2)	Total Reserve Excavation Units (m^2)	Total Fill Excavated (m^3)	Total Surface Scrapes (m^2)	Mapping/ Description		Total Debitage Recovered (no. items)	Total Formed Artifacts Recovered Recovered (no. items)
3237	*(8-10)(100m max)* / 8 (1x100m)		*35* / 35	*20* / 2	17.38	*25* / 25	√	√	12,509	328
3251	*(6)(60m max)* / 6 (1x60m)		*30* / 20	*15* / 0	10.5	*12* / 22	√	√	23,270	339

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Never forget this when the talk is clever:
Wisdom must be born in the flesh or wither,
And sacred order has been always won
From chaos by some burning faithful one
Whose human bones have ached as if with fever
To bring you to these high triumphant places.

—May Sarton

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It has been said of Jimmy Olsen that he did not suffer fools: that he suffered us either proves our competency or comments on his perceptions. No matter—Mr. Olsen sustained us.

Part I. RESEARCH CONTEXT

Chapter 1

INTRODUCTION TO THE TOSAWIHI QUARRIES

Robert G. Elston

...a shattered, overlapping, sometimes shallow, nondiagnostic, undatable, unattractive, redundant, and at times voluminous material record.
—Ericson (1984:2) on quarries

Tosawihi is the only toolstone quarry in the Great Basin for which there is unambiguous ethnographic reference. Although he apparently never visited the quarries, Steward (1938:162) wrote that Tosawihi ("White Knife") Shoshone groups living along the middle reach of the Humboldt River in the vicinity of Battle Mountain "procured a high quality of white flint for knives in the mountains to the north." That all other Shoshone groups identified themselves by food names testifies to the importance of this resource for the Tosawihi.

Ethnographers continued to mention the quarries in connection with the Tosawihi Shoshone (Harris 1940; Steward 1941) and the Tosawihi Shoshone retain knowledge of them (Richard Clemmer, personal communication), but the quarries did not become a subject of research until archaeologists began to work in the Humboldt Valley in the late 1960s. Heizer et al. (1968:23) speculated that the large number of white chert bifaces from South Fork Shelter resulted from use of the site by White Knife Shoshone. The existence of the Tosawihi Quarries was noted by Stephenson and Wilkinson (1969:50-51), citing a personal communication from knapping experimentalist, Don Crabtree, regarding the "Battle Mountain Quarries." Nevertheless, Mary Rusco properly is regarded the person who discovered the Tosawihi Quarries for archaeology. Rusco was first to map and describe the quarries in detail (Rusco 1976a, 1976b, 1979). She prepared a nomination to the National Register of Historic Places (Rusco 1983), and she was first to recognize the important role of Tosawihi toolstone in prehistoric economies of the Humboldt River Basin (Davis et al. 1976; Rusco 1978, 1982; Rusco and Davis 1979, 1987; Rusco and Seelinger 1974; Rusco et al. 1979, 1982). Although much of her work remains unpublished, Rusco was first to apply economic and geographic models to analysis of the distribution of Tosawihi chert.

Tosawihi is the largest known chert quarry in the Great Basin, and diagnostic projectile points suggest considerable time depth for its use. Tosawihi chert is distributed widely over a large region north of the Humboldt River, coinciding with the ethnographic territory of the Western Shoshone (Rusco 1979:2). White chert artifacts tend to dominate prehistoric assemblages between the Osgood Mountains and Elko in the Humboldt River Basin (Stephenson and Wilkenson 1969; Rusco 1976, 1979, 1982), as well as in uplands north of the river (Crittenden and Elston 1981; Elston et al. 1981; Clay and Hemphill 1986). The archaeological occurrence of Tosawihi-like white chert has been observed as much as 150 km from the quarries on the Snake River Plain (Rusco 1979, citing personal communication from Don Crabtree), and as far south as Gatecliff Shelter in the Monitor Range (Novick 1987). Even so, the proportion of Tosawihi chert decreases with distance until, at about 60 km, its dominance is replaced by other, more local materials (Rusco 1978; Tim Murphy, personal communication).

The distributional boundary at the Osgood Mountains is abrupt; west of the mountains, white chert is replaced by obsidian (Rusco 1979:2). For instance, Bard et al. (1979:86) report only a single white chert biface from Ezra's Retreat, a rockshelter site 65 km northwest of the quarries. This pattern, which coincides with the boundary between Northern Paiute and Western Shoshone, was noticed first by Stephenson and Wilkenson (1969:50-51), who observed that it appeared to be several thousand years older than the glotto-chronological estimate for the age of the cultural boundary.

Quarries in Archaeological Research

Interest in toolstone quarries began early in North American archaeology (cf. Holmes 1919; Honea 1983 and references; Ahler 1986:1), yet quarries only now are emerging from a long period of neglect that owed in large part to perceived methodological and technical problems inherent in their study (Ericson 1984:2; Purdy 1984:119-120; Torrence 1984:50). In the past decade or so, increased attention to adaptive cultural processes has subsumed the procurement and use of toolstone in subsistence systems and in trade (cf. Butler and May 1984; D. Davis, ed. 1978; Ellis and Lathrop 1989; Ericson and Earle 1982; Ericson and Purdy 1984; Johnson and Morrow 1987; Plew et al. 1985; Renfrew 1977; Vehik 1985; Wright 1977).

Microeconomics and geography provide theoretical approaches for most contemporary studies focused on quarry production and trade (Ericson 1977, 1984; Renfrew 1977; Torrence 1984, 1986; Luedtke 1984; Findlow and Bolognese 1984), while investigations of large scale lithic production and distribution systems, of which quarries are seen as one component, often incorporate aspects of Binford's (cf. 1983a) middle range theory regarding technological organization and mobility strategy (Goodyear 1979; Kelly 1985, 1988; Parry and Kelly 1987; Kelly and Todd 1988; Shott 1989). The organization of production at the toolstone source is seen as a crucial link between production technology and artifact distribution (Bradley and Edmonds 1988:181-183). Efforts to integrate ethnographic and ethnoarchaeological studies of lithic procurement (Binford and O'Connell 1984; Gallagher 1977; Gould 1977, 1980; Jones and White 1988) into archaeological investigations of lithic production (Leudtke 1984; Torrence 1986) are being made, and attention to site formation processes (Binford 1978a, 1978b, 1979, 1982; Schiffer 1987; Ahler 1986a) operating at quarries is apparent. With new theoretical approaches and methodological advances, the attributes of quarries that once dismayed archaeologists now are seen to offer enormous research potential.

Treatment of quarries in the Great Basin has paralleled that in the larger archaeological arena: for a long time they merely were noted (cf. Botti 1976; Davis 1964; Elston and Turner 1968; Grosscup 1956; Harrington 1951; Meighan 1955; Pippin 1980), but, with increasing frequency, they are being studied and described at various levels of detail (Elston and Zeier 1984; Elston et al. 1987; Elston and Budy 1990; Livingston and Pierce 1988; Pedrick 1985; Ragier and Lancaster 1966; Raymond 1984; Rusco 1976a, 1979; Singer and Ericson 1977; Thomas and Larsen 1988; Toney 1972; Tuohy 1970b). The present investigation of the Tosawihi Quarries, however, constitutes the first comprehensive investigation of a Great Basin chert quarry.

Lithic Resource Procurement in the Archaeological Record

Procurement of most biotic resources by hunters and gatherers usually leaves few residues and artifacts scattered widely across the landscape. Because non-lithic artifacts and procurement residues rarely survive long enough to enter the archaeological record, the archaeological visibility of places where biotic resources are procured (*locations*; cf. Binford 1980:9) is generally low. Artifacts accumulate only at locations where resources are encountered consistently and sufficient artifacts are discarded. Procurement *facilities* (hunting blinds, drive fences, weirs, etc.) are likely to occur solely at locations where resources are sufficiently abundant to balance the cost of construction (Thomas 1983a:84). Tools and facilities afford indirect evidence of resource procurement, but residues providing more direct documentation are rare in Great Basin archaeology.

The remains of facilities used for processing and storage (hearths, roasting pits, cache pits, etc.), and fossil evidence of resource processing and consumption (charred seeds, pollen, phytoliths, bones, coprolites, etc.), are more common in field and base camps. Nevertheless,

the interpretation of procurement behavior from these data is not straightforward; such sites usually are removed from the procurement location, so that it is difficult to know what resources were available in the camp catchment compared to those actually taken. Moreover, as productivity and locations of biotic resources vary over the long run, human groups may modify their annual ranges (Binford 1983a:46-47), making it difficult or impossible to estimate important factors such as site catchment and transportation costs for various resources. In any case, preservation of procurement and processing residues is accidental, and their proportions in the archaeological record rarely reflect the proportions in which they were deposited originally (Schiffer 1987).

In contrast, quarries often preserve a chronicle of prehistoric human economic behavior unique in its completeness. A toolstone quarry such as Tosawihi offers a static resource to which people return again and again. The creation of extraction facilities (quarry pits and adits), along with toolstone processing, generate vast amounts of non-perishable quarry and manufacturing debris that unambiguously mark localities of toolstone acquisition. The assemblages of adjacent workshop and camp sites are dominated by debitage from processing and manufacturing, along with smaller quantities of tools and waste from support activities. There is little doubt of the association between workshop-residential sites and toolstone quarry locations, even when separated by some distance.

Cultural and natural processes work to form and transform the archaeological record, and organic artifacts used to extract, process, and transport toolstone (digging sticks, antler wedges and percussors, baskets, etc.), along with subsistence residues, are no more likely to be preserved at quarries than they are at other kinds of open sites. But because toolstone is resistant to chemical and biological processes that degrade organic artifacts and residues, all the products and by-products of lithic procurement and processing at quarries that were not carried away by humans, or (in a few cases) transported or destroyed by violent geological processes (floods, volcanic eruptions, etc.), remain in the same proportions they were discarded (Schiffer 1987:27-28).

Consequently, the Tosawihi Quarries and surrounding archaeological sites contain a vast, relatively intact record of prehistoric toolstone procurement, along with a much smaller and less complete record of other activities. Over something like 11,000 years, the location of the toolstone resource remained constant; other factors affecting the costs and benefits of toolstone procurement, including social boundaries, settlement-subsistence strategies, trade and exchange systems, and technology are likely to have varied.

Research Potential of the Tosawihi Quarries

Tosawihi thus is an unusual place in the prehistoric landscape of the Great Basin, with enormous potential for investigation of the economics and organization of toolstone procurement; we consequently identified a number of research topics relevant to the quarries and their vicinity during the initial stages of our investigations (Elston 1988a). In broad categories, they include chronology, paleoenvironments, technological organization, subsistence strategies, the economics of lithic production, transportation, site structure and distribution, assemblage diversity, and site function. This list has been refined continually as we have gained information about particular areas and sites through testing (Elston 1989) and through the data recovery program reported here. It is important to note, however, that plans for intensive exploration and development of gold properties coincident with the Tosawihi Quarries vicinity, a matter of Federal oversight and regulation, prompted our Tosawihi research, *with investigations responding to the geography and schedule of minerals development.*

Most of the discussions contained herein are framed with reference to four subareas of the Tosawihi vicinity that we have investigated at various times and with various strategies

(Figure 1). Beginning work in 1987, we first surveyed the Tosawihi Quarries (26Ek3032; cf. Elston, Raven, and Budy 1987) in response to minerals exploration plans and surveyed the Western Periphery (Budy 1988), still in 1987, in response to a mine plan of operations. The Eastern Periphery (Raven 1988), corresponding to ancillary mine facilities, was surveyed early in the 1988 field season. The Northern Corridor, corresponding to a route that would permit the mine to be accessed from the north, was surveyed variously in 1988 (Drews 1988), 1989, and 1990. The 1988 field season saw a testing program underway that examined more than six score sites to be affected by mine development (Elston 1989). Testing assessed the significance and data potential of the sites so that formal data recovery plans (Intermountain Research 1988a-d) could be developed for those to be excavated. The twenty-five sites selected for data recovery, comprising the subjects of the present report, were investigated in the 1989 field season. The reader will discover that, while we observe Tosawihi from the perspective offered by these 25 sites, we broaden the perspective by drawing upon data developed during inventory of 238 sites and 225 localities*, and upon data and assemblages recovered by tests of 67 of them.

Without apology we observe that geographic constraints prevent the full study of numerous research questions in the present phase of investigation. At any point in time, toolstone procurement at Tosawihi was but one aspect of a cultural and economic system operating over a large area. Ideally, we would include the Tosawihi Quarries in a large scale, regional study (cf. Thomas 1983a, 1983b, 1988; Bettinger 1975, 1989; O'Connell 1975; Beck 1984), making sure to obtain an unbiased sample of sites from the entire area in which Tosawihi toolstone was processed and used, but presently this is not possible. Moreover, the location and shape of areas of minerals development strongly influence the sample of places so far investigated toward residential/workshop sites adjacent, but peripheral to, the main quarries. In comparison, we have studied relatively few quarry pits, or more distant, less quarry-related, sites. This effects our ability to address certain aspects of production, transportation, site distribution, technological organization, and assemblage diversity, while shallow soils and poor preservation of plant and animal remains in most sites limit studies of subsistence and paleoenvironmental reconstruction. Nevertheless, we have a full plate with regard to archaeological research at Tosawihi. The economics and organization of toolstone procurement are the major foci of our research, guided by the model outlined in Chapter 3 and developed more fully in subsequent chapters. In the process, we establish a theoretical and methodological framework that will facilitate future regional and local studies of the Tosawihi Quarries.

* The Tosawihi Quarries are known administratively as site 26Ek3032, a designation referring to a piece of the Tosawihi landscape encompassing discrete cultural localities that, for the most part, appear against a variable density background of opalite debitage.

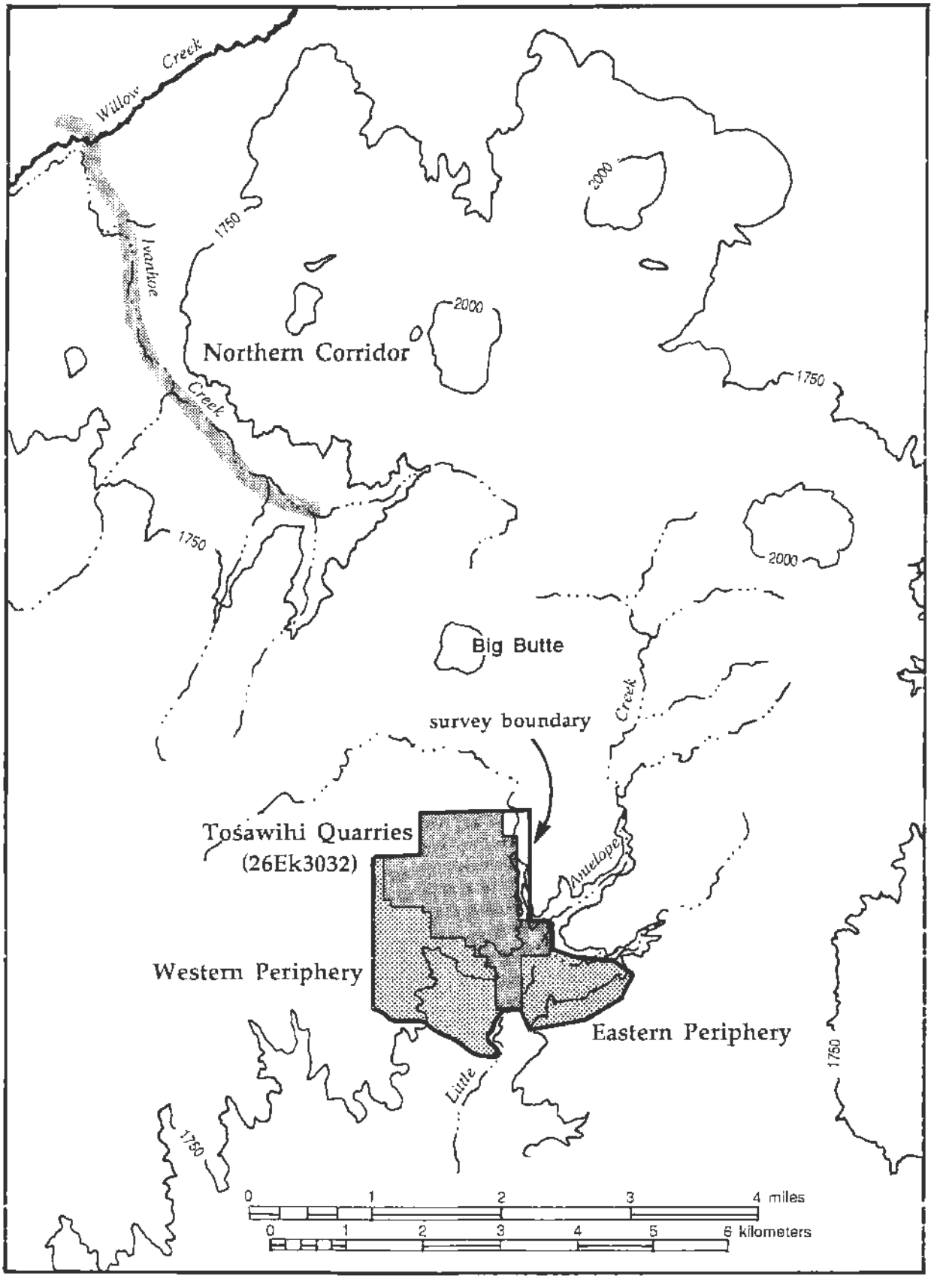


Figure 1. Principal study areas of the Tosawihi vicinity.

Chapter 2

THE NATURAL AND CULTURAL LANDSCAPE

Christopher Raven

The quarry lies like a jewel on the breast of the mountains, quiet, white, brittle, permanent, valuable. For ten millennia visitors carried its fragments away, sometimes far. Inexhaustible, it always offered measurable worth, while the lure of other landscapes fluctuated with the fortunes of warmth and water and plants and animals.

— Field Notes, 1989

To Aristotle's observation that four maps can be drawn of any landscape without repeating information, we are inclined to respond that that is not enough. Anthropologists have come to value information on the distribution of things in space, believing that spatial structures affect workable economies importantly and dictate a very great part of human behavior. To understand spatial aspects of behavior, then, or to anticipate their plausible alternatives, we need to map the multifactorial landscapes in which they are enacted, since the geography of opportunities substantially conditions the geography of events.

The landscape of central northern Nevada is subtly diverse in ways that always influenced how its various parts were used. Opportunities are scattered in space, and some of them in time, and efficient exploitation of the more valuable resources of the high desert province certainly always has required that foragers strategize their movements judiciously. The ricegrass comes to seed-ripe only for a brilliant, brief episode of every year, and Basin wildrye follows some months later, often in the same places. Deer observe seasonal agendas, and antelope congregate on the kidding grounds only episodically, and only in early spring. Most water fails by mid-summer under the current regime, and there is nothing to drink for the rest of the year throughout patches as large as 400 sq. km. Clearly, strategies of timing and placement, and the careful timing *of* placement, determined for many centuries where successful foragers should go, why and when they should go there, and what they should do at their destination.

The Countryside

Central northern Nevada lies on the poleward rim of the Great Basin (Figure 2). As elsewhere in the province, xerophytic plants and animals swarm sparsely across an arid landscape of basins and sometimes craggy ranges. Surface waters settle in sinks and evaporate, or they run off down the tilts of the landscape to settle and evaporate in lower, more distant sinks. The short summers are hot and the much too long winters cold (mean monthly temperatures range from a January low of -5° C to a pleasant high of 21° C in July), and the annual precipitation of 10 - 40 cm is realized chiefly as snowfall (Houghton, Sakamoto, and Gifford 1975; Brown 1960). Elevation (ranging from 1340 m to 2950 m amsl) dictates an acute spatial zonation of climate in any season. The Tosawihi Quarries occupy an intermediate upland (ca. 1600 m to 2100 m amsl) that experiences neither of the region's climatic extremes, although field crews have been heard to complain in the same month of debilitating afternoon heat and bone-numbing chill after dark.

While virtually all attributes of the landscape mosaic influenced to some degree how its various places were used by prehistoric human groups, we are concerned here particularly with details of geology, hydrology, flora, and fauna, since those configurations defined the principal opportunities, as well as the principal limiting factors, confronting foragers in the past.

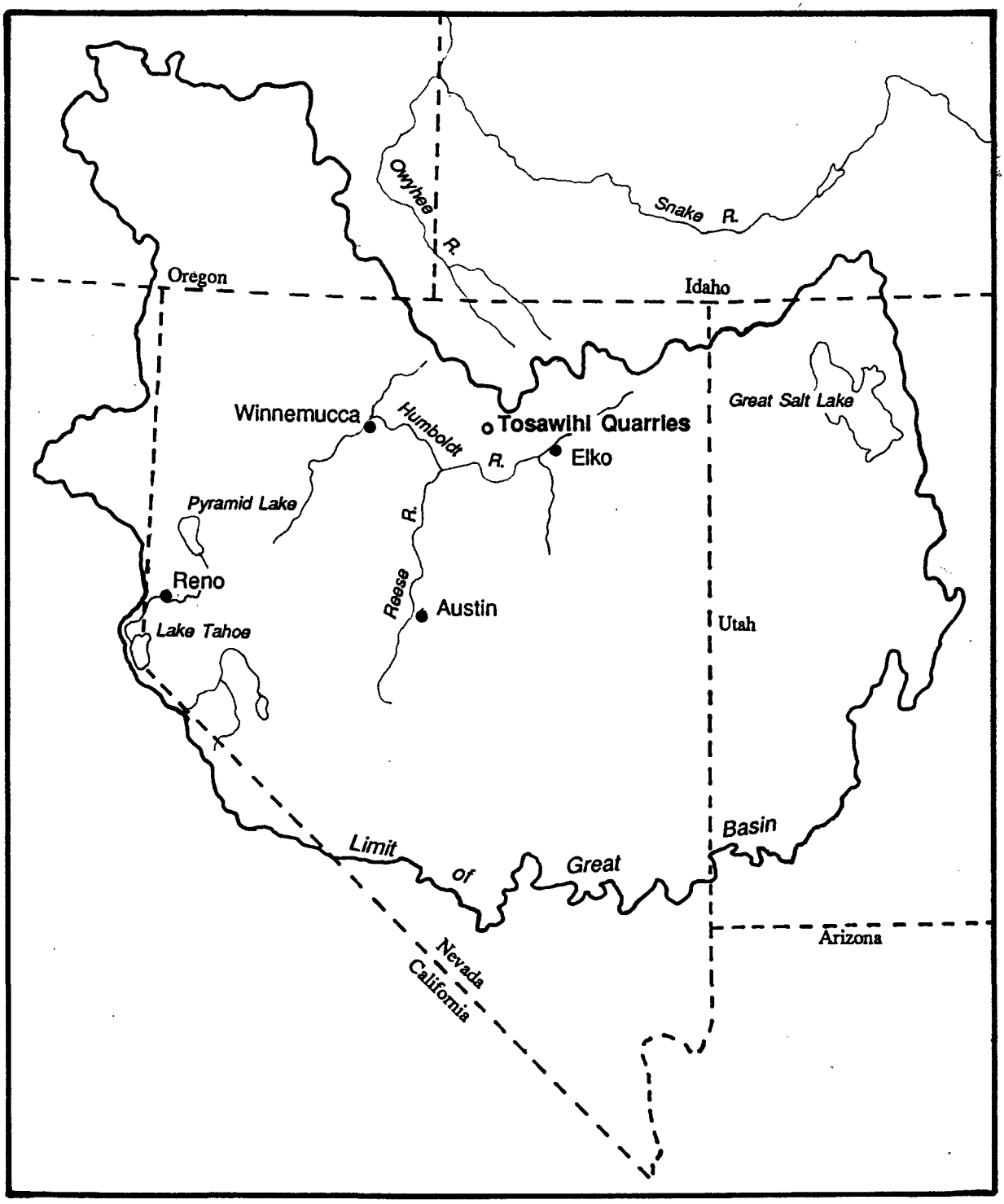


Figure 2. The Tosawihi Quarries in the Great Basin.

Landforms and Rocks

A long and complex geomorphic history has been played out in central northern Nevada, but the effects of most of its older events have been obscured from the contemporary landscape; the consequences of early episodes of mountain building largely have eroded away, and early sea beds lie buried by the sediments of later regimes. Geologically detectable only at depth, or in rare, more recently uplifted exposures, few pre-Cenozoic events left traces that could have been of much import to prehistoric foragers. Thus the dramatic upheavals of the Antler orogeny, a Devonian episode during which a wandering volcanic arc collided with what then was the western littoral of the continent and thrust upward a great shoreline highland, 90 km wide and meandering across our area of interest, are little evident on today's surface; most consequences of the event simply were washed out to sea or became buried by subsequent deposition (Coats 1987:85-87; Fiero 1986:86-90; Stewart 1980:36-41). Likewise, the Triassic arrival and continental accretion of the Sonomian land mass, although it altered substantially the relative configurations of land and sea, left surfaces largely eroded during the Jurassic and buried by the volcanism of later periods (Fiero 1986:95).

Even the turbulence attending the breakup of the Pangean protocontinent made less impact on the *effective* Holocene landscape than did the great volcanic storms of the mid-Cenozoic (especially, the Miocene), when massive ashes, ash-flow tuffs, and rhyolites spilled over the countryside (Fiero 1986:117-120). Coats (1987:68) plots the distribution of Miocene rhyolitic domes in southwestern Elko County, embracing the Tosawihi vicinity in what may be an enormous volcano-tectonic depression (Figure 3; cf. Coats 1987:67-69). Another wave of volcanism, coincident with Miocene extensional faulting that produced the principal overt topography of today's basin and range province, introduced basaltic and andesitic flows that now dominate much of the surface geology of central northern Nevada (Fiero 1986:134).

In the immediate vicinity of the Tosawihi Quarries, late Miocene or early Pliocene alteration of Tertiary volcanics modified the lithic terrane of the countryside in a way that was to have important economic consequences for both prehistoric and historic visitors. Hydrothermally-induced silicification of the rhyolitic ashes and tuffs left vast beds of a milky, internally homogenous opalite (Figure 4; cf. Bailey and Phoenix 1944:17-21) that evolved, over millennia of dehydration and crystallization, into a workable toolstone of remarkable durability. The chert-like cryptocrystallines of the Tosawihi Member (a name we propose here because the group has not been named geologically, although its incidence has had enormous long-term impact on prehistoric and historic land-use patterns) became the preeminent lithic raw material favored locally over the past several millennia for the production of stone tools. That its upper components trapped lodes of cinnabar rendered it attractive as well to mercury miners in the earlier decades of the present century, and prompted the initial historic exploitation of the Ivanhoe Mining District (Bailey and Phoenix 1944; Benson 1956; Hollister 1986:4; Smith 1976; Zeier 1987:4-8). Thus virtually the entire archaeological record of the vicinity, both prehistoric and historic, is likely to have been related intimately to the value and utility of the stones of the Tosawihi Member.

Water

Despite the inundations of the Pleistocene, the Tosawihi vicinity never retained a pluvial lake of any magnitude (Mifflin and Wheat 1979); the slope of the countryside was sufficient, and runoff corridors sufficiently available, that central northern Nevada missed the lacustrine episodes that punctuated the Holocene history of most of the rest of the state. The Tosawihi Quarries and their hinterlands lie entirely within the higher, eastern reaches of the Lahontan hydrographic basin (Mifflin and Wheat 1979:Pl. 1), from which surface waters drain west down the Humboldt River system to their terminal basin in the Humboldt and Carson Sinks. The

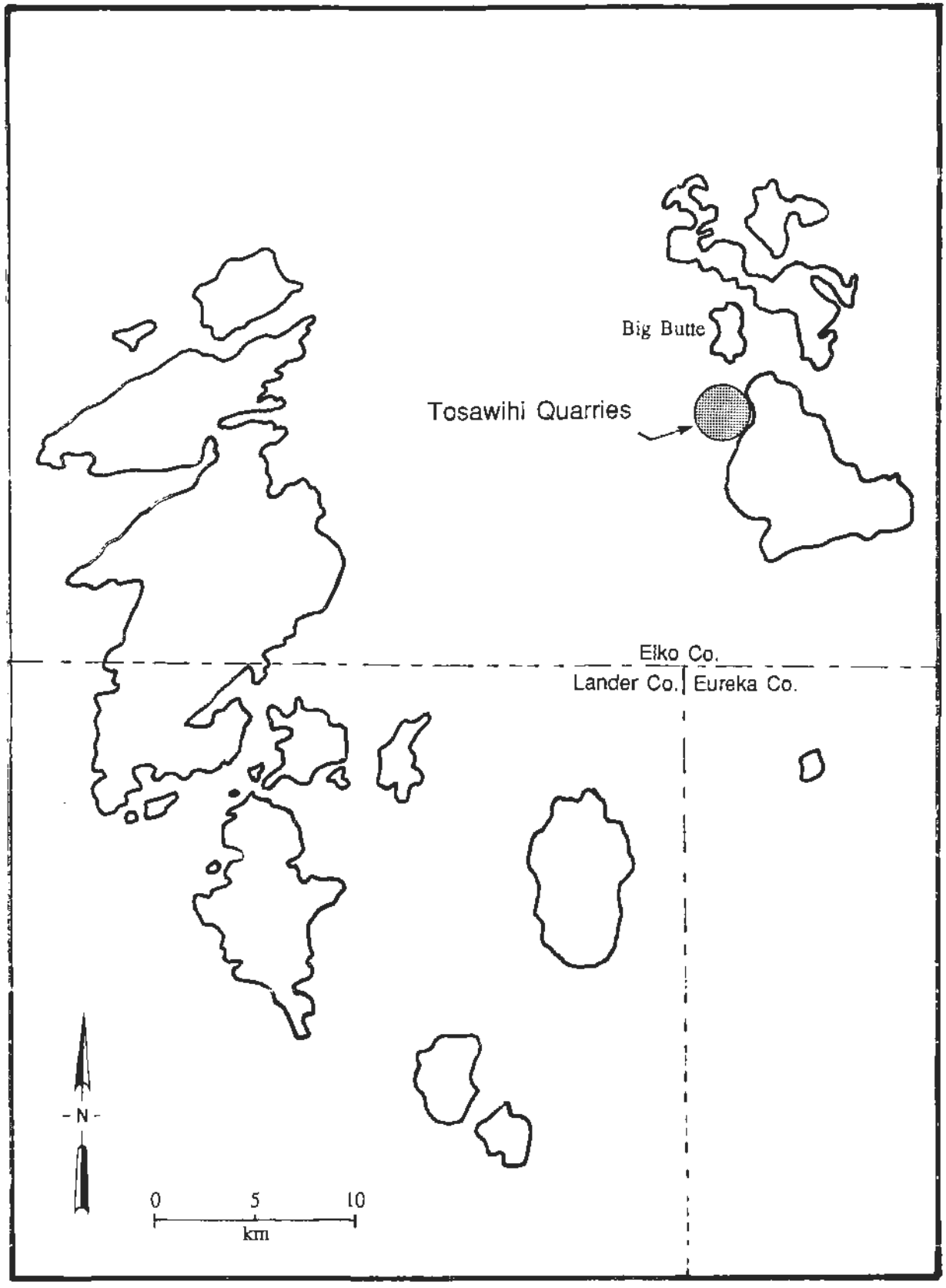


Figure 3. Miocene rhyolitic domes in Southeastern Elko County (after Coates 1987:68).

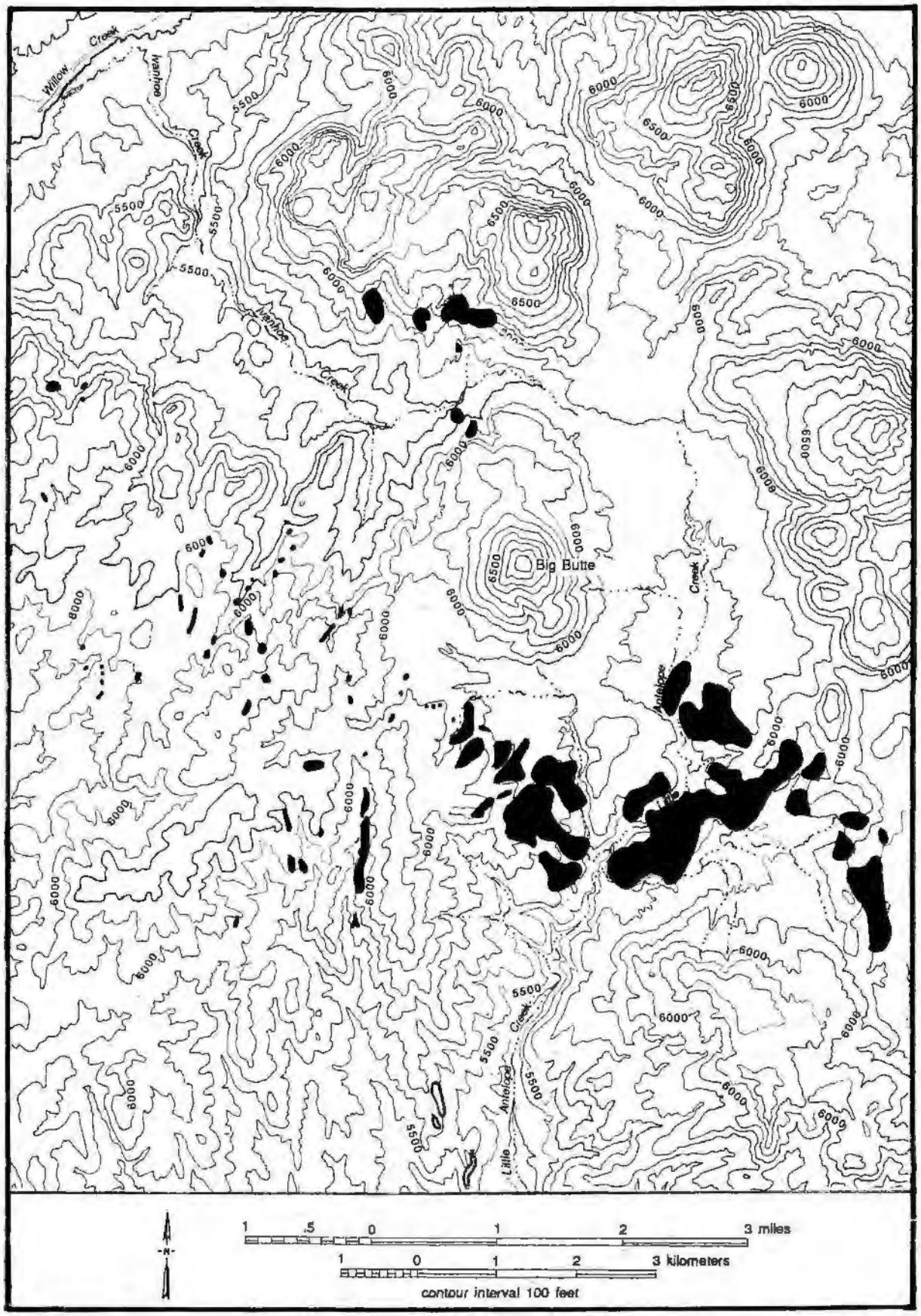


Figure 4. Silicification of the Tosawihi vicinity (after Q. Deng and R. Gosse 1990).

nearest Late Quaternary pluvial lakes stood in Buffalo Valley and Paradise Valley (the easternmost embayment of pluvial Lake Lahontan), about 75-80 km west and southwest of Tosawihi, and in Grass Valley, Diamond Valley, Ruby Valley, and Clover Valley, about 115-130 km to the south and southeast (Figure 5). We should not expect, then, to find in the local archaeological record much reflection, except indirectly, of the "Western Pluvial Lakes Tradition," a pervasive lake-margin orientation dominating much of the prehistory of the western Great Basin during the period 9000-6000 B.C. (Bedwell 1969, 1973).

The quarries lie well up the minor tributaries of the Humboldt River (Willow Creek and Rock Creek, both perennial, and the seasonal flow of Little Antelope Creek), only some 20 km from the hydrographic divide separating the Great Basin from the drainage of the Columbia River Basin (Figure 6). Waters falling north of the divide run down the branches of the Owyhee into the great westward-draining system of the Snake, thence into the Columbia, to empty finally into the Pacific Ocean. We do not think that there have occurred any very important changes in these drainage patterns during the entire time that people have inhabited the region. The issue merits note because the hydrologic location of the Tosawihi vicinity *may* have affected the economic orientations of prehistoric foragers importantly by bringing within the compass of a single day's walk access to a valuable riverine resource (salmon) generally not available to most other Great Basin groups. Some implications of this geography are discussed later in this chapter, and will be explored further in Chapter 20.

Water is scarce at Tosawihi under the current climatic regime; while perennial streams flank the vicinity, only ephemeral drainages transect it, fed chiefly by direct runoff from a watershed of modest size (Figure 7). The deeply-carved gorges of Little Antelope Creek and its immediate tributaries testify to a history of more substantial flows in the past, or to very long past episodes of gradual incremental scouring, but today (based on field observations from 1987 to 1990) their transport is minimal and they go dry by August every year. Too, the shallow aquifer generates few springs (Tosawihi Springs and Antelope Spring in the main body of the quarries, greater upwellings at Ivanhoe and Buttercup Springs near the Northern Corridor, and single minor seeps in the Eastern and Western Peripheries; cf. Figure 7). Of these, only the northern pair has continued to yield water past August in recent years, maintaining a modest, late-summer flow in Ivanhoe Creek; we infer that from time to time over much of the Holocene access to water must have imposed severe constraints on human exploitation of the quarries. On the other hand, various relict spring mounds (chiefly in Big Butte Valley) attest to more generous hydrologic regimes in the past, and the coincidence of archaeological habitations at the same locales argues that these defunct springs were productive during various periods of prehistoric human occupancy.

In part, the present dryness of the region may owe to a general recent decline in the local water budget, but it unquestionably has been affected as well by modern practices of intensive livestock grazing that have encouraged the proliferation of tap-rooted plants, sapping the aquifer and consequently lowering the water table. It is not unlikely that curtailment of the current grazing regime would result in measurable increases in spring productivity through all seasons, and a florescence of spring-associated vegetation.

Plants

Central northern Nevada occupies the heart of the Artemisian biotic province, a high desert countryside in which soils, landforms, temperature, and moisture conspire to sustain a shrubby upland dominated by big sage (*Artemisia tridentata*) and low sage (*Artemisia arbuscula*), perennial bunchgrasses including Great Basin wildrye (*Elymus cinereus*), bluebunch wheatgrass (*Agropyron spicatum*), fescues (*Festuca* spp.), and squirreltail (*Sytanion Hystrix*), and a host of spring-maturing forbs. The landscape is virtually treeless save where, at higher elevations, it is interspersed with fingers of the Montane Zonal Series (Billings 1951:113-119;

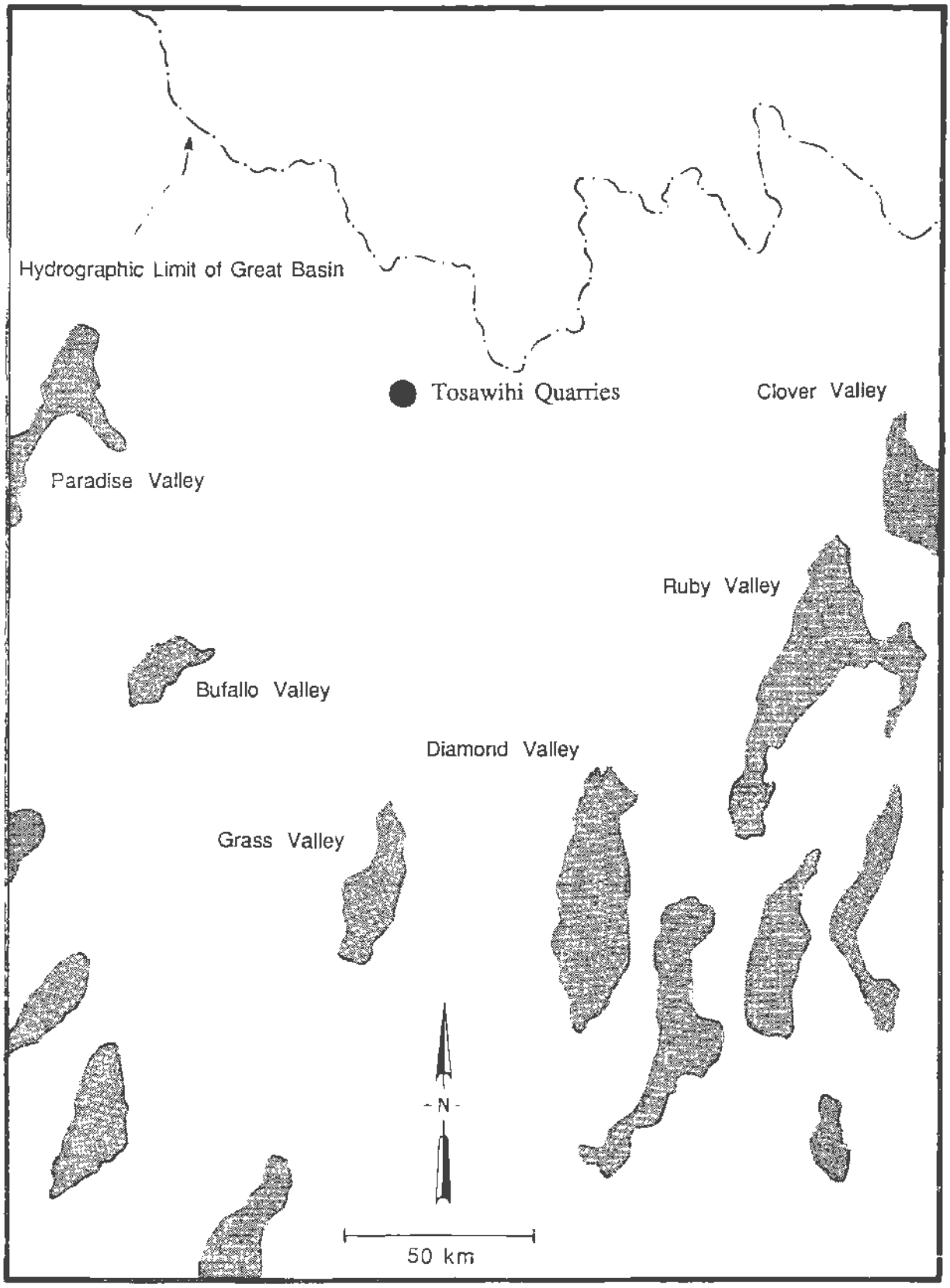


Figure 5. Late Quaternary pluvial lakes in Central Northern Nevada, Tosawihi vicinity (after Mifflin and Wheat 1979).

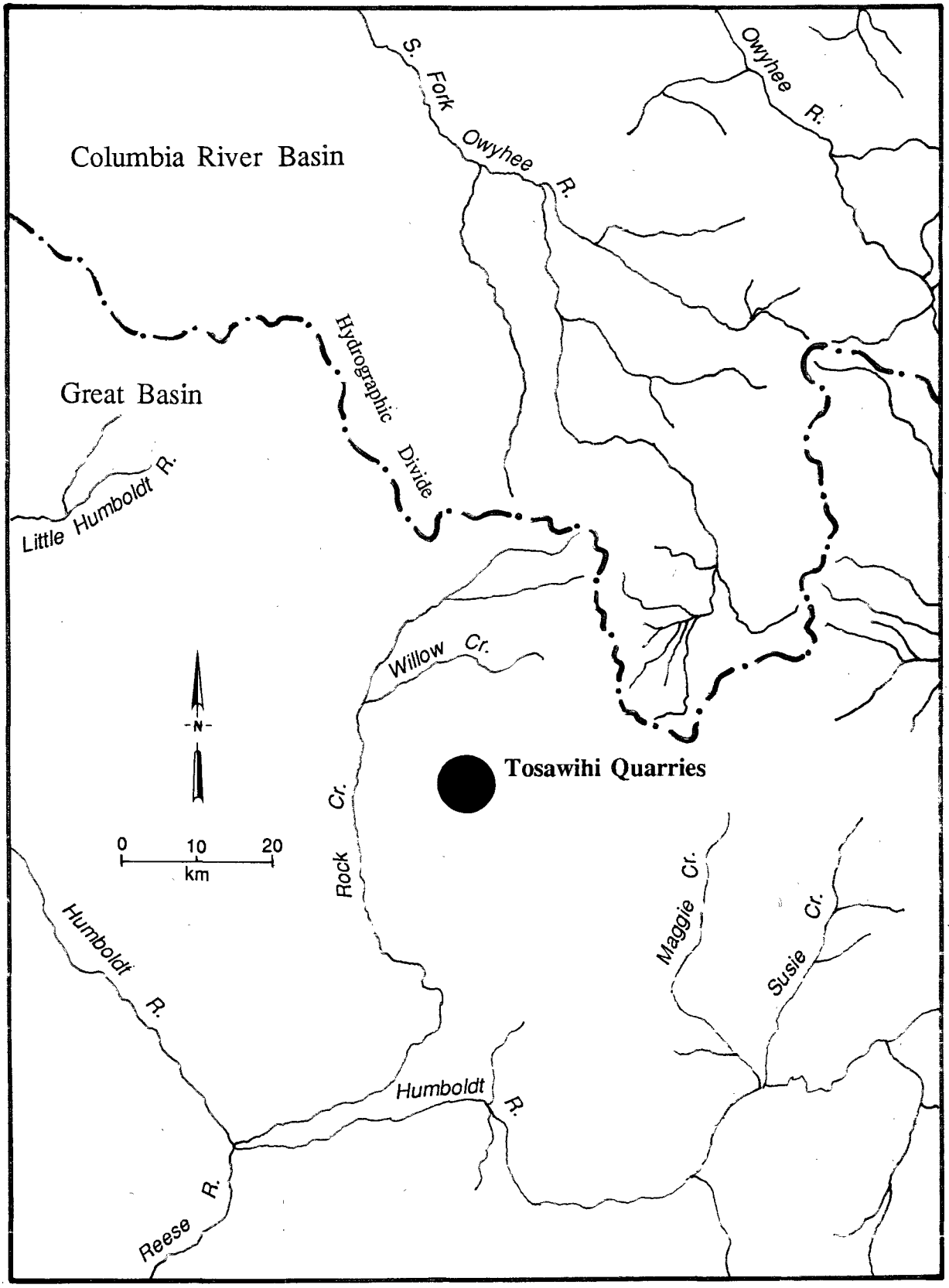


Figure 6. Principal perennial streams of Central Northern Nevada, Tosawihi vicinity (after U.S. Fish and Wildlife Service 1978).

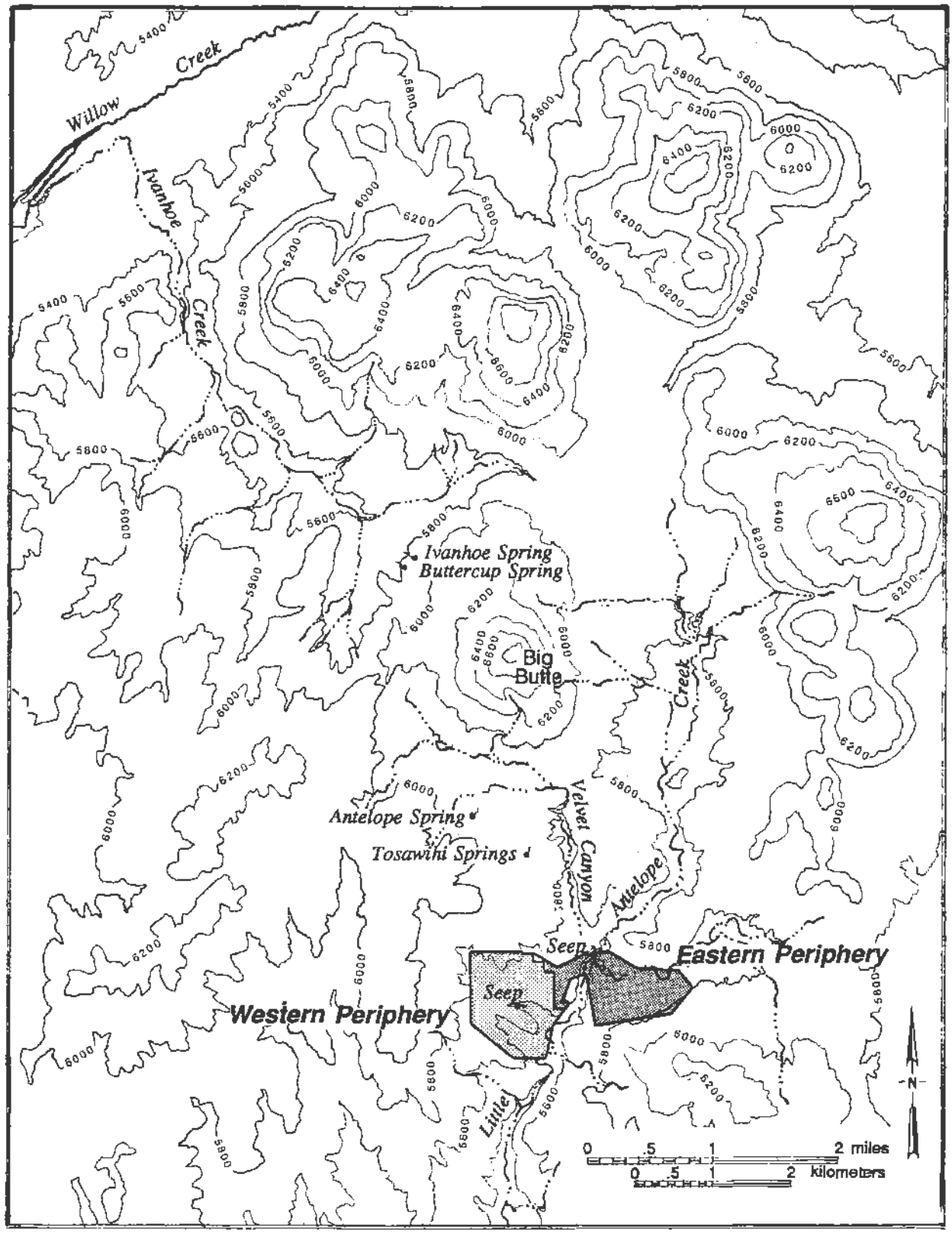


Figure 7. Water sources in the Tosawihi vicinity.

cf. Figure 8), in which stands of juniper (*Juniperus utahensis*) and pinyon (*Pinus monophylla*) are fringed by a mountain shrub association that includes bitterbrush (*Purshia tridentata*), mountain mahogany (*Cercocarpus ledifolius*), snowberry (*Symphoricarpos* spp.), and serviceberry (*Amelanchier alnifolia*). The distribution of pinyon, a major mid-to-high altitude subsistence resource in many other Great Basin settings, is latitudinally constrained; generally, the species does not occur north of the Humboldt River, and is absent from the Tosawihi vicinity.

Tosawihi lies in the rolling, mid-elevation sage grassland. There are no trees, and the largest shrubs we have seen are a few very widely-spaced serviceberry on the upper slopes. Big sage and low sage communities are interdigitated intricately on every hillside and crest, interspersed with phlox (*Leptodactylon* sp.) on the shallower, rockier soils and rabbitbrush (*Chrysothamnus* sp.) on the siltier flats and floodplains. In much more limited arenas (canyon bottoms and heavily shaded northern exposures, comprising less than 5% of the study area) relatively lush stands of wild rose (*Rosa* spp.) cluster with gooseberry (*Ribes aureum*), chokecherry (*Prunus virginiana*), serviceberry, and willow (*Salix* sp.), and the sandy floors of some of the gorges are laced with intermittent patches of *Artemisia ludoviciana,* an annual sage. A few otherwise barren exposures in the eastern periphery host unexpected clumps of *Coryphantha vivipara,* a small cushion cactus.

While all parts of the area currently are subject to intensive livestock grazing, and thereby express ecologies dependent on forces not at play in prehistoric times, native perennial grasses remain abundant in some settings; especially rich stands of Great Basin wildrye and bluebunch wheatgrass occur just north of the quarries, and virtually no patch is devoid of at least a sparse grassy understory (chiefly squirreltail, fescue, and bluebunch wheatgrass). Cheatgrass (*Bromus tectorum*, an alien annual) has encroached most disturbed zones, and in Big Butte Valley cheat grass, mustard (*Brassica* sp.), and thistle (*Cirsium* sp.) have rushed to occupy a large tract (more than 100 acres) recently burned. Too, grasses (both alien annuals and native perennials) are especially abundant on the berms of recent (historic) disturbances.

Scattered throughout the shrub communities are numerous forbs, among them various species that, prehistorically, may have held economic importance as food plants. In several settings, but never in great abundance, we have found various buckwheats (*Eriogonum* spp.), globe mallow (*Sphaeralca* sp.), *Mentzelia*, lupine (*Lupinus* sp.), larkspur (*Delphinium nuttallianum*), and bitterroot (*Lewisia rediviva*). Sedge (*Carex* sp.) and curly dock (*Rumex crispus*, an alien introduced during the past century) are found in a few wet meadows.

None of these plants is so abundant under the current ecological regime, so densely clustered, or so nutritionally valuable that it is likely to have formed a basis for prehistoric subsistence strategies. The grasses (and, by extrapolation, most of the edible forbs and shrubs; cf. Simms 1987) are low-ranked food resources, costly to procure or process when measured against their caloric returns. Too, their seasonal availability defines a fairly narrow window of time (roughly, May through July) during which foragers realistically might expect to harvest plants at Tosawihi. Even absent domestic livestock grazing there would be little plant food around the quarries, suggesting that, unless major climatic fluctuations have altered the biosphere substantially (and we have no data directly informative of this at present; cf. Drews et. al 1989:397-398), most currently observable plants played only marginal, incremental roles in the diet breadth of prehistoric quarriers. Some implications of our scant archaeological evidence reflecting the use of plants at Tosawihi are discussed further in Chapter 20.

Animals

Central northern Nevada falls within the Upper Sonoran and Pinyon-Juniper subdivisions of the Upper Sonoran life zone as defined by Merriam (1889), the largest and most diverse life zone of the state. Hall (1946:34-41) reports 83 mammalian species occurring

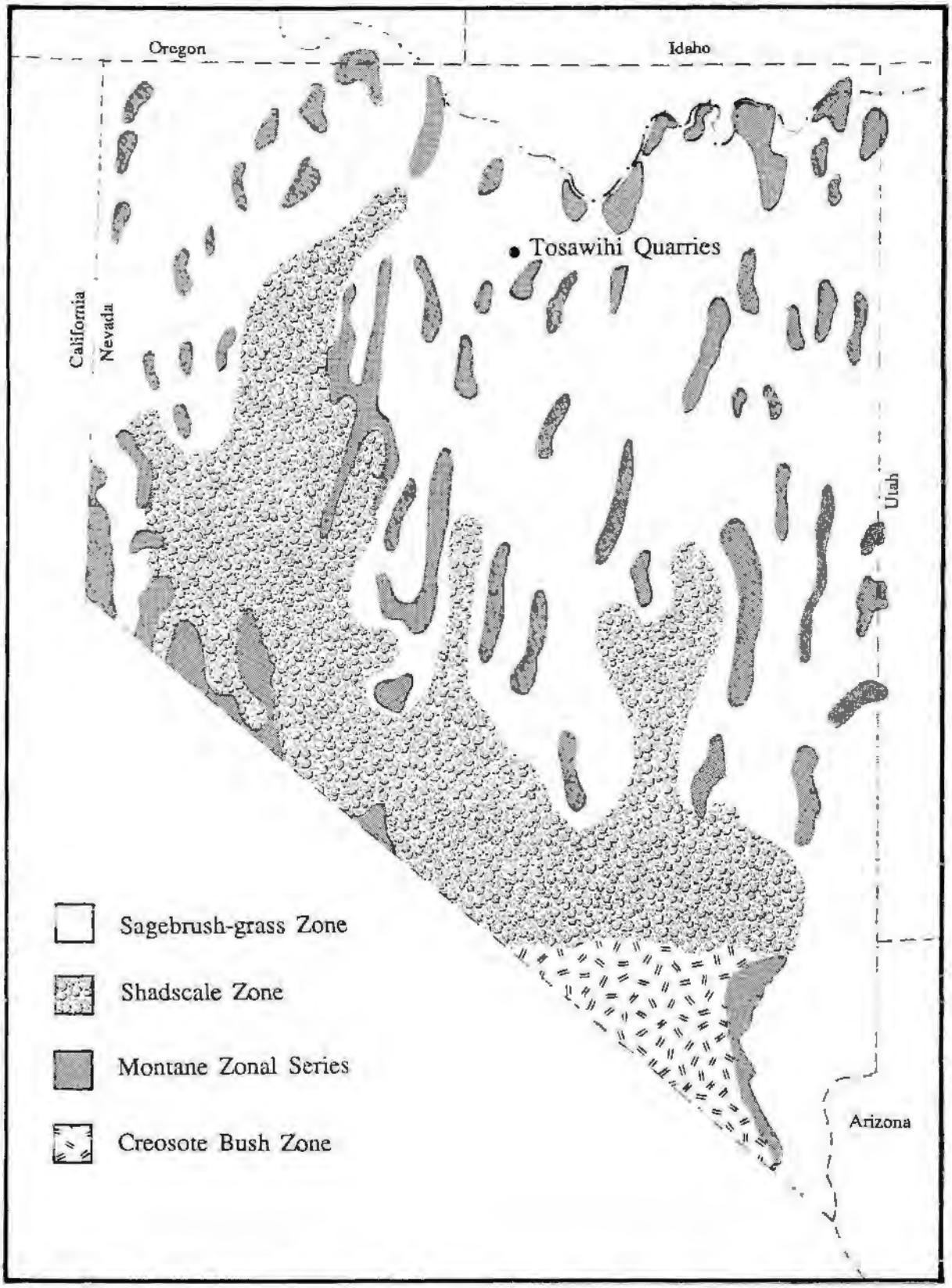


Figure 8. Principal Nevadan vegetation zones (after Billings 1951).

within it; of these, the populations of 35 species are exclusive to the Upper Sonoran or are denser there than within any other life zone. Characteristic species range from insectivores to artiodactyls, of the latter of which antelope (*Antilocapra americana*) and bighorn sheep (*Ovis canadensis*) find the Upper Sonoran their favorite Nevadan habitat. A cross-cutting zonation based on species distributions and centers of differentiation places our area of interest in the Elko center of the Central Rocky Mountain faunal area (Hall 1946:44-47), marked particularly by the exclusive occurrence of the Wyoming (Richardson) groundsquirrel (*Spermophilus elegans* [=*richardsonii*]) and subspecies of vagrant shrew (*Sorex vagrans amœnus*) and western jumping mouse (*Zapus princeps nevadensis*).

Because water is scarce and seasonal and the plant cover neither diverse nor particularly productive, there are not many animals around Tosawihi. Of larger mammals, only antelope and mule deer (*Odocoileus hemionus*) still come into the region, antelope on the open, rolling sage expanses and deer in the more sheltered gorges and upland crevices where tall shrubs and browse species cluster. Bighorn sheep currently reside no nearer than the Snowstorm Range, ca. 20 km northeast of the quarries (K. Gray, Nevada Department of Wildlife, personal communication 1989), but the recovery in 1988 of an immature sheep horn from the surface of a locality of archaeological site 26Ek3032 suggests that their residency in the Tosawihi vicinity lapsed only recently (i.e., within the present century?). Moreover, the unverified sighting of putative elk (*Cervus canadensis*) in Big Butte Valley in fall, 1987 (reported by C. Raven), and the observation (but *not* the collection) of an apparent elk antler on the slopes of Big Butte in 1989 (reported by S. Botkin), provocatively suggest that these rare but highly mobile artiodactyls still may traverse the region sporadically. Of course, the archaeological recovery of bison (*Bison bison*) bones from various contexts (cf. Chapter 14, this volume) implies prehistoric access to an even richer base of large game, irrespective of whether the species resided locally.

Smaller mammals are far more abundant, and include species of insectivores, bats, carnivores, rodents, and lagomorphs. While no formal species census has been compiled for the study area as a whole, we have, during the course of four seasons of archaeological survey and excavation, observed pocket gopher (*Thomomys* sp.), wood rat (*Neotoma cinerea*), chipmunk (*Tamias* spp.), various ground squirrels (*Spermophilus* spp.), marmot (*Marmota flaviventris*), cottontail rabbit (*Sylvilagus nutallii*), pygmy rabbit (*Sylvilagus idahoensis*), jackrabbit (*Lepus townsendii* and *L. californicus*), bats (order CHIROPTERA), badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), and coyote (*Canis latrans*). We suspect that most of the species identified by Hall (1946) as characteristic of the high valley/foothill biomes of central northern Nevada also may occur in the area, or may have done so in protohistoric times before livestock grazing induced a measurable attrition of habitat. Almost certainly, at least, our casual observations have under-represented the diversity of resident rodents, insectivores, and probably carnivores.

The very complex distributions of birds believed to inhabit the Tosawihi vicinity are discussed by Linsdale (1936; also cf. Ryser 1985); our far from exhaustive observations have logged sightings of golden eagle (*Aquila chrysætos*), red-tailed hawk (*Buteo jamaicensis*), kestrel (*Falco sparverius*), great horned owl (*Bubo virginianus*), common raven (*Corvus corax*), turkey vulture (*Cathartes aura*), sage grouse (*Centrocercus urophasianus*), and chukar partridge (*Alectoris chukar*), an introduced species. Numerous unidentified smaller birds inhabit each of the varied settings.

La Rivers (1962:101-104) discusses the fisheries of the Lahontan river system, wherein he counts ten original species still present during the historic period (also cf. Coffin 1984 and Sigler and Sigler 1987 for more general discussions of Nevada and Great Basin fishes). Most likely to have been important in prehistoric economies along the upper Humboldt and its tributaries are Lahontan cutthroat trout (*Salmo clarki henshawi*), Lahontan mountain sucker (*Pantosteus lahontan*), Lahontan tui chub (*Siphateles bicolor*), and perhaps the Tahoe sucker (*Catostomus tahoensis*). At Tosawihi we have observed only a few dace (*Rhinichthys* sp.) in spring-head ponds and some pools along Little Antelope Creek, suggesting that bigger fishes probably came no closer to the quarries than Rock Creek, ca. 10 km to the west, or its tributary Willow Creek, ca. 8 km north.

Of particular interest, however, is that neighboring our area of interest, just over the northern rim of the Great Basin, king salmon (*Oncorychus tshawytscha*) ran some 1800 miles upstream from the Pacific to spawn in the headwaters of the Owyhee River as recently as 1895 (La Rivers 1962:249-250; Gilbert and Everman 1985). Tremewan (1964) provides a vivid, first-person, past-century recollection:

> The salmon used to run up the South Fork of the Owyhee every spring. The ranchers in the Independence Valley and the people in Tuscarora would take them with pitch forks and spears...I remember the run of 1887. Those fish even went up that little stream that runs down through Tuscarora. It dried up completely in the latter part of July, but when it was high in the spring, the salmon could go up. Old Jess Snyder went out with a pitch fork one day and right under the bridge, he saw one spawning. He just put the pitch fork under it and heaved it on the bank. The fish weighed about 30 pounds.
>
> The Indians used to get them too. They would work the country near the reservation and bring them to Tuscarora in wagon loads.

Tremewan further recalls an abundant spring run of spawning cutthroat trout in the Humboldt.

Reptiles, whose regional distributions are described by Stebbins (1966), occur widely throughout the study area, although seldom in abundance. At virtually every site we observed one or two lizards, chiefly western whiptail (*Cnemidophorus tigris*), horned lizard ("horny toad;" *Phrynosoma* sp.), and side-blotched lizard (*Uta stansburiana*). In most settings snakes are scarcer or more furtive, but field crews have noted a few garter snakes (*Thamnophis elegans*) and gopher snakes (*Pituophis melanoleucus*) in all subareas, and just enough western rattlesnakes (*Crotalus viridis*) to inspire lingering caution.

Some Implications of the Coincidence of Resources

Why should prehistoric foragers have gone to Tosawihi? How are their activities likely to have been distributed over the landscape? And what sort of archaeological record are they likely to have left? Each of these questions, we believe, can be informed by referring to the geography of resources in the vicinity of the quarries, and by paying particular attention to spatial patterns of resource co-occurrence.

In the preceding pages we have sketched some general resource configurations characterizing central northern Nevada, and have related them to more specific constellations that occur in the immediate Tosawihi vicinity. We have not, however, dealt much with how these resources are likely to have generated specific *opportunities* for the prehistoric foragers who used the countryside, since effective opportunities usually are products of the complex interplay of sometimes unrelated factors. The costs, for instance, of procuring non-biotic resources escalate sharply in regions where the biomass is so little productive that subsistence during the act of procurement must be supported by transported stores; likewise, biotic subsistence resources are more costly where the distribution of water imposes lengthy travel between camp and the foraging patch. In *any* real-world circumstance, the costs and consequent benefits of engaging in *any* foraging enterprise at *any* level of technological or social complexity are situational, responding to the spatial coincidence of target resources and support resources.

At Tosawihi, the resources whose abundances and distributions appear most likely to have conditioned prehistoric land-use patterns are knappable toolstone, large and small game, plant foods (particularly, seeds and roots), and reliable sources of water. Of these, water

doubtless constituted throughout the Holocene the most stringent limiting factor; most springs (excepting Buttercup and Ivanhoe Springs, near the Northern Corridor) often fail by mid-year, when streams have gone dry and rainfall happens no more frequently than once a month. Quite simply, past August it is a long walk to the nearest drink of water from most places in and around the quarries, and foragers intent on plying other resources of the landscape would be hard-pressed to stay long without carrying water with them.

Biotic resources impose different kinds of constraints but they, too, fluctuate seasonally in distribution and abundance. Large gregarious animals (calorically, the most profitable subsistence resources available in almost any landscape) are not likely to have been plentiful locally save under dramatically altered (i.e., moister or cooler) ecological regimes, although some antelope doubtless could be taken by hard-working hunters throughout spring and summer under current climatic conditions, and deer well into the fall. We doubt, however, that their biomass bulks so high that foragers interested chiefly in large game would be prudent to abandon other patches or patch clusters (such as the Humboldt River corridor, Rock Creek, the Willow Creek floodplain, or the Snowstorm Mountains) to come to Tosawihi. On the other hand, occasional, fortuitous captures of big game probably could be counted on in almost any year to supplement a more predictable lower-ranked diet for foragers whose visits were motivated by other quests.

The relative abundance of small game, however, particularly lagomorphs and rodents, tends to be high enough around springs and along watercourses, as well as in a few upland settings with deep, friable soils away from water sources (e.g., Rodent Valley) that even under today's arid regime they might effectively, though briefly, support modest foraging populations. The attractiveness of water sources with resident colonies of small game as camping spots or foraging patches, however, probably would decline rapidly were they exploited continuously, owing to the depletability of localized animal concentrations. We have noted, for instance, a fairly boisterous colony of marmots (which *should* be quite high-ranked small game, although formal estimates of their caloric foraging return rates have not been calculated; cf. Simms 1987) inhabiting the meadows around Buttercup and Ivanhoe Springs, but their numbers could be decimated quite quickly through effective snaring techniques, requiring that small game foraging move further afield from the camp.

Of currently available plant foods, the most profitable to collect are bitterroot, best taken in spring (Simms 1987:118), and the various summer and fall-maturing berries. The distribution of bitterroot now is limited to a small but fairly abundant patch in the southern portion of the Western Periphery and to extremely meager occurrences elsewhere; berries, found only in a few microenvironmental enclaves (e.g., certain canyon-bottom and rim-base settings) and as isolated specimens, simply could not constitute under the present regime an economically important fraction of a human subsistence base, although they probably always would be collected by foragers already in the area during the appropriate season. Other plant foods, such as grass seeds, are more nearly ubiquitous and usually occur in larger, denser stands, but collecting them and processing them as food require, on the whole, significantly greater investments of effort for significantly lower caloric returns (Simms 1987). They are, then, "costlier" resources to exploit, and reliance on them necessarily inflates the cost of other activities (such as toolstone procurement) dependent upon them.

Toolstone, of course, always was present where it is now (at least throughout the period of human visits to the area), and it constitutes the single invariable on our map of the useful resources at Tosawihi; it does not move across the landscape (except by human agency), and its abundance is unaffected by seasons. This does not mean, however, that quarriers always should have concentrated their efforts at the same places, yielding them only in response to the depletion of the highest quality material. Rather, the likelihood that any particular toolstone source would be exploited doubtless was a function *both* of its intrinsic material quality as well as of the costs of exploiting it and, as we have observed above, those costs were affected in part by the locations of critical support resources (water, animals, and plants) upon which the quarry party had to subsist.

Although we do not control sufficiently fine-grained data on resource distributions within the Tosawihi study area to sketch except in broad strokes where foragers most profitably could pursue their interests, we note that the landscape can be subdivided on the basis of a number of cross-cutting resource opportunities. Even at a rudimentary level of modelling, in which the landscape is characterized only by the presence or absence of four proximate resource categories, we can define sixteen possible resource *profiles* each of which may occur in our area of interest, and each of which would offer a different suite of resource opportunities. These conceptual profiles are listed in Table 1, wherein any point on the landscape can be characterized by the presence or absence of a nearby, economically exploitable abundance of opalite toolstone, animals (big *or* small game), edible plants, and water. Seasonality is not considered in the scheme, since the profile of any individual tract changes seasonally (and does not necessarily repeat the same cycle of profiles in any sequent pair of years); too, the scheme does not address the almost certain probability of major environmental change throughout the Holocene, which doubtless induced changes in the resource profiles of places but *not* in the relevant resource categories by which their attractiveness is likely to have been measured.

Table 1. Conceptual Resource Opportunity Profiles.

Toolstone	Animals	Plants	Water
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	1	0
1	1	1	1
1	1	0	0
1	1	0	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
0	0	1	0
0	0	1	1
0	0	0	0
0	0	0	1

1: Presence of Exploitable Resource
0: Absence of Exploitable Resource

Complex as the array appears, it is, of course, merely an abstraction of alternatives, than which the decisions confronted by real-world foragers are vastly more complex. On the one hand, various other lower order resource distributions and landscape attributes also come into play; the availability of suitable hammerstones, for instance, affects the economics of quarrying and reduction, and topography affects the selection of campsites. On the other hand, our simple presence/absence dichotomy no more than symbolizes a suite of resource values the actual quantification of which complicates enormously the profile of each place, and renders the assessment of resource tradeoffs a labyrinthine exercise in cost/benefit decision making. In other terms, each instance where we recognize the *presence* of a resource actually represents a *value* measurable in various currencies (e.g., abundance, accessibility, and quality of toolstone, caloric return rates of foraging for available biotic species, abundance and reliability of water), and each value influences how a particular place will be used.

If we assume, as the archaeological record seems to suggest, that acquisition of toolstone and its reduction for transport were the principal prehistoric enterprises pursued at Tosawihi, then the geography of most activities should be tethered to the distribution of opalite (cf. Figure 4). To minimize transport costs, campsites should be located near toolstone sources, but they

also should correspond to the distribution of water (cf. Figure 7); Tosawihi Spring and the unnamed seeps in Little Antelope Canyon and Basalt Canyon appear to offer the most favorable coincidences of these resources. And assuming that quarrying parties should minimize foraging time, the most efficiently located campsites should give easy access to plant and animal resources; the ideal campsite for quarriers should exhibit resource profile 1111 (as in Table 1). Tosawihi Spring and the seep in Little Antelope Canyon are favorably located with respect to animals (rodents, and, at Tosawihi Spring, antelope), but plant foods in their vicinity (chiefly, grass seeds) are costly to exploit; these locations appear to reflect profile 1101, and should exhibit habitation residues dominated by early stage lithic reduction debris and hunting gear, with little plant processing equipment. The Basalt Canyon seep, owing to its proximity to bitterroot patches, more closely approximates the ideal camp location, although it is somewhat further removed from toolstone sources; we should expect habitation there to include early stage lithic reduction detritus as well as hunting *and* milling tool kits.

Of course, other resource profiles could characterize campsites not directly associated with quarrying; Buttercup Spring, Ivanhoe Spring, and the banks of Willow Creek and Ivanhoe Creek probably represent profiles 0111 or 0101, where foraging parties may have camped while exploiting local plant or animal abundances in the context of a general foraging round, perhaps on their way to or from the quarries, or during more favorable ecological regimes when biotic resources provided, in and of themselves, sufficient incentive for visiting the Tosawihi vicinity. Additional to hunting and/or plant processing paraphernalia, we should expect such campsites to contain only later stage reduction debitage. Places exhibiting unwatered resource profiles should contain a wide variety of task-specific sites with appropriately specialized tool-kits, but no habitations, while those exhibiting profile 0000 should have accumulated no *predictable* archaeological record whatsoever.

People in the Countryside

Human advantage was taken of the resource opportunities of central northern Nevada for at least 10,000 years, and of the Tosawihi vicinity for an apparently comparable period (cf. Chapter 19). We are interested at this point in the interplay of landscape and behavior, in the distribution of resources and how they were used, in the logic of making a living in a known and measured countryside, and in the archaeological record resulting from all that human activity. The strategies employed at Tosawihi can be reconstructed from two sources of data: from historical and ethnographic testimony on the lifeways of peoples inhabiting the region at the dawn of Euroamerican contact, and from the archaeological record. Both are informative of the role that the Tosawihi Quarries played in prehistory, and we discuss aspects of both of them here.

Native Peoples Observed: The Western Shoshone and the White Knives

When the upper drainage of the Humboldt River was visited for the first time by Euroamerican trappers and explorers (Peter Skene Ogden in 1825, John Work in 1831, and the Walker-Bonneville party in 1833), the countryside was found to be inhabited by "naked wretches" living, by all accounts, an impoverished existence, perpetually close to starvation (Ogden 1910; Irving 1837:259-261; Quaife 1934; Work 1913). These first reports of the Western Shoshone of central northern Nevada emphasize the mobility of their lifeway and the sparseness of their material culture, both, probably, concessions to the demands of making a living in a depauperate environment. Unknown at that time was the enormous extent of Western Shoshone territory, blanketing about half the state of Nevada and extending into portions of California, Utah, and Idaho (Figure 9), an approbation of the efficacy of Shoshone strategies for living in the desert.

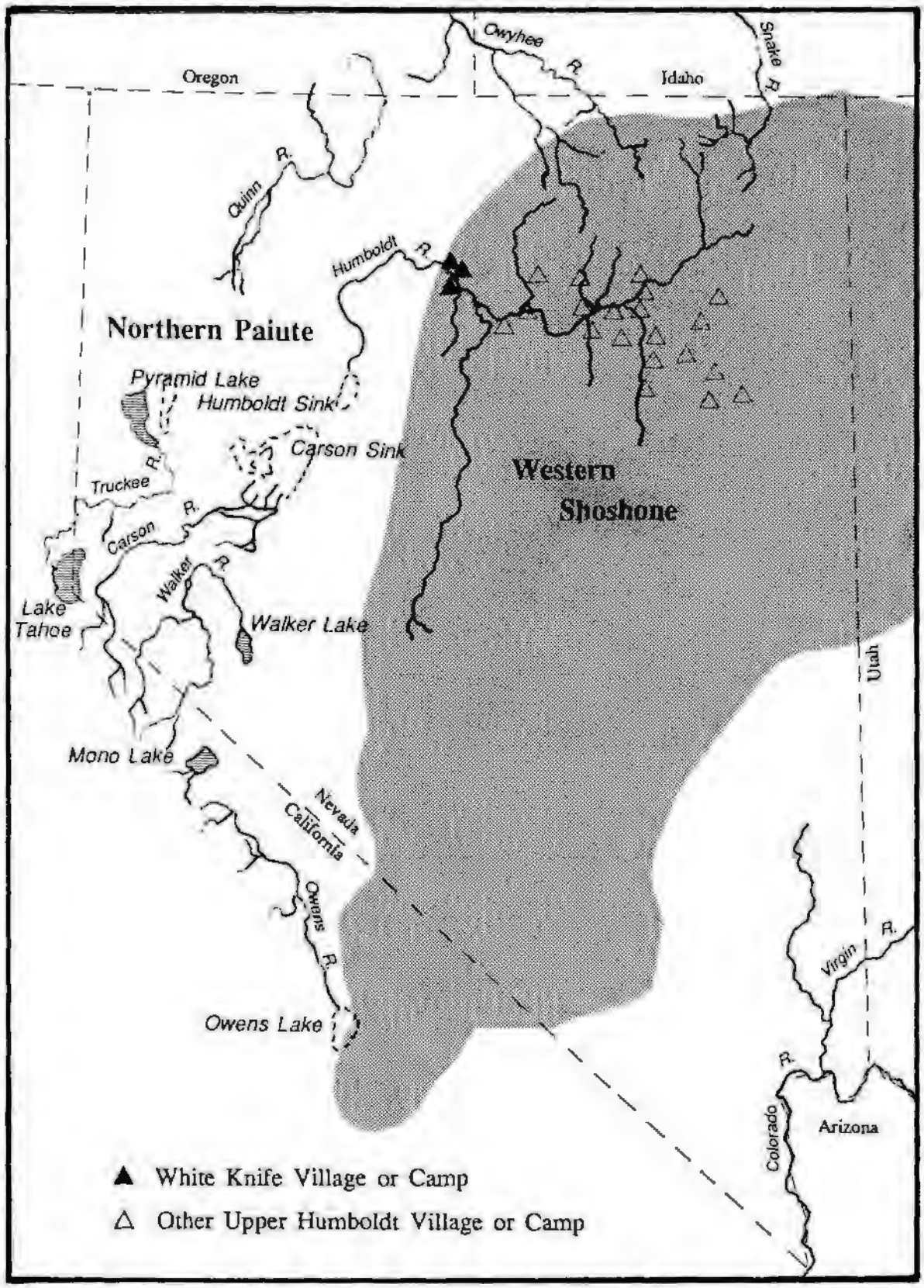


Figure 9. Western Shoshone Territory (after Steward 1937, 1938).

The Shoshone apparently expanded from a southern hearthland ten to fifteen centuries ago, when other speakers of Numic languages also spread north and east; the origin and timing of the expansion are inferred from linguistic evidence (Miller 1966, 1986). If such a movement actually occurred, it must have resulted in the displacement of earlier, now ethnically anonymous resident populations, since the archaeological record of the region clearly implies several millennia of prior human habitation. By the mid-nineteenth century the Western Shoshone had diverged into several smaller subgroups of which one, calling themselves *Tosawihi* ("White Knives"), occupied that stretch of the Humboldt River in the immediate vicinity of Battle Mountain and the adjacent hilly countryside.

Steward (1937, 1938, 1939, 1941) regarded the name *Tosawihi* to apply properly only to those Western Shoshonean groups who wintered around Battle Mountain and whose principal foraging radius encompassed the mountains flanking Rock Creek, but it was used variously to identify virtually all local groups in the region (Harris 1940:39; Powell and Ingalls 1874). Thomas et al. (1986:283) discuss the synonymy of the name, of interest here because it refers to the use of a high quality toolstone found in the mountains north of Battle Mountain, almost certainly the family of opalites outcropping at the Tosawihi Quarries. The name may have been applied to more distant groups who received the material through exchange or, since white cherts occur naturally for some distance along the upper Humboldt, those "Tosawihi" living further to the east may have earned rights to the name through the exploitation of local toolstone.

The White Knives shared a boundary to the west with the Northern Paiute (Stewart 1939, 1941), with whom they enjoyed generally amiable relationships including intermarriage and cooperation in hunting (Steward 1938:162); to the north, east, and south they met other Shoshonean groups. In the absence of land tenure, defense of territory, and exclusive rights in resources, the White Knives and their neighbors were able to benefit mutually from the natural occurrence of scarce but valuable attributes of the landscape. Harris (1940:55), particularly, emphasizes the egalitarian access to the countryside:

> There were no important property rights, no wars, no land-owning groups with bitterly defended boundaries, not even a marked ethnocentrism to separate one group from the rest and keep it intact.

This implies, of course, that control of a static resource such as Tosawihi opalite was not necessarily vested in a single ethnic group, and that wide archaeological distribution of the material *might* be the product of direct procurement by geographically diverse bands as much as the product of extensive exchange networks. Archaeologically, in fact, evidence of the two mechanisms could be indistinguishable unless readable ethnic "signatures" regularly were encoded in assemblage compositions, technologies, or support strategies.

While estimates of nineteenth century White Knife population range from an almost certainly too low 194 (Powell and Ingalls 1874) to 800 - 1000 (Harris 1940:42), most sources report the Indians to have been numerous and their territory, or at least that portion of it transected by the corridor of the Humboldt River, densely populated. Steward (1938:628) conjures that the more favorable localities (i.e., those downriver from Battle Mountain) may have supported one person per two square miles, a density exceptionally high compared to most other parts of the Great Basin outside Owens Valley. Harris (1940:42) contests that this figure applies beyond the lush riparian corridor of the Humboldt, and estimates that, area-wide, the White Knives occupied about fifteen to twenty miles per person.

People clustered along the banks of the Humboldt River in winter, during which season the population exhibited its least scattered distribution. Nonetheless, Steward (1938:161-162) remarks that these winter camps, composed of three to five related families, were smaller and less permanent than those characteristic of other Shoshonean groups. Harris (1940:44) further emphasizes the relative isolation of even the winter congregation by noting that each camp

group (family band) settled from one-eighth to one-quarter mile away from the next, composing large but very diffuse clusters of two to ten families. The consequent archaeological record should lack the large residential nucleations typical of most of the Great Basin, being the product of atypical behavior. Indeed, various observers of White Knife culture have remarked on this idiosyncratic pattern; Steward (1938:161) ponders:

> Why they did not deliberately concentrate in larger winter villages, which local economy certainly would have permitted, is not clear. Apparently they had no great urge, innate or learned, to associate with large numbers of people.

and Harris (1940:71), noting the independence, individuality, and autonomy of the residential group, but ascribing them more than Steward to environmental constraints, observes:

> Circumstances of food supply and poor transportation facilities prevented the occurrence of large or frequent group gatherings over an extended period of time, and true band organization was impossible. The camp group, therefore, was practically a complete ethnic unit, a microcosm of almost the total White Knives culture.

If the pattern described by Steward and Harris had protohistoric or late prehistoric precedent, its archaeological consequences should include small, lowland riverine habitations in greater abundance than occur in surrounding regions, and a concomitant dearth of large, semi-permanent residential nucleations. If, however, as seems possible, the pattern was an artifact of the historic era, emerging in response to early incursions of trappers and the subsequent floodtide of emigrants along the Humboldt River corridor during the gold rush, then protohistoric winter settlement in the area might be expected to exhibit the more typical Great Basin pattern of large winter villages.

Summer saw the fragmentation of winter clusters into individual, family-based foraging bands. Harris (1940:44-45) suggests that the seasonal foraging radius of individual camp groups ranged 25 - 100 miles from the winter camp, and that the same seasonal round was not necessarily reiterated in successive years. Steward (1938:162) reports the White Knives who wintered around Battle Mountain to have foraged particularly in the mountains above Rock Creek, which range would have brought them frequently within the vicinity of the Tosawihi Quarries. Farther travels were not uncommon, however, and both Steward and Harris report instances in which the summer subsistence quest carried foraging groups into the territories of neighbors; likewise, incursions by outsiders were expected.

Few ethnographic data have been collected regarding the structure of summer foraging patterns. Neither pine nuts nor salmon (among the most highly profitable target resources of the province) were available locally, but forays south to the vicinity of Austin were made to procure the former, and north to the tributaries of the Snake River for the latter (Steward 1938:162). Rabbits, antelope, deer, and mountain sheep (all available at or around Tosawihi) were the species most frequently hunted, and White Knife women engaged in the perpetual, ubiquitous Great Basin collection of plant foods. Antelope and rabbits often were taken in communal drives, sometimes involving the temporary amalgamation of camp groups; activities were directed by rabbit chiefs and antelope shamans, although these roles led to no other categories of social status (Harris 1940:154; Steward 1938:163). Most other subsistence quests were performed individually.

Large convocations were uncommon, although a few occurred in the context of seasonal festivals. Harris (1940:53) reports that as many as 300 people might congregate from nearby camps in the spring and fall for dancing and games; Steward (1938:163) notes that Iron Point and Battle Mountain were especially popular festival sites. Leadership of festivals, like that of communal hunts, was ad hoc, and vested authority did not extend beyond the duration of the festival (Harris 1940:53-54). Since authority was so little emphasized in White Knife society,

opportunities for the accumulation of prestige and wealth are likely to have been limited to economic success in the procurement and distribution of material goods.

White Knife technology was simple, characterized by a suite of classic Great Basin tools and processes. Material culture, consequently, was modest (Harris 1940). The distinctive archaeological signatures of White Knife culture, then, probably consist only of their isolating winter settlement pattern and their exploitation of Tosawihi opalite. To the extent that the former may reflect a prehistoric precedent and the latter an exclusive attribute, the White Knives should be visible as distinct *personae* in the regional archaeological record.

Prehistory

Aside from the immediate antecedents of the present work, little research in the upper Humboldt River drainage has focused specifically on the archaeology of the White Knives or on the exploitation of the Tosawihi Quarries. Broad syntheses, however, pitched at various levels of abstraction, provide a framework within which data collected at Tosawihi can be viewed from the larger perspectives of the western Great Basin (Elston 1986a), northern Nevada (James 1981; Smith et al. 1983), and the Humboldt River Basin (Elston and Budy 1990; Rusco 1982). These overviews, together with specific data from surrounding regions, allow us to develop expectations about the duration, nature, and intensity of prehistoric human use of the Tosawihi vicinity.

The distribution of archaeological sites in central northern Nevada was addressed first in the context of an extensive regional reconnaissance carried out by the Nevada Archaeological Survey (Stephenson and Wilkinson 1969); largely intuitive, the effort resulted in the recording of 91 prehistoric sites in a large area defined by Paradise, Eden, Kelley Creek, Evans, and Squaw Valleys. A time depth of about four thousand years was inferred. While little problem orientation guided the inquiry, Stephenson and Wilkinson made some observations of lingering interest. In the first place, they noted a predominance of hunting gear over plant preparation equipment, a pattern they attributed (1969:50), probably correctly, to the valley-margin and upland settings of most of the sites they found. In the second place, and of particular interest to the present investigations, they report a heterogenous distribution of utilized lithic material; west of the Osgood Mountains, local cultural assemblages are dominated by obsidian, while various cherts, evidently including Tosawihi opalite, tend to be favored to the east. This chert/obsidian cline closely approximates the reported ethnographic boundary separating Western Shoshone peoples from the Northern Paiute in the nineteenth century; Stephenson and Wilkinson (1969:50-51) suggest that it may reflect a cultural boundary of fairly long tenure.

The archaeological occurrence of Tosawihi opalites and similar white cryptocrystallines has been addressed in the context of other, usually site-specific, research in central northern Nevada, but the regional distribution of the material never has been examined methodically. At South Fork Shelter, for example, over 80 km from Tosawihi (cf. Figure 10), Heizer, Baumhoff, and Clewlow 1968) assumed that the large number of white chert knives recovered from excavations reflected prehistoric precedent for the ethnographically reported exploitation of the quarries. In the studies discussed below, more or less explicit attention has been paid to identifying the presence, relative abundance, and, in some cases, the functional role of Tosawihi opalites in diverse archaeological assemblages.

Prior to the inception of the present investigations, the vicinity of the Valmy power plant site (Figure 10) was the most thoroughly scrutinized archaeological zone in the region. Lying some 50 km southwest of Tosawihi, portions of the Valmy area were given intensive survey in the interests of cultural resource management (Bard 1980; Busby and Bard 1979; Rusco and Seelinger 1974); numerous sites were recorded, and three campaigns of data recovery ensued.

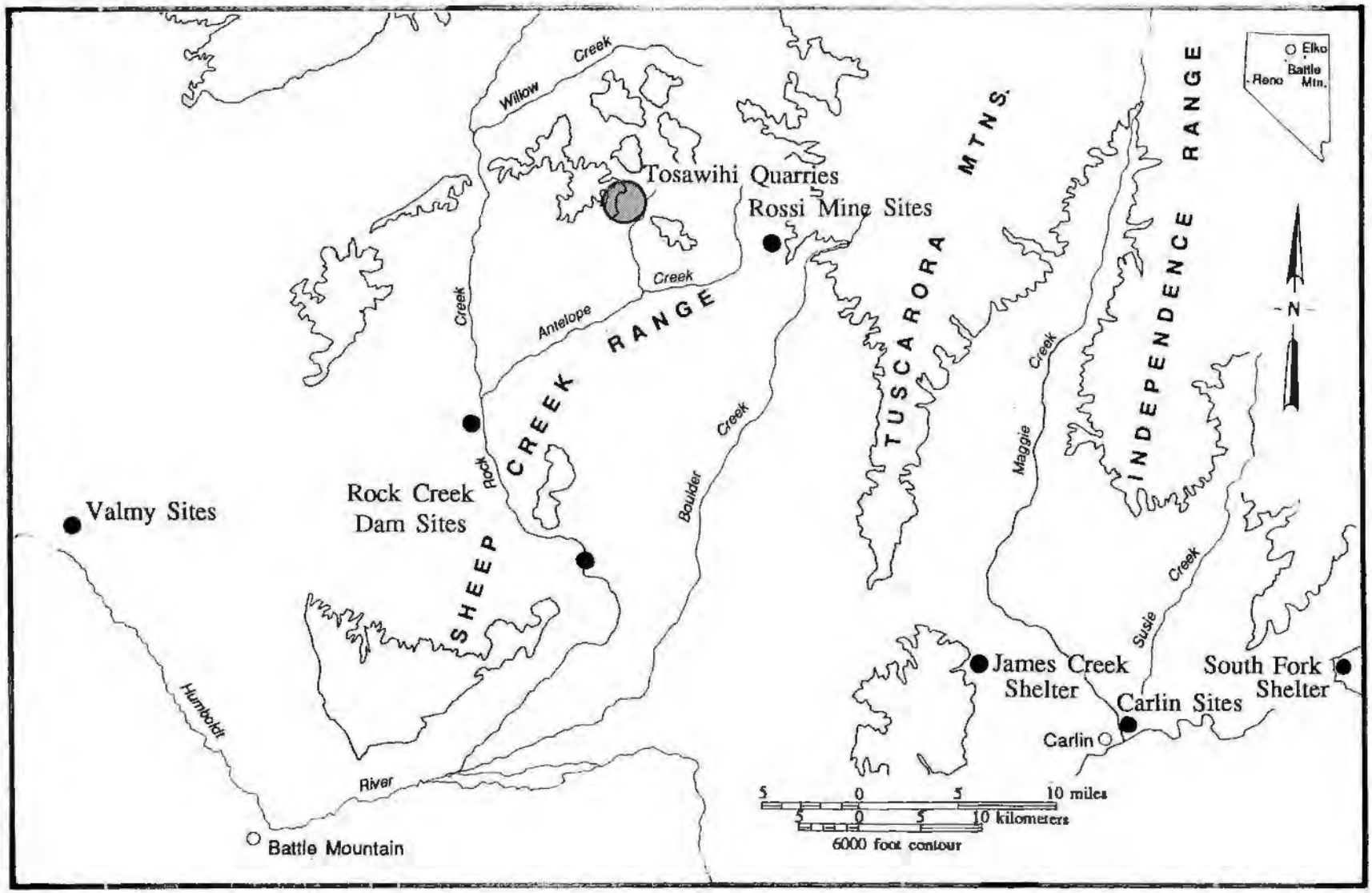


Figure 10. Locations of previous archaeological research in the Tosawihi vicinity.

First, surface collection and sample excavations at three sites near Treaty Hill led Davis, Fowler, and Rusco (1976) to conclude that human use of the area may have spanned the past 7000 years. Assemblage diversity suggested that two of the sites functioned as base camps, exhibiting modest plant processing equipment and projectile points ranging from the Northern Side-notched to Desert series. About 82.5% of the total lithic assemblage appears to consist of Tosawihi opalite, a fraction commensurate with expectations derived from ethnographic patterns. Moreover, the tool:debitage ratio of Tosawihi-like material is 2.2:100, while that for obsidian is 6.3:100; this implies that, despite the nearby occurrence of useable obsidian (Davis, Fowler, and Rusco 1976:51 refer to obsidian cobble sources only 15 -20 miles to the north and northeast), Tosawihi opalite was a cheaper commodity, available in more wastable quantities. These proportions vary little through time, suggesting a relatively long tenure of exploitation of the quarries. Lithic analysis indicates that most of the Tosawihi material was heat-treated prior to further reduction at Valmy, although a smaller fraction apparently was heat-treated on site.

Subsequently, Rusco and Davis (1979) made intensive surface collections in the Treaty Hill vicinity and tested two additional sites. As in the previous research, a 7000-year human chronology was inferred, and assemblage diversity suggested that five sites had functioned as base camps. Again, Tosawihi opalite dominates the local assemblage; 92.9% of the debitage and 69% of the projectile points are apparently of Tosawihi origin. Heat-treatment is common, being observed on 95% of the tools and 84% of the debitage. Low retrieval of cultural materials (0 - <3 specimens/m^3 of deposit excavated, opposed to the ca. 100 specimens/m^3 recovered in 1976) clearly indicates a lower intensity of use. The projectile point assemblage is weighted toward early and middle archaic forms (Great Basin Stemmed through Elko series), with an apparent *floruit* of hunting activity coincident with the production of Humboldt Concave Base points (which comprise 65% of the assemblage). Of all classes of flaked stone artifacts, only Great Basin Stemmed points tend to be manufactured of materials other than Tosawihi opalite.

The latest work at Valmy was undertaken by Elston et al. (1981), who made intensive surface collections and conducted test excavations and backhoe trenching at three major sites and several lesser localities near Treaty Hill. In part, the work was designed to inquire into the function of sites previously identified as base camps; assemblage compositions and site structure, however, indicated that the sites had been inhabited transiently by parties focusing on hunting and more limited plant food collection. Tosawihi opalite again dominates the local assemblages (constituting 92.8% of the lithic assemblage at NV-Hu-634, the richest site investigated). Principal occupation of the sites ranged from 6000 - 3000 B.P., with an earlier component (marked by Great Basin Stemmed projectile points) possibly relating to the period 11,500 - 8000 B.P.

About 29 km southwest of Tosawihi, sites along the Rock Creek drainage were reported by Botti (1985) and further examined by Clay and Hemphill (1986). Investigations at one open site and four rockshelters disclosed an intensive concentration on the reduction of bifaces of Tosawihi opalite (99% of the debitage, much of it tertiary, is apparently of Tosawihi origin, save at one rockshelter where Tosawihi material accounts for only 58% of the debitage); late prehistoric components are especially well-developed, with faunal assemblages dominated by small mammals. Further exploration of archaeological patterns along Rock Creek should be particularly illuminating, since the region is known to have been visited regularly by the White Knives.

Tosawihi opalite also dominates lithic assemblages occurring east of the quarries. In the western foothills of the Tuscarora Mountains, for instance, Rusco (1982) found Tosawihi material to comprise 90% of the tools and 99% of the debitage at seven sites in the vicinity of the Rossi mines. More strikingly, tool:debitage ratios in opalite at these sites were observed to be 1:46.7, but only 1:3.2 for all other materials, indicating that foreign material tended to be imported in the form of finished tools. Broadening the scope of inquiry, Rusco incorporated her Rossi mine data with figures from the Valmy sites as well as two sites near Carlin (Rusco 1979) to investigate the effects of distance from Tosawihi on local lithic assemblages; she

observed that the proportion of later stage biface and core reduction increases with distance from the quarries, supporting a generalized gravity model of lithic procurement and transport. The Carlin sites, however, although furthest from Tosawihi, exhibit the highest incidence of cortical flakes, suggesting that material sources may have been misidentified. Smaller sources of white chert occur variously along the upper Humboldt and doubtless were exploited locally; one such has been reported from the vicinity of Rusco's Carlin sites (Elston and Budy 1990).

More recently, several other mining-related projects in the western foothills of the Tuscarora Mountains have resulted in the archaeological survey of several thousand acres, the recording of hundreds of sites and isolates, and very limited testing of a few sites (Hicks 1989; Rafferty and Blair 1988; Russell, Tratebas, and Schroedl 1986; Schroedl 1986; Tipps 1989). These various investigations uniformly have found the principal lithic material used in the hilly country east of Tosawihi to consist of cherts, of which white chert predominates overwhelmingly, and to which all investigators are inclined to ascribe a Tosawihi origin. Assemblages in this region are composed chiefly of biface reduction debitage, bifaces, and projectile points (Early Archaic to Protohistoric types, with some indications of a Late Archaic intensification coincident with the use of Rosegate points); other formal flake tools, cortical flakes, and core reduction debitage are less frequent, and ground stone occurs sparsely only at a few habitations. Biface reduction is the principal activity identified at most sites.

Before Intermountain Research undertook investigations at Tosawihi, the only research directly concerned with the quarries had been that conducted by Mary Rusco and her associates over a period of more than a decade. Several unpublished papers (Rusco 1976a, 1976b, 1978, 1979, 1983) addressed the nature and composition of Tosawihi assemblages, the distribution of archaeologically transported Tosawihi opalite across the northern Nevada countryside, and the chemical "fingerprinting" of the material in order to objectify its recognition in non-local assemblages. Duffé (1976a, 1976b) attempted such characterization utilizing X-ray fluorescence techniques, but the results were not conclusive. Given the frequent occurrence of visually similar white cryptocrystallines in the upper Humboldt River basin, the issue of the correct identification of Tosawihi material becomes critical for resolving questions of ethnicity, resource transport, and trade; further research along these lines clearly is warranted.

Since 1987, Intermountain Research has conducted ongoing investigations at Tosawihi to identify the surface manifestations of activity areas, test the contents of many of them, order research agendas, and, as reported here, recover data from sites vulnerable to development. Survey of the main body of the quarries was reported by Elston, Raven, and Budy (1987), of the Western Periphery by Budy (1988), of the Eastern Periphery by Raven (1988), and of the Northern Corridor by Drews (1988); historic sites in the Tosawihi vicinity were reported by Zeier (1987). Concurrent with or following closely upon these studies came Elston's (1988a) initial iteration of research issues to guide all subsequent inquiry at Tosawihi (an evolved reconsideration of which appears here as Chapter 3) and a proposed plan for the cultural resource management of the quarries (Intermountain Research 1987). The testing of sites in the Eastern and Western Peripheries resulted in an anthology of new data (Elston, ed. 1989), generating along the way a detailed data recovery program (Intermountain Research 1988a-d) upon which the work reported here was based.

Although the focus of the present volume is on data newly acquired from the Eastern and Western Peripheries and the Northern Corridor, the findings of earlier investigations are synthesized and incorporated in both our analyses and conclusions. Our current understanding of local and regional chronology is summarized in Chapter 19.

Outside of recent work at Tosawihi, we really control very little regional data on the role of the quarries in prehistoric adaptive strategies. Although white "cherts" are known to be widespread in archaeological assemblages in central northern Nevada, it remains to be demonstrated that Tosawihi actually was the source of most of this material; troublesome local occurrences of visually similar natural deposits complicate our understanding of how Tosawihi opalites moved over the landscape. Resolution of the origin of these various lithic materials, and

definition of the chemical, physical, and visual signatures by which they can be identified reliably in the archaeological record, are achievements upon which an accurate human geography of the Tosawihi vicinity ultimately will depend.

Too, almost none of the research performed so far in the region has confronted the subsistence and settlement strategies by which foragers made a living over the past millennium. It is not sufficient merely to observe that they were hunters and gatherers, nor sufficient even to observe that sometimes (even if we can specify the times when they did so) they relied more on hunting or more on gathering; the resource structure of the countryside unquestionably dictated specific survival strategies, at times constraining and at times enabling enterprises such as the acquisition of toolstone. Until we can model how Tosawihi quarriers made a living across the changing environmental theater of the Holocene, we cannot begin to understand the economic exigencies of toolstone procurement, or to discern the logic of those quarrying strategies actually observed in the archaeological record.

In the following chapter we attempt to pose some answerable questions about how toolstone quarries tend to be used, and about how past use is likely to be recognizable archaeologically at places like Tosawihi. Some of our concern is to identify how toolstone procurement articulates with other ways that foragers use the landscape, and to learn how the economics of making a living in central northern Nevada affected, and was affected by, the costs and opportunities presented by Tosawihi opalites. In subsequent chapters we will explore how what we have learned of the archaeological record at Tosawihi informs us of what happened there in the past, and of how that instructs us to think about relationships between toolstone and the people who exploit it.

Chapter 3

MODELING THE ECONOMICS AND ORGANIZATION OF LITHIC PROCUREMENT

Robert G. Elston

> *The underlying principle is that, all else equal, more efficient strategies—those that produce the greatest return in energy relative to time or effort expended—will be favored over those that are less efficient.*
> —O'Connell, Jones, and Simms (1982:233)

Although several archaeological studies have focused on economic aspects of toolstone procurement and distribution (cf. Chapter 1), few have employed formal models and none has hazarded a comprehensive view of toolstone economics. The present chapter explicates a more formal approach developed over several previous archaeological investigations (Budy and Elston 1986; Zeier and Elston 1986), in particular, that of James Creek Shelter (Elston and Budy 1990).

The model of lithic variability applied to James Creek Shelter was informed by recent ethnographic and archaeological applications of microeconomics, including optimal foraging theory (cf. Earle 1980; Smith and Winterhalder 1981; Smith 1981, 1983; Keene 1981); it explored relationships between mobility, risk, and toolstone cost. James Creek Shelter is a small rockshelter that was used as a short term base by foraging parties between about 1250 B.C. and A.D. 1800. The site is adjacent a mediocre lithic source (Maggie Creek Chert), but more distant from sources of other, higher quality materials such as Susie Creek chalcedony (10 km), Elko hills chert (31 km), and Tosawihi chert (51 km). The model suggested that, in this situation, the longer the duration of occupation, the greater the risk of expending high quality tools, and the more advantageous the husbanding of supplies of high quality exotic material (through conservative design and maintenance techniques) while increasing use of local, lower quality toolstone. Tradeoffs between mobility and cost should be visible archaeologically in relative proportions of local versus exotic lithic materials in debitage, as well as in artifact staging and curation. These expectations largely were supported by the archaeological record of the site, where independent evidence of occupational duration was present.

The James Creek Shelter model addressed a special case; the site was a place where people processed locally procured toolstone, but toolstone procurement was not the reason for its occupation. Rather, the procurement and processing of local Maggie Creek chert was performed in support of other tasks involved with acquisition of food resources. The Tosawihi Quarries lie at the other extreme: at least during certain periods, the place was visited to procure toolstone, an activity supported by the procurement of food resources. While mobility and risk affected the costs and benefits of toolstone procurement at Tosawihi, we can expect them to have played out there very differently than at James Creek Shelter. Moreover, the organization and techniques of lithic procurement were archaeologically irrelevant and unknowable at James Creek Shelter, but they are critical to understanding the Tosawihi Quarries.

Toolstone is heavy, and its utility is realized only in its ability to increase the return of other resources. Optimization models are well suited to analysis of toolstone procurement. Data regarding the costs and returns of bedrock extraction and processing are crucial for such models, and the quarrying and processing experiments reported herein provide such data for the first time. We do not assume that our experimental rates are identical to return rates achieved by prehistoric quarriers and knappers, but they probably are within an order of magnitude, and they allow comparison with experimental and ethnographic data on the costs and benefits of food procurement and transportation (Simms 1987; Jones and Madsen 1989;

Metcalfe 1989; Metcalfe and Barlow 1991; Rhode 1990). Consequently, the following lithic procurement model is more informed by optimal foraging theory (Orians and Pearson 1979; Belovsky 1987; Stephens and Krebs 1986) than the model developed for James Creek Shelter, is more formal and comprehensive in its consideration of mobility patterns, and specifically addresses labor organization and procurement technology.

Lithic Procurement Strategies

Hunter-gatherers can respond to environmental variability by calling on technological and organizational skills and knowledge, the whole range of which could be carried by no single individual nor implemented at any one time or place. We assume that ancient people understood the properties and modes of occurrence of toolstones as well as they did plants and animals, and that they judged the costs and benefits of lithic procurement well enough to recognize risks, payoffs, and losses in order to make informed decisions most of the time. For purposes of analysis, we artificially isolate the body of skills, knowledge, activities, and locations that have to do with lithic procurement and refer to them in the aggregate as a *lithic production system* (Ericson 1984:3; Elston 1986c:138), without suggesting that anyone but an archaeologist ever relied on such a conception. Lithic production systems are further abstracted into several components, including patterns of mobility employed to bring people and toolstone together, organizations of labor involved in procuring and transporting toolstone, and techniques of extraction and processing. These are employed in various combinations as *lithic procurement strategies* to deal with the nature of toolstone and its distribution in the landscape, the location and distribution of food resources, seasonality, and other environmental variables that affect costs and risks of procurement. Since hunter-gathers apply a repertoire of organizational and technological options in response to a variable environment, different lithic procurement strategies are expected in different circumstances.

Minimizing Cost, Maximizing Return

Foragers may sometimes seem to be faced with the choice of minimizing costs or maximizing returns in procurement strategies, but these goals are two sides of the same coin to the extent that maximizing returns results in obtaining more product for time and energy invested. Any minimization problem can thus be restated as a maximization problem (Stephens and Krebs 1986:7); indeed, optimality models in evolutionary ecology usually assume maximizing goals in order to facilitate the definition of currency, constraints, and decision variables. This approach, however, is feasible only if the all variables in the problem can be well defined.

Unfortunately, we presently do not know how to define most variables of prehistoric lithic procurement strategies in ways that will permit construction of maximization models. Each of the several components (eg. mobility patterns, scheduling, labor organization, technology, procurement techniques, etc.) of a particular lithic procurement strategy may have a different currency, set of constraints, and decision variables. Although we believe that much of the archaeological record is the result of individuals arriving at similar economic decisions in similar circumstances, we are confronting (and attempting to explain) an archaeological record resulting from *myriad* behaviors and individual acts over long periods of time. Confronting the consequences of individual decisions is possible (but usually trivial) at the level of the discrete artifact; we are more often interested in explaining trends in archaeological variability at a larger scale: why sites at Tosawihi have particular spatial distributions; why the assemblages of some sites contain lots of bifaces while others do not; why some sites were occupied continually over long periods of time while others were visited infrequently.

Much of this kind of variability can be modeled as the result of scheduling, labor organization, positioning, and activity segmentation. We *can* assume that foragers manipulate these variables in order to maximize some rate such as time available for quarrying and processing, but in most archaeological situations, we will find it impossible to quantify and sum the different contributions toward that goal. A more productive strategy is to assume that foragers seek to increase the benefit/cost ratio of resource procurement by minimizing indirect costs of forays such as food, water, travel time and lost opportunity. We may also assume that minimizing indirect costs of lithic procurement decreases risk. Consider that while nutritional benefits are immediately accrue on the procurement of food resources, inedible toolstone confers no *direct* energetic return. The benefit of toolstone procurement is, through tool use, to *eventually* increase efficiency in procurement and processing of food and materials from which clothing, shelter, and non-lithic tools are made. The deferred benefits of investing in toolstone procurement are thus analogous to the deferred benefits of food storage, and both involve risk: the possibility of loosing the energetic stake in procuring and processing as well as the deferred benefits. Thus, we might reasonably expect foragers to avoid as many indirect costs as they can in food storage and lithic procurement.

Minimization of indirect costs in toolstone procurement should result in patterns of archaeological variation observable in site placement, activity segmentation and assemblage content. As modeled subsequently in this report, our expectations are framed in qualitative or relative expressions that can be tested by statistical pattern recognition: certain kinds of sites will tend to be located *nearer or further* to water, plant or toolstone resources; certain artifact or feature types are expected to occur with *greater or lesser* frequency in different functional site classes. The few *quantifiable* proxies of rate maximizing behavior that we can define for the archaeological record reflect the direct costs and returns of lithic procurement (time and energy for extraction and processing); it is in this domain that we develop rate maximizing models of lithic procurement behavior.

Managing Risk

Risk is the probability of loss or of a bad outcome (Wiessner 1977:5), a consequence to be avoided. Risk is not quantified here, but is part of the warranting argument for cost minimization and serves the heuristic purpose of visualizing the object of various procurement strategies. Given the basic premise of cost minimization in lithic tool procurement and maintenance strategies, increased cost looms as the greatest risk. Both procurement and use of toolstone are costly, but each involves different kinds of risk operating at different time scales. Acquiring toolstone involves *venture risk*, the probability that procurement and opportunity costs will exceed the benefits of any lithic resources gained (Elston 1990). Venture risk is borne for the duration of a procurement foray, ranging from minutes to several days (Figure 11). Venture risk increases during a toolstone foray in proportion to time, energy, and opportunity costs, each of which varies in different phases of the work. We assume that venture risk rises rapidly to unity during extraction and stays there until processing begins; with sufficient return, venture risk then decreases rapidly during processing and falls to zero when processed toolstone is in hand. Together, search, handling, and opportunity costs (defined below) determine whether a toolstone venture pays off or not, so the prudent quarrier will strive to minimize them.

The consumption of toolstone increases *contingency risk*, the probability of having insufficient toolstone to meet subsistence needs (Elston 1990). Such inability is lost opportunity, but unlike choosing to take a particular resource and giving up the opportunity to do better (or differently), the cost of insufficiency is not balanced by any kind of return. Contingency risk is borne for the time it takes to consume a supply of toolstone. In the model graphed in Figure 12, lithic procurement cost is held constant for simplicity. As an initial supply of toolstone is

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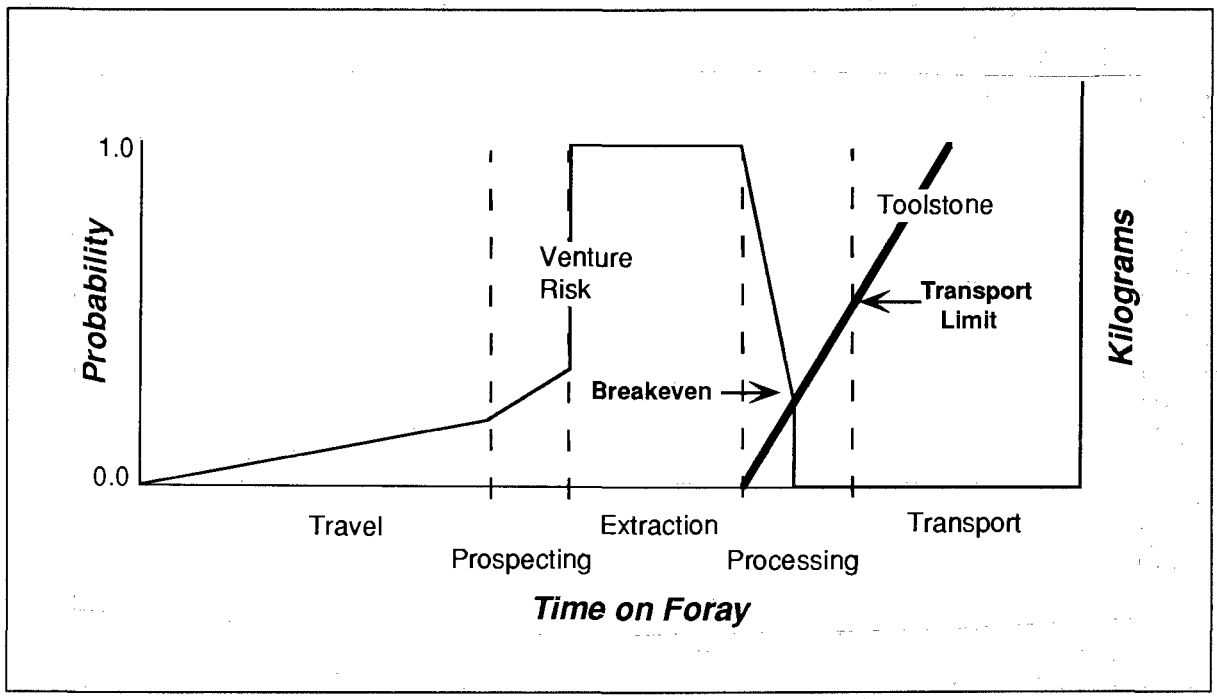


Figure 11. Venture Risk Model.

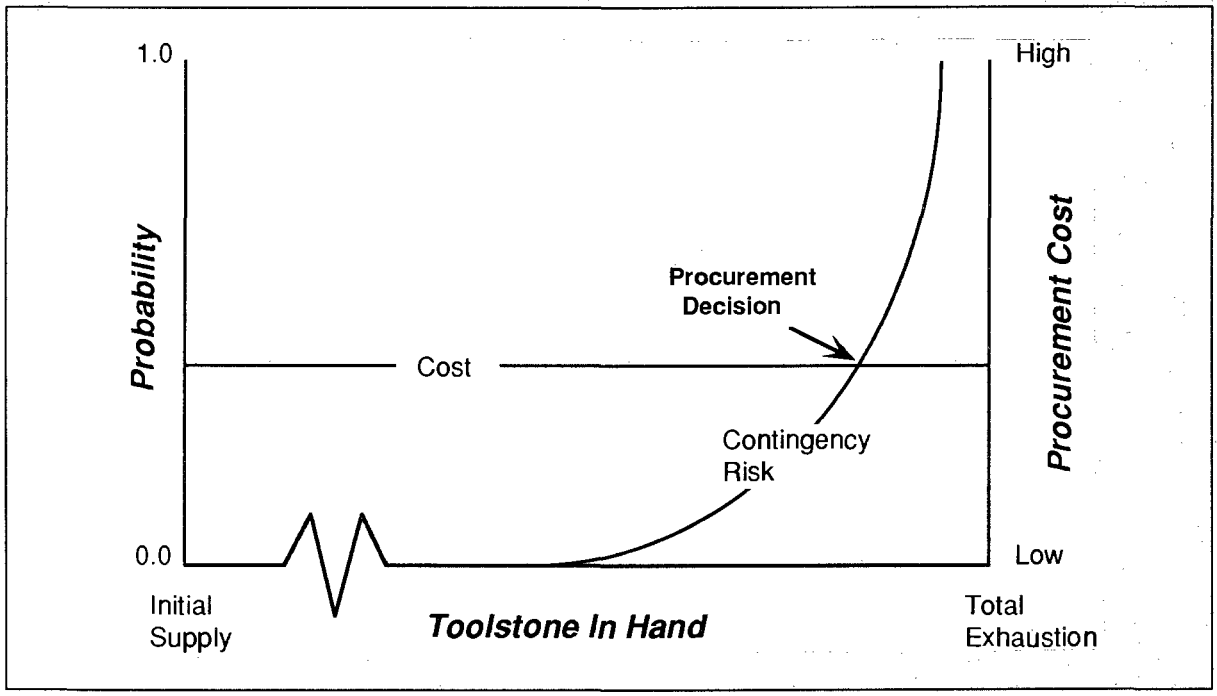


Figure 12. Contingency Risk Model.

consumed, the ability to meet subsistence demands becomes more and more at risk. The decision to procure toolstone is triggered when toolstone supplies fall low enough that potential costs of insufficiency (contingency risk) begin to approach the costs of procurement, but before supplies are totally exhausted. Since contingency risk increases (albeit slowly at first) from the moment of toolstone acquisition, it seems reasonable to assume the desirability of monitoring and managing lithic consumption to avoid insufficiency.

Extrinsic Cost Factors

Some costs of lithic procurement among hunter-gatherers are controlled by extrinsic factors governing the nature of toolstone, while other costs are controlled by choice among components of lithic production strategies (e,g., mobility, organization, technology). Extrinsic factors include the quality, abundance, distribution, and mode of occurrence of lithic raw material in the landscape.

Toolstone Quality

In the Great Basin, most piercing, cutting, and scraping tools were made by flaking or knapping stone. Knapping is most controlled and efficient when applied to a brittle, isotropic medium (Cotterell and Kamminga 1987) such as obsidian (volcanic glass) or cryptocrystalline or microcrystalline silicate stone (flint, chert, jasper, chalcedony, opalite). Fine-grained basalt and andesite also will serve, as will a host of less vitreous rocks, but they offer impaired control in reduction as well as reduced efficiency and durability of the resultant tool. Isotropy, sharpness, durability, and *compliance* (a word substituted for "workability" or the oxymoron "plasticity," *sensu* Goodyear 1979) in reduction are desirable qualities, but difficult to find strongly expressed in the same toolstone. The use of high quality toolstone is a parameter in tool design that seeks to prolong tool use-life (Goodyear 1979; Kelly 1988; Parry and Kelly 1987; Kelly and Todd 1988).

The Lithic Terrane and Absolute Toolstone Availability

Gould (1980:123) refers to the distribution of toolstone in a particular area as a lithic landscape. A more formal term is the geological *terrane*, "the area or surface over which a particular rock or group of rocks is prevalent," or "an area or region considered in relation to its fitness or suitability for some specific purpose" (American Geological Institute 1976:429). In most lithic terranes, high quality raw materials are quite rare compared to low quality stone. Nevertheless, some lithic terranes are richer than others, depending on the mode of toolstone occurrence, abundance, and distribution (Gould 1980:123). One can characterize lithic terranes at different scales ranging from the entire territory used by a group to the foraging radius around a base camp. As we shall see, lithic procurement strategies are sensitive to scale, because scale affects various costs of procurement.

The *absolute availability* of toolstone in a lithic terrane is given by its physical presence and distribution in the landscape. Absolute availability is resource specific and beyond human control. If the lithic terrane contains no obsidian, obsidian is simply not available in that terrane. At the scale of annual range, the absolute availability of toolstone is high in a lithic terrane where there is a good quality lithic source within the foraging radius of most residential camps (for instance, Figure 13a), and such a lithic terrane would be ranked as rich indeed. In

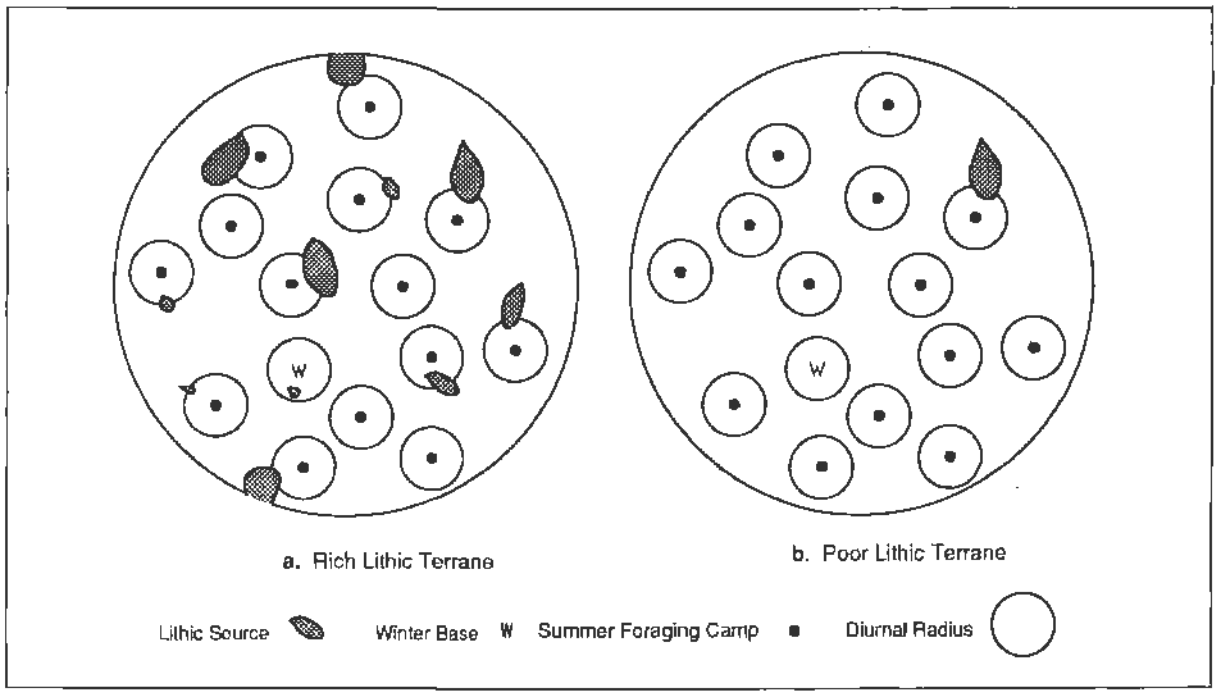


Figure 13. Lithic terranes.

contrast, an annual range of equal size in which there is only one lithic source of middling quality (Figure 13b) constitutes an extremely poor lithic terrane where the absolute availability of toolstone is low. Lithic procurement and maintenance in these two terranes call for different strategies. In the first case, people could move through the annual range with relatively little attention to the scheduling of lithic procurement or tool maintenance; lithic procurement and toolstone utility costs would be about the same everywhere. In the second case, lithic procurement over much of the annual range would have to be planned carefully to ensure sufficient toolstone to support subsistence tasks throughout most of the year. If we varied the quality of the lithic sources in our examples, so that all the sources in Figure 13a were mediocre to poor, and the quality of the single source in Figure 13b very high, we might rank the terranes differently and expect to see other sets of procurement and maintenance strategies.

Variable Cost Factors of Lithic Procurement

The foregoing suggests that choice of toolstone procurement strategies influences the cost in time and effort that must be spent to acquire lithic tools. Strategic variables (mobility pattern, labor organization, and procurement techniques) can be manipulated to vary access, effective availability, search and handling time, and opportunity costs.

Effective Toolstone Availability

While the absolute availability of toolstone is given by nature, its *effective availability* can be manipulated by modifying procurement strategies. Increasing or decreasing residential mobility, altering the shape or size of the annual range to exclude or add sources, or contriving

to be in the vicinity of sources at times when need for toolstone is highest (or opportunity costs least) can affect toolstone availability significantly and result in differences in the intensity of exploitation at various sources (Goodyear 1979; Elston 1990). Another option is to employ more intensive extraction techniques; for instance, Great Basin hunter-gatherers influenced the effective availability of toolstone at sources such as Tosawihi by making subsurface material available through intensive quarrying.

Toolstone Access

Access is the ability of one group to exploit a given resource vis-à-vis competition with other groups (Ericson 1984:3), and thus is dependent on social boundaries. Hunter-gatherers may be restricted to a poor lithic terrane because better ones are occupied by other groups. In such a situation, access to extraneous lithic sources usually requires the expenditure of time and energy for the maintenance of social networks and the accumulation of surplus goods for trade. This *social overhead* can be a significant factor in lithic procurement costs, and may lead to reduced procurement or abandonment of a source by a particular group.

Procurement and Opportunity Costs

As for any other resource, the procurement of toolstone involves search and handling time (Stephens and Krebs 1986:13-14). *Search time* entails time spent traveling to the toolstone source or patch, finding toolstone items in the patch (*prospecting*), and visual inspection and assaying of likely toolstone items (Figure 11). *Handling time* includes time spent in extraction, processing (or manufacturing), transport, and maintenance. *Extraction* of lithic resources occurs after the decision to go for an item of toolstone has been made; it can be as simple as plucking an item from the surface, but may necessitate excavation of soil to recover toolstone clasts or excavation of toolstone in beds and outcrops. *Processing* includes those tasks (decortication, contouring, bifacial reduction, heat-treatment) necessary to render the toolstone usable. Search time can be varied through changes in mobility pattern and prospecting techniques, while extraction and processing time are functions of quarrying and processing technology and tool design. Transport costs vary directly with distance and weight of the load (Jones and Madsen 1989); they can be mitigated by putting the manufactured object into use as soon as possible (ideally, before it leaves the quarry).

Search and handling can be thought of as *direct costs*. The decision to acquire toolstone entails *indirect costs* as well, perhaps the most important of which consists of the loss of other resources not taken, or *opportunity cost* (Stephens and Krebs 1986:11). There is a direct relationship between the direct costs of procurement and opportunity costs, because the amount of time an individual spends in lithic procurement is equal to the amount of time lost to other opportunities. One might expect, therefore, that, whenever the direct costs of lithic procurement rise as a result of intensification, for example, steps will be taken to reduce opportunity costs, probably through manipulation of mobility pattern and labor organization.

Procurement Techniques

Four basic techniques are used to procure toolstone: encounter, surface collection, quarrying, and retrieval. All could have been employed at Tosawihi.

Encounter Procurement

The *encounter* technique involves opportunistic procurement of lithic resources. As people move across the landscape, any suitable raw material encountered may be collected from the surface and incorporated into toolkits. Processing and tool expedience can vary situationally. This technique has the lowest procurement costs; it can be embedded seamlessly in hunting, gathering, and traveling from one place to another (Binford 1979), search and opportunity costs are well amortized, and it incurs the least venture risk. Handling costs are low because the amounts of raw materials are small (Figure 14), and it also serves to monitor the distribution of toolstone in the lithic terrane, reducing future opportunity costs. On the other hand, surface material often is so dispersed that time between encounters is significant. In addition, surface items generally occur within a narrow size range constrained by local geology. Surface toolstone is usually weathered (checked, dehydrated), and most pieces have to be *assayed* (tested for quality); many will be rejected because of stresses and flaws that would increase processing time and decrease use-life. Moreover, of surface items retained for processing, waste to toolstone ratios are likely to be relatively high. By definition, this technique never affords the opportunity to procure large amounts of high quality material, but, in combination with a pattern of high mobility in a rich lithic terrane, might yield a significant proportion of the annual toolstone requirement. Ethnographic accounts (Gould 1977, 1980; Hayden 1979a; MacCalman and Grobbelaar 1965) suggest that surface collection of toolstone often is employed on an encounter basis to obtain for expedient tasks tools which then are discarded on the spot.

Surface Collection

Encounter procurement grades into *surface collection,* but the latter implies a more intensive process, requiring greater time investments, opportunity costs, and venture risks. Surface collection is likely to occur in places where toolstone clasts are sufficiently abundant

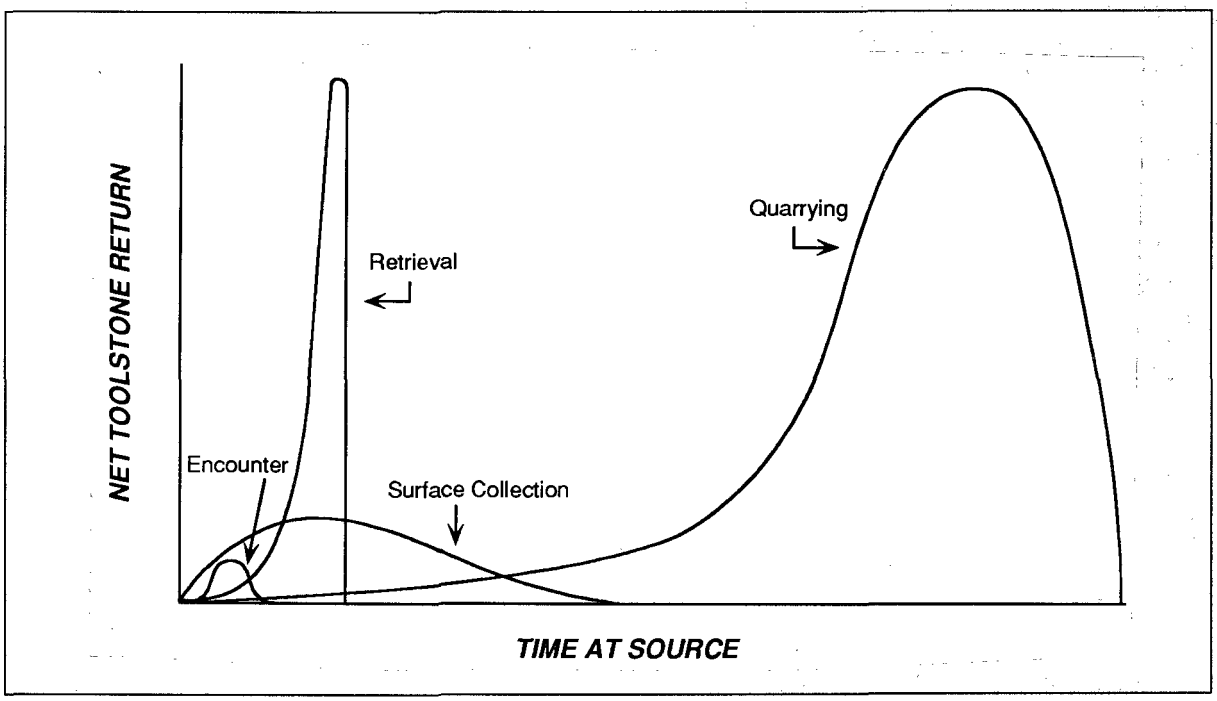


Figure 14. Hypothetical return curves for different lithic procurement techniques.

and concentrated to provide a positive return for the investment in search and handling time, which is much higher than in encounter procurement. It is more difficult, then, or impossible to embed surface collection in other tasks, because more material is assayed and processed. The quality of surface material is likely to be low for the reasons stated above. In most surface patches, the dispersion of items, high ratio of unsuitable material, and constrained size range will keep average post-processing return rates relatively low (Figure 14). Moreover, surface patches eventually may be depleted.

Quarrying

Procurement of toolstone through *quarrying,* or extracting lithic raw material from clasts in soil or from bedrock, extracts by far the greatest search, handling, and opportunity costs, and entails the greatest venture risks; it also can pay off in the acquisition of large amounts of high quality toolstone (Figure 14). Quarrying search time often involves looking for new sources of buried toolstone with a visual search of the ground surface, assaying likely pieces, and removal of overburden from toolstone deposits, usually by excavating a pit (Binford and O'Connell 1984; Jones and White 1988). Prospecting is risky because it can prove fruitless; a strategy of working in or adjacent a pit of known productivity may decrease search time and variance in returns. Handling costs include the isolation and extraction of toolstone masses, along with excavation of waste rock in which toolstone is embedded. If bedrock is to be quarried, it must be broken up into manageable pieces with hammers and wedges, and possibly with fire (Binford and O'Connell 1984).

Quarrying buried toolstone has several advantages, including higher quality and greater size of clasts than usually is available in surface material. Quarries often can produce vast amounts of material before they are exhausted, and are capable of yielding the highest volume of material per foray; sometimes more toolstone is processed than can be transported. Buried toolstone is less subject to weathering and thermal stress; moreover, its moisture content increases its compliance, thereby decreasing waste and contingency risk. Localities can be selected to ensure uniformity of quality, thus maximizing the ratio of toolstone to waste rock. With exploitation of bedrock, the size of cores and flake blanks theoretically is limited only by technology and human physique.

Retrieval

The technique of *retrieval* procurement (Figure 14) depends on overproduction, where more toolstone is processed at the source than is transported (Figure 11). The surplus may be cached at or near the source and retrieved at some later time. Retrieval is likely to be associated with quarrying because of the scale of production. Caching trades the energetic cost of overproduction for reduction of transportation costs and minimization of future labor and opportunity costs, since retrieval of a cache requires only the costs of travel and transport. Uncertainty in returns and associated venture risk are minimized absolutely. Overproduction and consequent caching are likely to occur where excess time or energy are available to produce more artifacts; residential occupations are favorable settings, since longer stays in an area may generate surpluses of time or energy.

Extending Tool Use Life

At first glance, extension of tool use life appears beyond the realm of lithic procurement, but in fact, strategies for getting the most from tools are integral to procurement cost minimization, guide the basic decisions of what toolstone to procure, and prescribe procurement and processing techniques. Techniques for extending tool life include use of high quality

toolstone, large tool size (demanding large blanks), symmetry of design, simultaneous use of bifaces as both tools and cores, and standard techniques for maintenance and rejuvenation (Goodyear 1979; Kelly 1988). Heat-treatment is used to improve sharpness and compliance (although at some expense of durability and increased risk of failure in manufacture). That many of these techniques require costlier forms of lithic procurement suggests that people are willing to bear increased venture risk in return for decreased contingency risk. Tool life extension employed elsewhere in the technological system theoretically can be gauged through such measures as the ratio of flake tools to biface tools, of resharpened edges to total used edges, of bipolar reduced tools to total number of tools, and many others (Zeier and Elston 1986; Elston and Budy 1990, Elston 1990; Kelly 1985).

Toolstone Utility and Returns

Paraphrasing Stephens and Krebs (1986:104-105), *utility* is the benefit a consumer derives from a particular package of goods. Under this broad definition, toolstone in various forms may confer benefits other than utilitarian value, e.g., medicinal and spiritual power, prestige, or ethnic identity, among others. Nevertheless, at this juncture, we choose to focus on utilitarian benefits.

Toolstone Utility

Since people do not derive energy directly from toolstone, and stone tools generate utilitarian benefits only when they are used, one measure of toolstone utility can be expressed as actual benefit in service time per unit weight. Hence, toolstone that produces tools with the longest average service life per unit weight (Saggers 1984; Gould and Saggers 1985) has the greatest utility. But because adequate ethnographic and experimental data regarding bifacial tool use lives are lacking, we must assume further that, for a given lithic material, *use life utility* (ulU) is directly related to mass where objects under consideration have a similar range of function and morphology and were made under roughly the same technological constraints, user skills, and work conditions.

Tool mass gives us an easily measured quantity, but one that admittedly is several times removed from fitness:

$$\text{fitness} \Rightarrow \text{efficiency} \Rightarrow \text{tool use} \Rightarrow \text{tool mass}$$

Nevertheless, for a given lithic material, we assume:

$$\text{ulU}(10{,}000 \text{ gm of Stage 3 bifaces}) > \text{ulU}(1{,}000 \text{ gm Stage 3 bifaces})$$

That different functional types of tools confer different kinds and amounts of benefit in use is a potential complication of any scheme to evaluate lithic utility. We avoid this problem by assuming that the *functional utility* (fU) of a tool is 1.0 when it is able to perform adequately the task set for which it was designed, and less than 1.0 during manufacture or after failure. Variability in tool utility is expressed in use life, which, we have assumed previously, is directly related to tool mass. For example, a simple flake tool can have an fU at or near 1.0 the moment it is struck from a core, while the fU of a biface increases as it is processed from blank to early stage biface, to later stage biface, to heat-treated biface. The difference between the two is that the use life utility of the flake tool is soon expended, while

the biface is used in a long series of tasks with routine edge maintenance and repair of minor failures. As its morphology changes through maintenance and repair, it may be applied to a variety of tasks, or may change function altogether, but its functional utility remains at 1.0 through most of its use life.

Proportional utility, frequently appearing in optimal foraging models, was employed recently by Metcalfe (1989; Metcalfe and Barlow 1991) to model transportation costs and by Elston (1990) to compare utility of bifaces and flake tools. Proportional utility avoids the problem of comparing utility among different types of resources or different tool types by scaling the utility of each resource unit from zero to one. Applied to lithics, this model assumes that the utility of unprocessed toolstone is related to the proportion of waste to usable tool; waste has a utility approaching zero (ignoring the potential utility of flakes), while usable tools have a utility at or near one. Proportional utility is used to estimate the optimal amount of processing before transportation of toolstone from the quarries.

The quality of a particular toolstone is important, but does not determine toolstone utility totally. Both functional and use-life utility can be extended through technology and design, and decreased by procurement costs (service time minus time consumed by travel, search, extraction, and processing). Consequently, the net utility of the highest quality toolstone can fall below the net utility of mediocre material simply as a function of distance to source or difficulty of extraction (Figure 15).

Returns

The average return *rate* is the amount of toolstone obtained per unit of search and handling time, and depends in large part on the waste (mass of items rejected, minus mass of discarded processing debris) to toolstone ratio. *Gross returns* are simply the mass of material

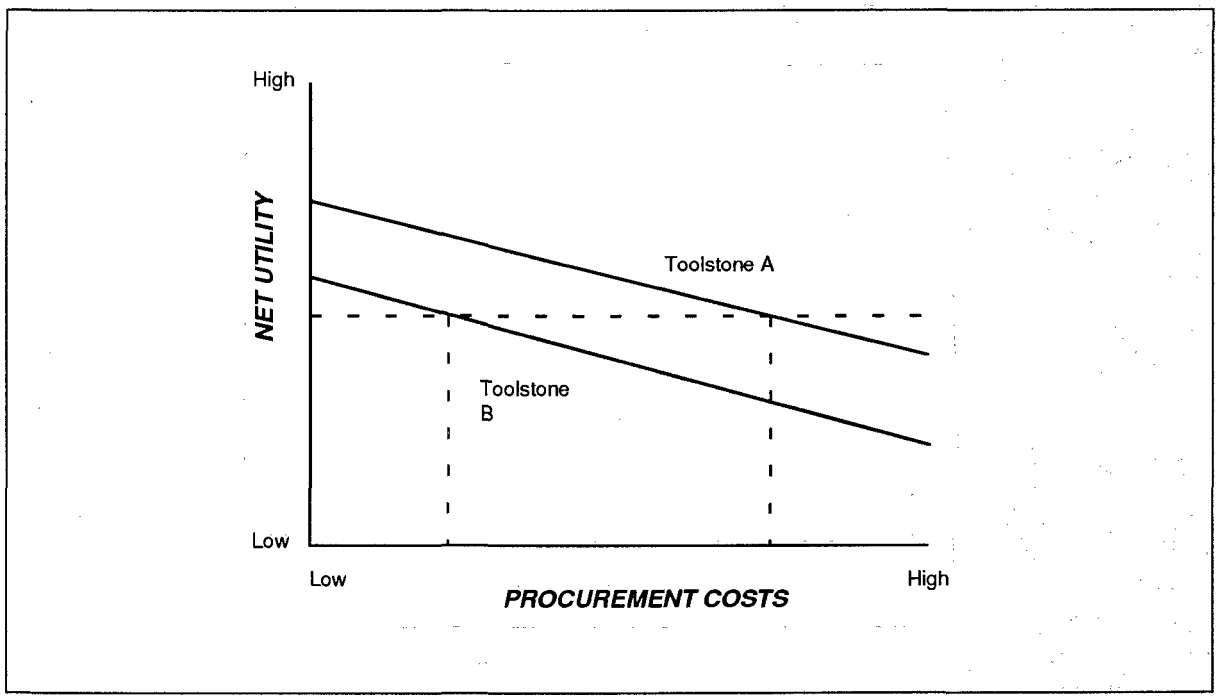


Figure 15. Net utility as a function of procurement costs.

(in grams) extracted (geR) or processed (gpR), while *net returns* (neR; npR) are gross returns divided by mass of material culled or failed. Gross or net return rates (geRr; neRr; gpRr; npRr) are gross or net returns divided by *extraction cost* (Ce) or *processing cost* (Cp), or both (in minutes or kilocalories):

$$npRr = npR/(Ce + Cp)$$

For example, the npRr of a 1000 gm biface that took 60 minutes to extract and process is 16.67 gm per minute, while the npRr of a 1000 gm biface that took 120 minutes to procure is 8.33 gm per minute. If the fU of both bifaces is 1.0 and their ulU's are similar, the prudent forager should prefer the quarrying situation where npRr is greatest.

Material handled but left at the quarry, even if partially reduced into bifaces and intended for later recovery, is not counted in returns for that quarrying foray. Toolstone caches may have utility in the reduction of opportunity costs and handling time on future trips to the quarry, but they may never be recovered. Thus, the net return of any particular foray (nfR) is limited by human load-carrying capacity (HLC):

$$nfR = (npR <= HLC)$$

Figure 14 compares hypothetical net return rates for encounter procurement, exploitation of surface patches, quarrying, and retrieval. Encounter procurement takes very little time, but generates little return. While surface collecting in a good patch, net returns rise quickly to a value set by the average encounter rate for the patch and are either maintained there for the time the patch is occupied or gradually begin to fall off as potential toolstone in the patch is sampled. In contrast, initial search at the quarry produces very little until a "strike" is made. Post-processing returns then rise steeply to values far beyond those that can be obtained in surface exploitation, and, just as rapidly, fall off when the material exposed in the pit is "worked out." These high returns balance the greater handling costs involved in quarrying. The return rate for retrieval is highest of all; it takes very little time, but has a very large net return.

Manipulating Costs through Mobility, Organization, and Scheduling

The preceding discussions identified costs of lithic procurement. Still assuming a basic goal of cost and risk minimization, we now turn to the ways costs can be manipulated.

Mobility Patterns

Mobility refers to the strategies employed by people to position themselves vis-à-vis resources, particularly to food, water, and shelter (Binford 1980, 1982; Kelly 1983; Thomas 1983a, 1988). Mobility patterns are designed to deal with variable temporal and spatial availability of subsistence resources. Binford (1980) has characterized hunter-gatherer mobility as a continuum with foraging and collecting at the antipodes. Since ethnographic Great Basin hunter-gatherers commonly practiced a seasonally mixed-mode residential strategy (Thomas 1983a), we are less interested in contrasting foragers and collectors than we are in exploring the consequences of different mobility patterns of lithic procurement at Tosawihi. The value of mobility pattern and economic zone models is that they provide means of relating variability in the exploitation of the quarry to regional settlement and subsistence patterns known ethnographically and inferred archaeologically.

Imagine that resources occur in a series of economic zones (foraging radius, logistical radius, annual range, and extended range, described below), delineated by constraints on human mobility and load-carrying ability. Mobility patterns include foraging in the vicinity of the residential base, residential moves to new resource areas, logistical moves from residential bases, or combinations of these. Mobility affects toolstone supply and demand because it is linked to boundaries imposed by social constraints and the distribution of biotic resources not necessarily congruent with lithic sources. Toolstone can be abundant in places devoid of game or food plants, but scarce in places where lithic tools are needed to capture or process biotic resources. The annual range of one's neighbors may constitute a rich lithic terrane, while one's own is a lithic desert. Accordingly, mobility patterns influence access, effective availability, and utility of toolstone.

Organization of Labor and Activities

Varying the organization of labor and activities should affect procurement costs profoundly. Optimal task group size is likely to be related to mobility pattern and mode of procurement. We should not expect large groups to be involved in logistically organized retrieval procurement, nor intensive quarrying to be carried out by an individual. Division of labor by sex, age, or skill might increase procurement efficiency, particularly on longer forays where quarrying has to be supported by local foraging to reduce opportunity costs. In this case, we might also observe the greatest spatial segmentation of tasks and variation in site function.

In a given year, Great Basin hunter-gatherers tended to operate over a relatively large area with frequent residential moves during the spring, summer, and fall. This *annual range*, a subset of a larger *extended range,* can shift from year to year. From each residential base camp, food and other resources are exploited in a relatively small area within the *foraging radius*, or *diurnal range* (the distance one can walk, do business, and return in a day [Thomas 1983a]). When return rates fall off (a matter of days to a few weeks) and foraging in the vicinity of the residential base no longer is profitable, the camp is moved to a new area with access to a new set of resources. The foraging strategy is best adapted to environments in which target resources are distributed evenly across the landscape, or are available sequentially over an extended period. In the Great Basin, foraging typically was practiced during the period of greatest productivity in spring and summer.

High mobility through a large annual range often makes a greater number of toolstone sources available. Choices can be made among the highest quality sources, but groups may not be able to predict accurately when they will be in the vicinity of any particular source, and are limited in the amount of toolstone they can transport between sources. Since considerable time may elapse between visits to the best sources, contingency risk is an important consideration. Highly mobile groups tend to "gear up" (Binford 1979) with new tools when a high quality lithic source is encountered, leaving their old tools behind. Consequently, the lithic tools of mobile foraging groups are likely to be highly symmetrical in form (for efficiency and ease of maintenance) and large in size (mobile storage of toolstone); Paleoindian tools are a case in point (Goodyear 1979; Kelly and Todd 1988). That biface technology, particularly well adapted for use by highly mobile hunter-gathers (Kelly 1988), has been the focus of lithic production in the Great Basin throughout prehistory perhaps is indicative of the overall importance of mobility in the region.

Low residential mobility with logistical movement is a pattern adapted to more heterogeneous environments in which resources are distributed unevenly or are seasonally unavailable. This pattern was typical of Great Basin groups in the fall and winter. Long term residential base camps are established; resources in the foraging radius are exploited from them, but a much larger area (the logistical radius) also is exploited by means of special task groups formed to procure a specific resource or restricted range of resources (i.e., pine nuts or

mountain sheep). Such groups travel a long distance from base camp, establish one or more temporary field camps, procure and process the target resource(s), then return to base camp with the goods. Logistical field camps are occupied for a relatively short period of time, perhaps a few days (but cf. Binford 1982:7; Downs 1966:30). Because human load carrying capacity is strictly limited (Jones and Madsen 1989), resources usually are processed at or near their source to reduce bulk and weight. Storage is an integral part of the collector strategy, designed to deal with seasonal shortages and transport limits. Goods can be cached at the field camp for later retrieval, at the main base camp, or at points between the two. Logistically based hunter-gatherers, or those practicing a seasonally mixed mode strategy, may operate within a smaller annual range than more mobile foragers. When this limits access to toolstone sources, use of high quality sources within the annual range probably will increase.

Scheduling

Scheduling lithic procurement is important in order to minimize opportunity costs of food resources. Scheduling conflicts and time limitations with regard to key food resources can increase toolstone demands sharply for limited periods (Torrence 1983). For instance, time is available to pursue intensive methods of quarrying and ensure the acquisition of the highest quality toolstone only in the absence of acute toolstone demand and when opportunity costs are low. Duncan Metcalfe (personal communication) has suggested that intensive methods of lithic procurement are most likely at times when variance in food patch return rates are lowest (Figure 16), so that the added potential lithic utility of toolstone balances some food resource opportunity costs and makes it more attractive to be at the quarry than at other places. In the model of lithic procurement diagramed in Figure 17, procurement costs vary through time with changes in seasonal mobility and climatic conditions. Episodes of lithic procurement are timed to coincide with the lowest points in procurement cost, but might respond also to toolstone demand, time constraints, or other factors. Note that the curves suggest different rates of toolstone consumption and contingency risk in various seasons.

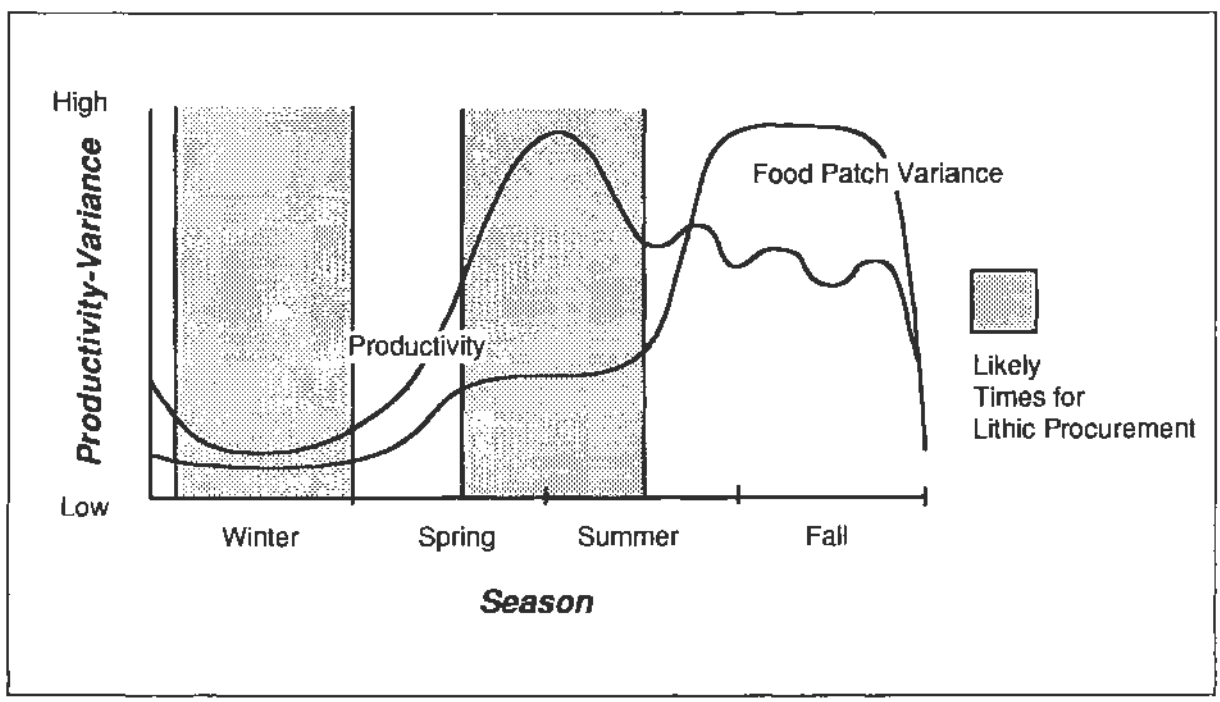


Figure 16. Seasonal variation in food patch returns and overall productivity.

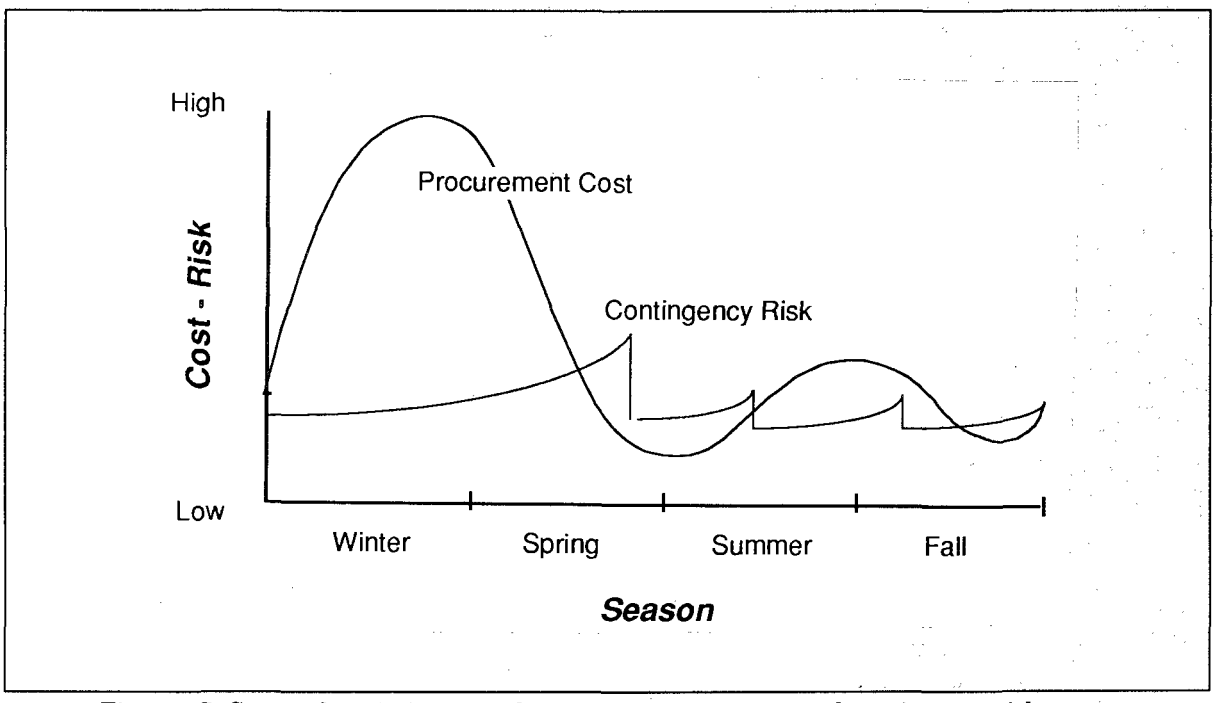


Figure 17. Seasonal variation in toolstone procurement cost and contingency risk.

Toolstone Demand and Output

It is reasonable to expect lithic procurement strategies to respond to different costs and levels of demand for toolstone by changes in *output*, or amounts of toolstone produced in a given period. There is, however, no simple relationship between cost, demand, and output. The following section is more of a cautionary tale than a model, but serves an heuristic purpose.

Demand can refer to a *particular* commodity (Campbell's Vegetarian Vegetable Soup; Tosawihi chert) or for a *generic class* of commodities (canned soup; obsidian, regardless of source). *Individual demand* is the total amount of some resource that a consumer wants per unit of time. In classic economics, individual demand for a commodity is summed to produce *market demand* (A. Smith 1982:1-2), and this too can be particular or generic. In the absence of markets, individual demand can be summed at various scales, for instance *household demand* or *regional demand.* Luedtke (1984:65) defines demand as "the amount of lithic material necessary per fixed unit of population over a fixed period of time."

In free market economies, demand theoretically is linked to supply through price. Prices rise and fall inversely with supply, and demand usually is related inversely to price. In the market economy, supply and price (cost) are set by producers and sellers; the buyer-consumer responds to cost by demanding more or less of the commodity. Demand feeds back into the system and stimulates more or less production, resulting in higher or lower prices. In a non-market, hunting and gathering economy, the consumer usually is the producer whose perceived survival needs originate demand. If a producer-consumer experiences a rise in toolstone cost due, for instance, to reduced access to a source, he or she, or an entire group, can elect to acquire toolstone from some other source. This decision lowers individual and group demand for material from the first source, but has no effect on its cost, which remains high as long as access is restricted. In this case, demand responds to cost, but cost does not respond to demand; rather, a lower cost resource is substituted for the higher cost resource through a change in lithic procurement strategy. This, however, does not necessarily have any effect on *overall* toolstone demand at the scale of the individual or group.

Among hunters and gatherers in temperate environments, individual or household toolstone demand probably rises and falls within a relatively small range in a yearly cycle tied to the frequency of activities that consume toolstone (Figure 17). For groups with limited winter residential mobility, it is likely that the most acute demand for toolstone will be felt toward the end of winter encampment when supplies are low and contingency risk high in the face of the coming foraging season. Other acute peaks may occur from time to time, but these are more likely to be situational and not usually visible in the archaeological record. Major, long term fluctuations in toolstone demand on the regional scale may be responses to changes in food procurement that increase toolstone consumption, or, more likely, population growth with attendant declines in mobility and range, along with competition for lithic resources; trade is a possible outcome. Such large scale, long term changes in mobility and range can show up in the archaeological record as variation in output at particular sources.

The more mobile the group, the more lithic sources potentially available to it; less production need occur at any one source to satisfy demand. Less mobile groups, or groups with otherwise decreased access to toolstone sources, who are unwilling to relax toolstone quality and tool design standards, may need to focus on the relatively few high quality sources available within their range. Neither group nor regional demand may have increased, but now all demand must be satisfied at a few sources. This may involve more intensive (and costly) methods of lithic procurement, using the time and energy formerly spent in travel through a larger territory, spread out over exploitation of several lithic sources. If adopted over long enough periods, intensification may be extremely visible, as it is at the Tosawihi Quarries.

Another alternative is to relax tool design parameters and step down to use of lower quality material that is cheaper to procure within the limited range (Figure 15). Overall demand for and consumption of toolstone may increase in this situation because it now takes 50 kg of poorer quality toolstone to fill the same needs once satisfied by 30 kg of higher quality material. This scenario may play out in the archaeological record, however, as a decrease in output at formerly favored high quality sources and lack of visibility elsewhere because the abundance of poorer material is so high that no single source need be exploited very much.

Thus, increased output at a particular lithic source can be a response to many factors, which may or may not include increased demand at a particular scale. We suspect that archaeologically visible variability in the intensity of exploitation of a source *most likely* signals a decrease in effective availability and access vis-à-vis other sources in the annual range; confirmation of this requires a regional study of toolstone procurement.

Implications of the Model

The preceding discussions present a model that identifies costs of lithic procurement and suggests how they can be manipulated, assuming a basic strategy of cost minimization and risk avoidance. As we will develop further in the following chapter, there are two basic strategies for minimizing costs of toolstone: cheap procurement and prudent use. The use of either or both, and the particular ways in which they are likely to be realized, are conditioned by situational demands.

The model suggests that the economics of toolstone procurement can be an important aspect of hunter-gatherer adaptation. Further, it suggests that situations in which toolstone procurement costs "essentially nothing" because it is embedded in the acquisition of food resources, occupies slack time, or is pursued when primary food target resources fail to materialize (Binford 1979:260), may not be common. While embedding toolstone procurement in subsistence activities can amortize many procurement costs (thus reducing venture risk), opportunity costs are not necessarily canceled. Because toolstone consumption confers no direct energetic benefit to the consumer, opportunity costs vis-à-vis food resources are attendant on

each decision to acquire toolstone. Binford (Binford and Stone 1985:152) cautions that his 1979 description of Nunamiut toolstone acquisition is not intended as a general model of lithic procurement. Nevertheless, it is worth observing that encounter and surface collection procurement of the kind Binford describes for the Nunamiut Eskimo, *if the only procurement strategy used*, would exacerbate contingency risk in any but very rich lithic terranes or technological systems wherein maximizing toolstone utility is not an important concern.

We expect that the Tosawihi Shoshone (and other prehistoric Great Basin hunter-gatherers with mixed mode mobility patterns) employed different strategies of lithic procurement depending on position, season of the year, and scheduling demands in the procurement of other resources. Furthermore, the mix of lithic procurement strategies is likely to have varied through prehistory, along with changes in overall mobility and settlement/subsistence systems. Our model suggests several possible lithic procurement strategies that could have been employed at Tosawihi. We examine the likely archaeological consequences of these in Chapter 4.

Chapter 4

RESEARCH DESIGN

Robert G. Elston, Eric Ingbar, Melinda Leach, Christopher Raven, Kristopher Carambelas, and Kathryn Ataman

> *Models are undeniably beautiful, and a man may justly be proud to be seen in their company. But they may have their hidden vices. The question is, after all, not only whether they are good to look at, but whether we can live happily with them.*
>
> —Abraham Kaplan
> The Conduct of Inquiry (1964)

Chapter 3 provides a theoretical structure for the study of the Tosawihi Quarries based on economics; relationships between costs and benefits of quarrying are framed in terms of abstract values such as time, energy, quality, and utility. Although we outline the archaeological consequences of different modes of lithic procurement, the scenarios are without dimension until adaptive variability in time and space, signaled by cultural, technological, and ecological change, are taken into account. Toward this end, we have collected a very large amount of data regarding chronology, paleoenvironment, technology of procurement and processing, and subsistence, as well as site formation, structure, function, and distribution.

In this chapter, we discuss the linkage between data and theory, and present the rationale for methods of data collection (the methods themselves are so diverse and numerous that they are more sensibly presented to the reader in later chapters when needed to explicate the particular phenomena or analyses described). Most of the present chapter is devoted to economic models and their archaeological consequences in site formation, site structure, site function, assemblage composition and diversity, and subsistence. At the end of the chapter we discuss briefly the economic geography of toolstone procurement and use, diachronic change and how it can be detected and interpreted in the archaeological record at Tosawihi, and paleoenvironments.

Economic Models and Prehistoric Use of the Tosawihi Quarries

In hunter-gatherer systems, lithic terrane and organizational patterns interact to affect toolstone cost. Factors affecting toolstone search and handling costs intrinsic to a given lithic terrane are toolstone abundance and distribution (including the relative accessibility of high quality toolstone and its ratio to lower quality material) and mode of toolstone occurrence. The time available for lithic procurement, and the opportunity costs it entails, are controlled by mobility patterns, subsistence strategies, and labor organization. Since there is much to suggest that hunter-gatherers attempt to minimize costs of food procurement (which results in direct energetic benefit) in order to maximize returns (Belovsky 1987), we assume that hunter-gatherers also should seek to minimize costs of stone tool manufacture and maintenance in most circumstances. Two strategies are available to realize these goals, minimizing procurement costs ("cheap procurement") and maximizing toolstone usefulness. The former strategy minimizes opportunity costs. The latter strategy lowers toolstone demand within an economy. Each strategy is discussed below and its archaeological implications considered.

Tosawihi as a Lithic Terrane

In order to put these propositions "on the ground" we must understand the lithic terrane of the Tosawihi Quarries, particularly with reference to opportunities and cost minimization strategies for lithic procurement. The nature of Tosawihi toolstone is the aspect of the resource least controlled by prehistoric miners and knappers; geological forces created the opalite and determined its accessibility. If, as we suspect, toolstone quality was a major factor guiding prehistoric choices among toolstone sources, it is important to understand the range of variation in toolstone quality *at* Tosawihi. The calculation of fall-off rates and the decrease in utility with time and distance require chemical and mineralogical identification of Tosawihi chert at sites far from the quarries. Thus, understanding the geology of Tosawihi opalite, its range of quality throughout the Quarries, and its chemical nature are essential to understanding the economics and strategy of prehistoric extraction-production. The lithic terrance of Tosawihi Quarries is explored in the following Chapter.

Models of Cheap Procurement: Minimizing Opportunity Costs

Because hunter-gatherers are rational decision-makers, they should attempt to minimize the loss of other potential benefits incurred by labor demands. As outlined in Chapter 3, collecting and processing raw materials necessarily entail a series of such opportunity costs, or lost chances to acquire, process, or consume resources. The efficient hunter-gatherer, however, can minimize opportunity costs by manipulating labor and mobility scheduling.

A Perspective on Organization and Mobility Patterns

The opportunity costs of toolstone procurement can be reduced in several ways. One is to position activities so that travel time and transport costs are minimized (Kelly 1990; Jones and Madsen 1989). A related option segments the organization of labor so that some, but not all, individuals risk opportunity costs. These strategies—activity positioning and labor organization—are not mutually exclusive; any set of activities may combine them.

Efficient workers organize their work spatially so that time spent in travel and transport are abbreviated, volumes of material needing to be handled separately are minimized, and energetic outlays are diminished. Two spatial strategies afford these desirable results; the location of tasks can be fitted to the geography of resources, or geography can be adjusted by transporting resources to more favorable locations. In the ensuing discussion, we refer to the former as reliance on *propinquity*, to the latter, as *convenience*.

Propinquity guides the location of activities in response to the natural distribution of things on the landscape; travel and transport costs can be minimized by staging activities near the resources on which they depend, and single-resource tasks (especially extractive ones) can be performed most efficiently where the relevant raw materials are immediately at hand. The archaeological expression of propinquity consists of site distributions highly correlated with the distributions of resources attracting their dominant activity, so we should expect quarrying sites to reflect the distribution of toolstone, hunting sites to reflect wildlife distributions, and milling sites to reflect the geography of food plants. Such patterns are *monistic*, that is, they are conditioned by consideration of a single resource (Figure 18a). Where multiple activities entail multiple, non-coincident resources (e.g., at residential sites), however, site location is likely to modify propinquity in favor of placement central to several target resources (Figure 18b); this *pluralistic* or "central place" solution to distance minimization has been a recurrent discovery

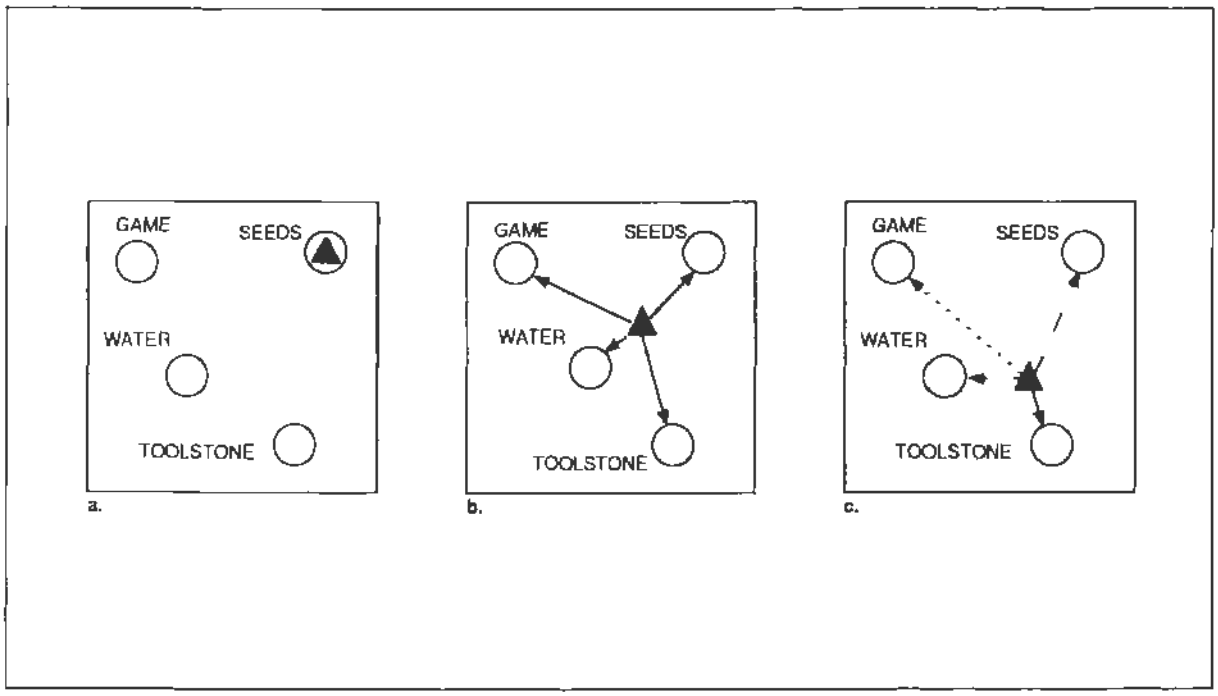


Figure 18. Site location strategies. a. Monistic location, emphasizing propinquity only to seeds; b. Pluralistic location, emphasizing equal propinquity to all resources; c. Pluralistic location, emphasizing ranked propinquity in the order toolstone-water-seeds-game.

of classical geography (Christaller 1933; Isard 1956; Losch 1954), and variants of the model have been applied analytically to help understand the spatial behavior of foraging populations (Orians and Pearson 1979; Stephens and Krebs 1986:53-60; Wilmsen 1973).

In practice, of course, some resources are more important than others, and their attraction is stronger; a dominant resource can exert displacement from central location (Figure 18c) because it must be exploited more frequently than others, because timing of its exploitation is critical, or because the costs of transporting it are disadvantageous. Water, for instance, often "tethers" the residence of otherwise mobile populations to the vicinities in which it occurs (Taylor 1964), and quarrying can be done only where suitable rocks are available. The habitations of quarriers, then, if they are to maximize efficient use of space, should be stationed at or immediately adjacent those water sources closest to sources of toolstone; the distribution of other pivotal resources (chiefly, subsistence materials) should fine-tune the optimal placement of residences.

Convenience, on the other hand, is an arranged circumstance; things are brought to a central location (*convened*) in the interest of making them easier to use, extending the time that can be spent in processing them, or bringing them within the ambit of other resources or toolkits with which they need to interact. Every act of transport constitutes an adjustment of resource distributions, yielding a temporary, expedient geography of useful things; most such acts, we assume, are undertaken to serve efficiency in the organization of work. Distance minimization remains the principal strategy by which time and effort spent in work are reduced and the handling of materials is diminished, but the strategy is consummated by moving *things* to *sites* rather than the reverse. Thus, basalt and quartzite hammerstones (as well, probably, as other specialized tools) are transported for use at quarrying locales, food and water are carried to work sites, task-specific tool kits are scattered across the landscape at places where their function is realized, foraging products such as meat, seeds, and roots are relocated to habitations for processing and consumption, and the products of quarrying and early stages of

lithic reduction sometimes are convened from raw material sources to locations more favorable for further reduction, heat-treatment, or tool manufacture.

Archaeological Expectations of Propinquity and Convenience

At Tosawihi, quarriers confronted an heterogeneous landscape in which target resources (especially, toolstone), as well as critical sustaining ones (water, animals, and plants), were distributed unevenly and *non-coincidentally*. We propose that locational decision-making was based on costs and benefits of access to each target resource. Foragers estimated the most advantageous mix of propinquity and convenience that minimized the time, energy, and distance required to obtain the target resource set. If true, the archaeological record should exhibit patterning in the distribution of functionally distinct activities, and that patterning should reflect a spatial logic minimizing the acquisition costs of four principal currencies (toolstone, water, animals, and plants). Leaving for later discussion the impact of seasonal fluctuation in some resources, we consider below how propinquity and convenience are likely to have affected the degree to which these currencies contributed to the location and composition of the principal site classes expected to occur at Tosawihi. We assume, for purposes of developing some specific expectations, that acquisition of toolstone was the principal motive for visiting the quarries and the principal factor contributing to the local archaeological record.

Residences

Residential sites should be positioned at locations maximizing access to all target resources; if all resources are of equal importance and demand the same procurement costs, the most economical solution should be to reside at that point from which the average distance to all of them is least (i.e., the central place solution; Figure 18a). But because of frequency of need, differential transport costs, or non-transportability, some resources exert *hierarchical* demands of propinquity in the placement of residences. We expect water to be chief among these, since it must be consumed frequently, is costly to transport, and its sources cannot be convened; all residential sites in the Tosawihi vicinity, then, should be found in immediate proximity to water, and, because its sources are scattered and infrequent, the distribution of water should be a relatively reliable predictor of residential locations.

Quarriers, however, should select from available water sources those that also maximize access to toolstone, and so should reside where water occurs nearest to stone sources. Archaeologically, the intensity of quarry-related activity, reflected by quarrying tools, facilities, and products (especially the earlier stages of lithic production), should be directly proportional to distance from toolstone, and should decline away from toolstone to a point from which it no longer is profitable to stage diurnal quarrying forays. Beyond 10 km from toolstone (an empirical daily travel radius; cf. Lee and DeVore 1968), we do not expect to find *any* evidence of diurnal quarrying (although later stages in the reduction of quarried products are likely).

The operation of propinquity with respect to subsistence resource distributions is likely to be more subtle in locating quarriers' residences than other classes of residential site, but its archaeological consequences remain potentially detectable. Once quarriers have segregated water sources appropriately close to desireable toolstone, they still are likely to face a choice among alternate residential locations. If we assume that the choice is made from site locations at which water reliability, toolstone quality and accessibility from surface, and distance between toolstone and water are equivalent, prudent foraging quarriers should locate residences at those places minimizing distance to the most favorable foraging patch or mix of patches. Such placement in large part should be a function of group composition and the organization of labor;

groups composed exclusively of males probably should do best by selecting campsites close to large game to enable off-hours hunting, while mixed parties should seek proximity to the highest-ranked resource patches (small game, roots, and, least desirably, seeds; cf. Chapter 20) exploitable by a non-quarrying labor force of women and children. In practice, of course, subsistence needs are likely to have been managed through a mixture of labor specialization and task scheduling, but in either case, the archaeological consequences of positioning quarriers' residences to accommodate foraging concerns should consist not only of relative propinquity to favorable resource patches, but also the convening at the residential base of subsistence gear, food processing facilities, and subsistence residues. Millingstones within residential precincts, for instance, probably reflect site placement successfully near food plant patches, while their absence may reflect either field processing of more distant plant resources or site selection biased in favor of hunting. Likewise, the proportion of high-utility to low-utility faunal residues in quarrying camps should reflect distance from big game habitats directly.

Quarries

Since primary toolstone extraction can occur *only* where suitable raw material is available, the role of propinquity in positioning quarrying activities would *seem* to be trivial; it is not. While toolstone quality is likely to be the prime selector of which stone source or group of sources will be exploited, other factors figure as well. If we assume toolstone quality and accessibility from surface to be equal at a number of sources, then quarriers should exploit that source closest to the residential base, *since the economic geography of toolstone sources already has been altered by the decision to camp at a certain place*. By invoking propinquity in the selection of quarrying sites, costs of travel and transport can be reduced to the benefit of quarriers.

The relationship between residential site location and toolstone procurement location, then, is reciprocal, but the logic of locational decision-making is not circular; at Tosawihi, usable toolstone is distributed far more widely than water, and more choices were available in selecting where to get stone than where to camp. Tradeoffs between toolstone quality and distance from camp should define a threshold beyond which it becomes less likely that quarriers will venture, and we expect that the Tosawihi vicinity harbors some sources of very high quality toolstone that went unexploited, or were exploited less intensively, simply because their location relative to water and potential campsites was unfavorable (i.e., more costly). Likewise, material quality should define a lower threshold beneath which stone should not be exploited however close to camp it might lie. Archaeologically, then, we should expect those sources of usable material lying closest to residential sites to have been quarried most intensively, with distance-dependent falloffs in intensity of use mitigated chiefly by variation in toolstone quality.

Upon the quarry are convened all the paraphernalia of extracting stone from a bedrock matrix: the toolkits of digging, wresting blocks from parent material, and breaking them into transportable packages. The Tosawihi landscape offers little raw material for these other than hammerstones, however, so we should expect the importation of exotics (wood, antler, robust bone) to serve as digging sticks, wedges, and pries; their archaeological detectability, of course, would be contingent upon preservation. Hammerstones offer a better opportunity to observe the operation of convenience; sources of basalt and quartzite occur erratically in the Tosawihi countryside, but rarely coincident with toolstone sources. While the transport of hammerstones inevitably entailed certain costs, their utility in quarrying is unlikely to have been ignored and the effort to get them and bring them to a quarry likely to have been repaid (within constraints imposed by distance). Their search and pursuit costs, however, would have contributed to the overall expense of toolstone procurement. And because their use inflates the cost of toolstone, hammerstones offer a potential opportunity to observe the interplay of convenience and propinquity; given two toolstone sources of equal quality equidistant from a residential base, the source closer to a supply of hammerstones should be the one more economically exploited.

Reduction Stations

The products of quarrying are convened for use away from their place of origin, but not in the form in which they emerge from the ground. Transport costs and the risk of failure can be diminished by initiating lithic reduction before transport, and we expect this to have been the case at Tosawihi. In fact, surface survey of the entire vicinity and preliminary testing in the Eastern and Western Peripheries found "reduction stations" to be the most numerous class of activity feature, outnumbering quarry features by a factor of 1.4:1 and residential sites by 6.6:1. Two issues of propinquity are likely to have affected their locations.

In the first place, elimination of substantial waste mass *before* significant transport has occurred reduces the cost of getting usable toolstone packages to their destination, so early stages of reduction (irrespective of technological trajectory) should be undertaken at or near the stone source. This means that the distribution of most archaeologically distinguishable early stage reduction stations should be *clustered* (rather than random or uniform; cf. Clark and Evans 1954), and that they should cluster in the vicinity of their parent quarry. Such clustering should allow prediction, in fact, of the general location of utilized but otherwise undiscerned stone sources (e.g., buried quarry pits, collapsed adits). Of course, some early stage reduction stations are likely to be coincident with primary quarry debris at the source, and thus are likely to be difficult to segregate archaeologically. Likewise, individual reduction episodes may be interwoven inextricably; even successful material sourcing should fail to tease them apart, since they are likely to derive from the same source. Palimpsests and high density of packing within a cluster of reduction stations, however, may serve as proxy indices of intensity or duration of use of the parent quarry.

In the second place, later stages of reduction entail the removal of less waste mass, so limited transport can precede their accomplishment without incurring excessive transport costs. Too, if later stages in the reigning reduction trajectory are enabled by heat-treatment (a time-intensive process), it actually may be advantageous to transport partially reduced material to a camp setting, where its processing can be tended in off-hours or by a non-quarrying labor force. In this case, late stage and post heat-treatment reduction stations should cluster around or be nested within the residential precinct.

The role of quarries and residential sites in centralizing the location of reduction stations does not imply that *all* reduction stations will be members of such clusters, but we expect that most will. Moreover, we do not expect most non-clustered reduction stations to occur in free spatial variation over the landscape. Rather, they are most likely to occur in transport corridors between quarries and residential sites, the consequence of stopovers at favorable foraging patches, minor water sources, or topographically inviting flats and benches where a little productive work could be done. That such locations still are partially governed by propinquity, and still technically share membership in clusters, may be difficult to distinguish archaeologically unless both origin and destination of their transport can be determined.

Minimizing Opportunity Costs of Toolstone Procurement through Mobility and Organization

Propinquity and convenience are relative terms; they describe the relationship of activities to the distribution of resource targets. Because labor organization mediates between task and task location, the larger pattern created by positioning and labor organization strategies is a *mobility pattern*. At one end of the continuum of mobility patterns is a *logistical pattern*, in which resources are moved to consumers. At the other end is a *residential pattern*, in which consumers move themselves to resources. Points lying between these two extremes are equally important, and represent different mixtures of these two "pure" patterns of mobility.

Labor organization effects these different tactics of locating activities within a landscape. Segmentation of tasks serves to minimize the costs associated with any given activity. For example, the use of a central place to gather non-coincident resources may be most efficient when each resource is exploited and transported by a different task group. As long as resource acquisitions are shared, each task group incurs an opportunity cost but the group as a whole does not. Another option is to vary how labor is deployed temporally; the scheduling of tasks and task groups also serves to minimize the net loss of other resource opportunities.

Various mobility and labor scheduling options are available to toolstone collectors, ranging from unplanned collection of raw material found in the course of travel and foraging (an encounter strategy), purposeful gathering of toolstone within the vicinity of the residential base (diurnal or residential strategies), dispatching special task groups to the toolstone source (a logistical strategy), and combinations of all strategies. Which strategy comes into play at any one time is influenced, of course, by a number of factors—seasonality of quarry use, scheduling decisions demanded by the procurement of other resources, regional population density, trade demands, and more. Thus, no one mobility pattern is inherently "better" than any other at cost minimization; rather, each has a range of cost minimization payoffs depending on the particular situation in which it is utilized (cf. Chapter 3).

Data relating to group composition and mobility strategy may be relatively abundant at Tosawihi, but teasing them from the roar of extraction and processing debris (e.g., distinguishing logistical from residentially organized forays) at the quarries is a thorny problem (Thomas 1983a, 1988; Elston and Budy 1990). In the following sections we illustrate several models reflecting points along the continuum of potential mobility and organization. We assume that prehistoric groups could schedule and organize their visits to Tosawihi as they wished, and could choose from a full range of technological options for exploiting toolstone observed there. The archaeological record thus need not fit any of these interpretive models isomorphically; instead, the models illustrate the range of variation expected in prehistoric use of the quarries and their vicinity.

Encounter Strategy

The simplest toolstone procurement strategy is to collect toolstone as it is encountered (Figure 19a). As residential or logistical movement brings foragers to toolstone sources, raw material is assayed, collected from the surface, and either used expediently and discarded (Hayden 1979b) or incorporated as personal gear into toolkits (upon which old gear may be discarded). This *encounter* strategy can be employed anywhere, and is most effective under conditions of mobility, as for instance, while people travel from one place to another. It is less a pattern of convenience or propinquity than it is of simple opportunism (cf. Binford 1979:258). We doubt that encounter procurement alone can meet all toolstone demands, particularly in technological systems where tool design constraints (size, form) are important.

The archaeological signature of encounter procurement of toolstone should be characterized by low debris densities. Lithic assemblages should be relatively small and dominated by processing debris (abundant primary flakes, core remnants, biface fragments, hammerstones), but also might contain a fair number of exhausted tools made of exotic materials. The visibility of this pattern is expected to be very low at Tosawihi, perhaps apparent only in the occurrence of isolated projectile points and isolated lithic reduction scatters.

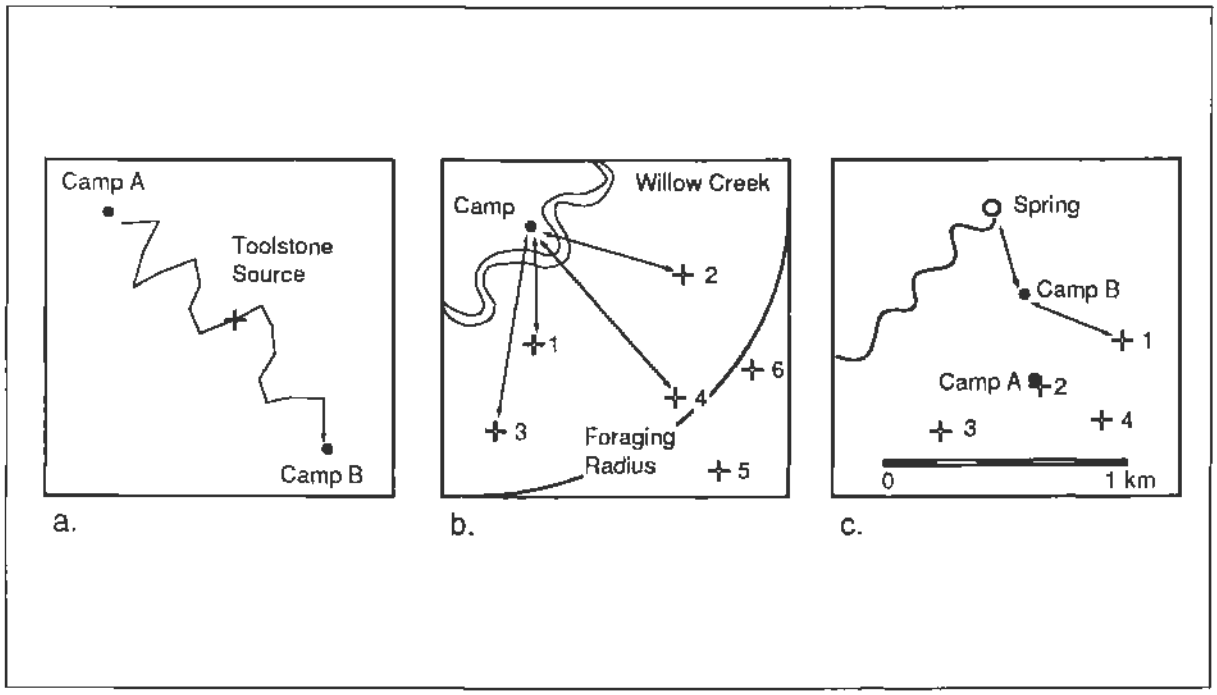


Figure 19. Mobility patterns and toolstone procurement strategies. a. Encounter procurement during travel on residential move. b. Diurnal procurement from camp on Willow Creek; because of travel costs, profitability of source **4** is least and that of source **1** is greatest. Sources **5** and **6** are beyond diurnal range. c. Residential camp **A** monistically located at toolstone source **2**; camp **B** is located pluralistically with reference both to toolstone source **1** and a spring.

Diurnal and Residential Strategies

If residential movement to the vicinity of a toolstone source forfeits other higher return resource options, there may be higher opportunity costs for the group as a whole, prompting this kind of residential mobility only under some conditions or in some seasons. In the case of moves to the Tosawihi Quarries, opportunity costs can be minimized by scheduling residential group moves to coincide with productive foraging seasons when variation in food patch returns are low (cf. Chapter 3). If such food gathering opportunities produce excess resources for storage and future consumption, then opportunity costs are further ameliorated.

Propinquity to food resource patches may be forfeited in the choice of residential base location to ensure that toolstone sources are placed within the daily foraging radius (Binford 1983b). The Tosawihi Quarries are within the 10 km diurnal range of camps on Willow Creek, Rock Creek, Little Antelope Creek, Antelope Creek, and Ivanhoe Creek; these settings probably provided attractive conjunctions of resource sets (cf. Chapter 2), and so were favored for residential bases of this sort.

Diurnal Strategy. Employing a *diurnal* lithic procurement strategy, one to a few people conduct a toolstone collection trip within the foraging radius of the residential base and return in the same day (Figure 19b). Opportunity costs are minimized, both by using normal foraging trips to gather toolstone (as in the encounter strategy described above) and/ or by using only a part of the work force for toolstone procurement while the rest of the group exploits other resources.

Although transport costs are lower than for longer distance logistical procurement, diurnal exploitation of toolstone is constrained by the time available for work, which decreases with distance from the residential base. Since the profitability of toolstone is the ratio of toolstone obtained during a particular foray to handling time (extraction and processing time; cf. Stephens and Krebs 1986:23, 54-55), distance affects the extraction techniques that can be employed at a toolstone source. Thus, resources in close proximity to the base camp (such as source 1, Figure 19b) can have lower profitability (be of lower quality or require more intensive methods of extraction and processing), while resources in the vicinity of the maximum diurnal range (such source 4, Figure 19b) must have very high profitability (be of high quality and require little processing) to achieve a payoff.

This suggests a continuum for lithic resource procurement within a given daily foraging radius. At the maximum diurnal range, it would pay only to procure very high quality, pre-processed lithic material—for example, to retrieve cached flake blanks and bifaces. With shorter distances or travel times, a likely target might be previously quarried, but relatively unprocessed, material available from the surface of quarry pit berms and dumps. Closer still to the base camp, it might pay to grub through quarry pit berms in hopes of encountering chunks of high quality material requiring minimal processing. Finally, when close enough to the base camp, it pays to employ full scale quarrying techniques.

The archaeological visibility of diurnal use in the quarries is expected to be low. Accidental tool loss, disturbed caches, and debitage from assaying and processing surface toolstone are indistinguishable from similar features generated by quarrying, processing quarried material, and supporting occupation of the quarries during logistical or diurnal use. Perhaps the best evidence for diurnal use consists of shallow pits excavated in quarry pit berms to glean previously quarried but discarded toolstone.

Residential Strategy. A *residential* strategy is in effect when propinquity to other resources has been sacrificed for propinquity to toolstone, and the residential base is positioned so close to the toolstone source that travel time is no longer a significant cost of lithic procurement. At its most extreme, this results in residence *on* the quarry, a *monistic* residential strategy (Camp A in Figure 19c). A *pluralistic* residential strategy results in location of the residential base with some consideration also for non-toolstone resources local to quarries (Camp B in Figure 19c). In the Tosawihi landscape, monistic, toolstone-based residence may rocket opportunity costs, since toolstone sources often are spatially disjunct from many other natural resources (cf. Chapter 2). This suggests that residence and quarry sites should coincide only when a) the quarry locality also coincides with the location of water and food resources, or b) occupation is of such short duration that the location of local non-toolstone resources is irrelevant. Nonetheless, this kind of mobility and organizational pattern should result in an archaeological record of quarrying debris associated with indicators of residential use of places (cf. Chapter 24).

The greater the duration of occupation in the vicinity of the quarries, the more foragers will have to depend on local resources for support, and the more likely they are to employ a pluralistic residential strategy, occupying sites near, but not on, quarries. This in turn is likely to result in greater segmentation of tool production, with early stage processing performed at the quarries and later stage processing (including heat-treatment) performed at the residential base or at intermediate stations (Elston, Raven, and Budy 1987; Elston 1989). Assemblages generated during such residence should contain few tools related to quarrying, and greater frequencies of tools reflecting procurement and processing of biotic resources (projectile points, partially consumed tools of local Tosawihi chert, grinding equipment, pottery), tool maintenance, and replacement (exhausted tools of exotic materials). Debris representing later stage lithic processing and heat-treatment should be abundant. Such relatively long-term camps should contain cooking and heat-treating hearths, and possibly evidence of differential use of space.

In contrast, monistic residences on, or immediately adjacent, quarry locales should be dominated by debris and features related to quarrying and early stage processing (flakes, core

remnants, biface fragments, hammerstones), but perhaps with the addition of small assemblages of equipment related to short term residence such as pottery, grinding equipment, and weapons.

Logistical Strategy

At the opposite end of the mobility continuum is a logistical pattern of exploitation. Small, logistically organized task-groups conduct short-term, toolstone-targeted collection forays requiring overnight or longer trips away from the residential base. In the example depicted in Figure 19b, sources 5 and 6 are located beyond the diurnal range of the Willow Creek camp; their exploitation from that camp would require a logistical trip. There may be many reasons for such logistical use of the Tosawihi Quarries, including specialized procurement for exchange, critical functional requirements necessitating high quality toolstone, or religious and social incentives (Gould 1980, 1985; Gould and Saggers 1985; Hughes and Bettinger 1984). Whatever the motivation for logistical use of a toolstone source, opportunity cost is minimized by labor organization, since only a few group members are removed from the residential labor pool. Yet, transport of quarried products may be costly. Transport costs in part may be ameliorated by other functions of logistical forays such as resource monitoring (in which case the logistical party maximizes its opportunity yields), or embedding procurement of other resources in the trip; game was taken during ethnographic logistical quarrying trips observed by Jones and White (1988) and Binford and O'Connell (1984).

Scheduling of logistical forays also may help minimize opportunity costs, depending on seasonal labor needs. For example, logistical forays may have been mounted from either a winter residence base or a summer foraging camp, and each may have exacted different opportunity costs. Summer forays may have been "cheap" in terms of provisioning the foray party, but expensive in terms of the opportunities lost to the group as the labor force was reduced. Winter forays may have been costly to provision, but if labor productivity was low in the winter they may have entailed lower opportunity costs.

Given the small group size characteristic of logistical forays, the quantity of toolstone transported back to the residential base may be low; the energetics of toolstone transport require that the return of "useful" stone be maximized. As in diurnal exploitation, the highest payoff would accrue from retrieval of a cache; this, in fact, might be the only payoff sufficient to justify a winter trip to the quarries. Certainly, one would not expect a logistical foray to focus on mediocre material from the surface or in quarry pit berms, because toolstone of similar quality is likely to be available at much less cost closer to home. Intensive methods of extraction (excavation of quarry pits or adits) and attendant large scale processing are expected only when people could remain at the quarries long enough, so seasonality may be important in this regard, as well.

Logistical camps for direct procurement are likely to be located near the source since less time need be spent in foraging. Little segmentation is expected in direct, logistical procurement—processing and residential activities are expected to occur at or near the place of extraction with little caching. The assemblages of logistical field camps are expected to be relatively small, to exhibit little diversity, and to be dominated by processing debris (flakes, core remnants, biface fragments, hammerstones) and weapons. This assemblage composition is so similar to that expected from monistic residential occupation that it may not be possible to differentiate the two. Time constraints will prevent the production of large surpluses of toolstone, so the creation of caches is not expected during logistical use of the quarries, and heat-treatment may be deferred until return to the home base. Hearths are expected to be minimal in construction, and other features absent, in summer logistical camps. Winter logistical camps should require the construction of shelters and more elaborate hearths, or the occupation of rockshelters.

Caching Strategy

Caching artifacts near their source is another strategy to minimize opportunity costs. Artifact caching trades the energetic cost of overproduction for future minimization of opportunity costs, since retrieval of caches requires only the opportunity and labor costs of travel and transport; neither procurement nor production costs are incurred. Caches also minimize future procurement costs (cf. below). Because caching depends on overproduction—excess time or energy to produce more artifacts—it should occur most often in settings where excess time or energy were available. The best candidates for such settings are residential sites.

Mobility and Organization in the Archaeological Record

In the preceding discussions, several simple archaeological expectations were presented. These are essentially ethnographic in scale, and are not necessarily visible in the archaeological record. Many different combinations of mobility scheduling and labor organization may have contributed to the archaeology of the Tosawihi vicinity—over millennia, decades, or even seasons of the same year. A primary attribute of the complex archaeological record resulting from so complex a history of use is its spatial structure.

Since strategies of economizing rely so heavily on how space is used, we assume their archeological consequences to be overt, detectable, and interpretable. Particularly, we expect spatial relationships in the archeological record to comment on the macroscopic role of environmental influences in locating prehistoric activities (Binford 1978a, 1983a:109-143, 1983b; Losch 1954; O'Connell and Hawkes 1984; Wagner 1960), as well as on the more microscopic details of how group size, work structure, and duration of occupation affected the relocation of resources and the use of space within activity areas (Binford 1983a:144-192; O'Connell 1987; O'Connell, Hawkes, and Blurton Jones 1991; Simms 1988).

At Tosawihi, we expect most observable spatial patterns to be referable to the organization of toolstone procurement, and we expect to be able to segregate specific patterns relating to the extraction of lithic raw material, the conduct of subsequent stone reduction and processing, and the feeding and sheltering of quarriers. Artifact size and stage with regard to distance from source, and functional type of site in which artifacts are found, also should reflect organizational patterns of lithic processing. The principle of least effort suggests that, from a given residential base, the most intense exploitation should occur at the nearest available source, other things (such as stone quality) being equal (Chapter 25). In future research, the actual distribution of raw materials in residential bases from different sources (assuming these can be identified), will test the model and suggest where other things are *not* equal.

Identification of these patterns and interpretation of their meaning necessarily will rely on other categories of inquiry; particularly, our reading of the spatial component of the record will depend on judgments of site function informed by analyses of landscape geography, site formation and transformation, assemblage composition and diversity, feature composition and distribution, and the nature and distribution of subsistence residues.

Recognition of site formation processes—understanding how the archaeological record of Tosawihi formed—is an important precursor to interpretation of the archaeological record at Tosawihi. Site formation processes govern how archaeological sites form initially and are transformed subsequently (Binford 1979, 1980; Schiffer 1976), and their study involves both anthropological study of how sites form due to human action and how they are modified by natural processes (cf. Chapter 22).

People create archaeological sites by living and working in them. Use of space is differentiated as people sleep in one place, work in another, and dispose of refuse in yet another. Several models of site formation processes derived from ethnographic data (Binford 1977, 1978a, 1986; Binford and O'Connell 1984; Yellen 1977a; Gould 1977; 1980) are applicable at Tosawihi. Activities at residential sites also can be expected to create cultural features and transform archaeological sites; examples include the excavation and cleaning of hearths and heat-treating features, creation of debitage scatters, disposal of lithic and other waste, clearing of work spaces, and shelter construction. In caves and rockshelters, the latter may effect massive transformations of archaeological deposits (Elston and Budy 1990).

Geological and biological processes begin to transform archaeological sites as soon as they are created. At Tosawihi, the notable agencies of non-cultural site transformation are slope movement, eolian and alluvial deposition, and bioturbation by burrowing animals. Pack rats (*Neotoma* sp.), mammalian predators, and raptors all contribute to the faunal content of caves and rock shelters; the former two may cause extensive disturbance of archaeological deposits through burrowing (Elston and Budy 1990).

Investigation of site formation processes requires careful analysis of sediments in context, and understanding site-transforming cultural and natural features. An integrated interpretation of site formation can be derived from feature mapping, trench profiling, and geomorphic studies (as in Chapters 16, 17, 18 and 22). Where applicable, analysis of faunal remains can reveal proportions of naturally and culturally introduced bone (cf. Chapter 14; Schmitt 1990).

Data on spatial relationships at Tosawihi were gathered at several scales. Intrinsic attributes of site location were monitored by recording topographic, hydrologic, floral, and faunal details of site settings, and by comparing site distributions to the distribution of available deposits of toolstone. Intrasite locations and distributions of functionally classifiable features were mapped. Intrafeature and interfeature patterns of artifact distribution were discovered by intensive surface scrutiny and mapping, various case-specific strategies of systematic collection (chiefly, patterned surface scrapes and limited excavations), and subsequent analyses (size grading and functional characterization) of collected assemblages. These data are employed in Chapters 21 and 25 to test the degree to which our assumptions about distance minimization account for spatial configurations in Tosawihi archaeology.

The spatial structure of a site often suggests the size, social structure, and duration of occupation of groups occupying it (Binford 1978a; 1983a; O'Connell 1987; Zeier and Elston 1986; Novick 1987; Thomas 1983b, 1988; Elston and Budy 1990). Obviously, quarry localities, workshops, rockshelters, and open habitation sites all may exhibit different structures because each presented a different set of spatial constraints and each may have been occupied by groups of different size for different sets of activities over different periods of time. The ethnoarchaeological literature, particularly that of Australia, provides some insight into what we might expect of the site structure of lithic quarries and workshops (Jones and White 1988; Binford and O'Connell 1984; Binford 1986; Gould 1977, 1980: 124-125; Hayden 1979a:51; O'Connell 1974, n.d.; Tindale 1965:140); this is explored in Chapter 22.

Whether or not the organization of field camps is highly structured probably has a great deal to do with length of occupation. If archaeologically visible, sites occupied for a very short duration usually have a correspondingly simple structure (or none at all). Conversely, the structure of sites occupied over longer periods, and those consistently reoccupied, may be highly structured as occupants clear certain space and keep it clean, empty hearths, and otherwise organize and reorganize work areas and places of debris disposal. These relationships are investigated in the analysis of feature aggregation in Chapter 25.

The functions of archaeological sites at Tosawihi have been classified tentatively on the basis of limited evidence from surface collection and testing (Budy 1988; Raven 1988; Elston 1989), but these distinctions remain to be demonstrated. For instance, what *really* were the functions of "reduction stations," small, discrete lithic scatters usually found on ridges or in

small rockshelters? Do they represent hunting stations, procurement of lithic material by groups passing through on their way elsewhere, or places where specialized reduction tasks were carried out? Do sites provisionally named "residential" on the basis of the presence of ground stone and "finished" tools contain additional evidence to support this classification? We have observed considerable structural complexity in several open sites; are more complex sites functionally different from less complex ones?

Site function is addressed in Chapters 23 and 24 by assessment of variability in the content of individual localities and comparison of assemblage composition and diversity (Thomas 1988; Elston and Juell 1987; Elston and Budy 1990). Functional tool classes and use wear evidence signal ranges of activities; the presence or absence of distinct feature classes (eg. hearths, storage pits, and house pits or other structures) reflect both the duration of occupation and functional range of a site.

Models of Cheap Procurement: Production Efficiency

Manipulation of labor organization and mobility scheduling is one option available to hunter-gatherers to minimize the cost of lithic procurement; another is to maximize the amount of "useful" toolstone procured with a given amount of energy. Because the opportunity cost of quarrying is a comparative measure (actual gain minus forfeited gain), increasing the amount of toolstone garnered with a given amount of energy necessarily lowers opportunity cost (cf. Chapter 3). As in mobility and labor scheduling, an overall strategy of efficient procurement can be accomplished through a variety of options.

In general (and at Tosawihi), different kinds of toolstone occurrence (e.g., bedrock, outcrops, cobbles) have varying costs and benefits associated with extraction. Given constraints on time or energy, it is likely that prehistoric quarriers focused on those occurrences with the lowest cost-to-benefit ratios, ignoring those less profitable (cf. Chapter 3). At Tosawihi specifically, bedrock deposits provided toolstone of the highest quality, but, in terms of time and effort, it was the most costly to extract. Quarrying techniques, quarrying tools, and the organization of human work were the means by which the costs of subsurface toolstone extraction could be minimized.

Techniques and Tools

Subsurface quarrying always requires more time than surface collection, regardless of technique. Some quarrying methods, however, are less costly than others. Excavations forming pits and adits allow quarriers the opportunity to focus most of their efforts on extracting toolstone, with maintenance restricted mostly to periodic cleaning and disposal of quarry waste. Other methods, such as the excavation of shafts, galleries, or drift tunnels, almost always demand investments of time and effort in the design and maintenance of the mining feature (cf. Shepherd 1980:12-18).

Subsurface quarrying requires removal of overburden prior to toolstone extraction. Ethnographers have documented the use of modern steel tools in toolstone extraction, (Binford and O'Connell 1984:412; Gallagher 1977; Jones and White 1988:62; James O'Connell, personal communication), but most prehistoric quarriers were limited to tools fashioned from stone and organic materials. Bone and antler picks, rakes, points, and levers used to loosen overlying soils and rock have been recovered from a number of quarries (H. Lech and J. Lech 1984:193; McBryde 1984:273; Mercer 1987:160-163; Rudebeck 1987:151, 153; Schild 1987:142; Shepherd 1980:19-20, 28-33). Removing loosened sediments from the work area can be accomplished by

pushing materials aside by hand (cf. Binford and O'Connell 1984: 412), but shovels and containers are more efficient. Scapulae from large mammals were recovered from quarry features at Tosawihi (cf. Chapter 14) and other quarries (Ahler 1986:75-76; Rudebeck 1987:153; Shepherd 1980:32-33), and are efficient when used as shovels to scrape loosened sediment away from the work area (Shepherd 1980:32-33). For hauling spoil greater distances, a container would have been appropriate. Burton (1984:241, cf. Figure 2) notes that the Tuman axe makers' *grenj kon*, or quarrymen's basket, solves the problem of moving large amounts of rock quickly.

Once a sufficient work space is cleared, quarriers can extract toolstone in the form of clasts, cobbles, or boulders from a soil matrix, or chunks and flakes from primary bedrock. Hammerstones are perhaps the most important tool for extracting stone from large boulders or bedrock. Large, two-handed hammerstones are effective for loosening lithic material that surrounds toolstone, or for pounding against the weak planes of a rock surface in order to free pieces (cf. Burton 1984:242). Small, one-handed hammerstones are useful for removing large flake or core blanks from parent material. A liability of hammerstone use, however, is that internal fractures are introduced which ultimately inhibit flake propagation and make the stone useless for tool fabrication. Wooden, bone, and antler wedges (cf. Burton 1984:241; Rudebeck 1987:153; Shepherd 1980:82) are effective for skirting this problem; driven into cracks or joints by hammerstones or billets, wedges force chunks from their parent material without destroying the stone or producing internal flaws.

With the exception of hammerstones, most quarrying tools used at the Tosawihi Quarries should have been kept as personal gear (cf. Binford 1979:262-263), either cached at the quarries or stored as passive gear at a base camp, since their availability in the vicinity was not reliable. An additional reason to keep them as personal gear, versus trying to locate them situationally (Binford 1979:264-266), is that their manufacture at the quarries would have occupied time that could have been spent quarrying. Hammerstones, on the other hand, are readily available around Tosawihi in the form of quartzite and basalt boulders; they easily could have been procured situationally, and left as site furniture.

Charcoal concentrations in many quarry features at Tosawihi suggest that fire may have been used in toolstone procurement. The use of fire (and water) in toolstone extraction relies on differential thermal expansion and contraction of the constituent minerals of a lithic material, and it is most successful on heterogeneous rocks (Shepherd 1980:19) or large, isolated pieces (Binford and O'Connell 1984); its application, then, is contingent on the geology of the toolstone being extracted. The Tuman axe makers, for instance, never used fire because it was unsuitable for the conditions (Burton 1984:260). Binford and O'Connell (1984:418), however, observed fire being used to break a large quartzite boulder into smaller chunks, and informants told Jones and White (1988:62) that fire sometimes was used to crack large rocks. Akerman (1979:144) reports that fire was used throughout the Kimberleys for extracting toolstone from bedrock.

Labor Availability

Given limited time, quarriers can maximize the amount of quality toolstone procured by intensifying the amount of work completed per unit of time. Organizing human labor for toolstone procurement is the principal way in which this could have been accomplished. For instance, Yolngu quarriers were observed working at various toolstone procurement tasks simultaneously (Jones and White 1988:74); while one man extracted cobbles from a pit, others flaked stone or searched for new sources. Putting more men to work at the Tuman ax quarries increased the overall output significantly and, consequently, more men could claim axe stone (Burton 1984:242). Actualistic quarrying experiments at Tosawihi (Carambelas and Raven 1991) have shown increases in the rate of overburden removal with two quarriers either working as a team or relieving one another at quarrying.

Organizing human work by age, sex, or ability is another means of minimizing the costs of quarrying. Binford and O'Connell (1984:409) note that the ability to procure toolstone was expected of all Alyawara men, and Yolngu quarriers emphasized that it was the work of men to flake stone, that of women, to haul it away (Jones and White 1988:61). Moreover, older Yolngu men were responsible for core reduction and production of primary flakes (tasks considered more demanding and requiring greater skill), while younger men excavated quarry pits and completed secondary thinning of flakes (Jones and White 1988:62, 71). The relatively skilled task of removing axe stone from an outcrop was completed by only a few Tuman axe makers, while unskilled labor was put to work removing waste stone from the work area (Burton 1984:242).

When contemplating how human work may have been organized at the Tosawihi Quarries, an important issue to consider is the composition of the group from which quarriers were drawn. Task-specific work groups that made short but work-intensive forays most likely would have been organized from a permanent base camp composed of multiple families. Supported by others at a temporary field camp, quarriers could have extracted and processed quality toolstone without having to focus on other subsistence activities. Jones and White (1988:76) estimate that between 50 and 100 finished *ngambi* points could have been produced by 3 or 4 Yolngu quarriers in a single day, when supported by individuals at a base camp. On the other hand, opportunistic quarrying seems most likely when residential mobility was greater and groups were composed of fewer individuals, perhaps only an extended family. Less time could have been devoted to quarrying, since personnel would have had to participate in other subsistence related activities.

Archaeological Consequences

Subsurface toolstone extraction creates pits and adits surrounded by berms composed of soils and lithic debris. These features are subsequently filled in by quarriers who expand or excavate adjacent; erosion also fills in quarry features (cf. Chapter 22). Broken or rejected cores and large quantities of raw (not heat-treated) lithic material make up the cultural fill (Wilke and Schroth 1989:170).

Complete and fragmented hammerstones of various shapes and sizes also should be present within and around quarry features. Lithic material suitable for hammerstones is abundant in the Tosawihi vicinity, and probably allowed quarriers to procure hammerstones situationally and leave them as site furniture (Binford 1979:263-266). Using a gravity model, hammerstone size already has been shown to be an inverse function of distance from basalt or quartzite source (Elston, Raven, and Budy 1987). Organic materials from which other tools were fabricated were not present or predictable in the Tosawihi vicinity; when quarrying was not underway, these tools (personal gear; cf. Binford 1979:262-263) probably were cached in the vicinity or at a base camp. Therefore, organic tools should be present only in fragmented or exhausted form, and only when conditions permit them to be preserved (cf. Chapter 14).

Social groups visiting the quarries may be manifest in the types of sites they created, as discussed above. For example, short-term, task-specific groups should be represented by quarrying and reduction locations and, at a short distance from these, field camps (Binford 1980:9-10). More heterogenous social groups, on the other hand, probably conducted a number of activities additional to toolstone procurement, reflected in base camps and locations (Binford 1980:9). Consequently, detection of social groups requires determination of site function and structure, as discussed above.

Extending the Utility of Toolstone

The foregoing outlines ways in which hunter-gatherer groups could lower the relative costs of toolstone through labor or scheduling strategies and procurement tactics. These tactical options pertain largely to the exploitation of particular lithic sources. Another option to reduce toolstone costs is to extend the period of its utility within a toolkit. Extending utility reduces the overall demand for toolstone within an adaptive system, and consequently reduces the systemic cost of its procurement. This section discusses how such a cost reduction strategy may be played out.

Necessarily, we approach variation in the extension of toolstone utility from the perspective of technological organization. Technological organization derives from the fit between the tool using activities in an adaptive system and the tools used to perform them. Insofar as tool using activities can be anticipated, technology itself can be organized (cf. Kelly 1988:717). Many factors affect technological organization among lithic economies; these include activity planning, labor organization, nature of the lithic terrane, and available resources. We limit our discussion here to those aspects of technological organization most determinant of toolstone costs, specifically, initial tool design and manufacture tactics, and tool maintenance and recycling tactics.

Tool Design and Maintenance Tactics

The design and initial production of tools unquestionably is a complex process (Bleed 1986:738-739), and one not particularly amenable to retrodictive analysis since diverse design criteria may result in similar tool forms. For example, Kelly (1988:718) argues that a biface may result from three different design decisions: to create a useful core providing flakes for use as tools, to serve as a tool in its own right, and as the byproduct of shaping a core for some other purpose (for flakes of appropriate sizes and shapes, hafting, etc.). Thus, tool form alone cannot be taken as homologous with design decisions. Nonetheless, initial tool design strategies amongst mobile foragers must minimize the costs of pre-manufacture and post-manufacture transportation, the cost of initial manufacture, and the costs of maintenance. The benefit against which these costs must be measured is the energy gained through use of the tool. The calories derived from killing a deer with an arrow, for example, must offset the energy expended in pursuit of the prey as well as the energy spent on producing the weapon to take the prey.

One trade-off that design decisions must confront lies in the range of tasks for which a tool is suitable. Tool forms that have many useful edges, but are not particularly suited to one specific task, can be considered highly *flexible* (Goodyear 1979). On the other end of the spectrum lie tool forms that are good only for a single task, yet perform it very efficiently. Because transport and production cost are important factors, most tools incorporate some degree of flexibility.

Another trade-off dictated by the economics of tool manufacture is the degree to which a tool is modifiable, that is, its potential to be changed into another form as needed. Since chipped stone production is a reductive process, the ability to modify a tool is often (although not always) related to how much stone is contained in a given form. This aspect of tool design can be summarized as *recyclability*.

Mobile technologies face two simultaneous problems created by disjuncture between spatial locations of toolstone and resources upon which tools are employed. First, a mobile technology must be *portable* (Goodyear 1979), since excessive tool transport is costly; the caloric return of a resource may be canceled by the caloric cost of carrying too-heavy tools. Second, tool *availability* (Bleed 1986:739)—the readiness of an implement at the time it is needed—must be

ensured to avoid contingency risk (cf. Chapter 3); to arrive at a resource unable to derive benefits from it for want of appropriate tools also is costly. The simultaneous requirements of portability and availability of tools virtually dictate that mobile technologies incorporate flexibility and recyclability in tool design strategies.

Because the energy gained by using tools must offset the cost of toolstone procurement, production, and transport, it is possible to model some general but simple relationships among tool form flexibility, recyclability, and activity structures. Activity structure in this highly simplified model consists of the predictability by foraging groups of two factors: action and location of action. Either can be known or unknown.

Activity scheduling is an important component of hunter-gatherer mobility systems (Binford 1980, 1982). Mobility systems in which, in the long term, both location and actions are known in advance can be considered *specialized foraging*. When actions are known, but location is not (again in the long term) such a system can be called *targeted foraging*. When the actions to be undertaken are not known, but the location is known, one can consider the system to be one of *generalized foraging*. When both task and location are unknown, the system can be considered *aimless foraging*. No single mobility system need fit perfectly into one of these categories; probably, in fact, none does (Thomas 1988). The point is simply that activity scheduling is an important component of adaptation and it underlies much of what is meant by the term "mobility system."

Activity scheduling is closely related to the costs and risks of stone tool use (Chapter 3). Under the terms of this model, whenever an action can be anticipated, tool needs are known and contingency risks are low. Consequently, tool design can be determined in advance, permitting the costs of tool design and use to be minimized. Likewise, knowing where an action will occur determines whether transport cost can be predicted, decreasing venture risks. When both the action and its location are known, foragers can predict all aspects of technological costs, lowering both venture and contingency risk. Conversely, when action and location are unknown, no aspect of technological cost is predictable; venture and contingency risks are both high. Bleed (1986) argues that because tool availability is the most important aspect of a technology, flexibility and recyclability should characterize tool forms associated with unpredictable activity structure (high contingency risk situations). Similarly, under predictable activity structures, tool form flexibility and recyclability may be less important than the efficiency of the tool in processing a specific resource in a given amount of time.

Bleed (1986) combines the dimensions of flexibility and recyclability, preferring instead "maintainability" and "reliability" to describe the two dimensions, respectively. Since tool form flexibility and recyclability are determined through different sets of observations on archaeological specimens, they are held separate here.

Initial design decisions limit the potential future uses of tools. The argument sketched above suggests that flexibility and recyclability, as starting properties of different tool forms, are related to (anticipated) activity structures and risk avoidance, and, by extension, to mobility strategies, which are long-term aggregates of activity structures. The potential utility of different tool designs is played out in the actual use, maintenance, and recycling of the tools themselves. Maintenance tactics involve refurbishing tools for use in the same task, and reshaping or reworking tools for use in other tasks. The former category includes resharpening and repair of tool edges and shape, the latter, modification of tool edges and shape. Resharpening and repair of tools is cost effective when future actions and the tools to be used in them are expected to be similar to those at present, since tool maintenance without subsequent use is simply wasted energy. Recycling differs fundamentally from resharpening, in that it indicates anticipation of need for a different tool form at the expense of the current one. In a sense, resharpening indicates a steady state and recycling indicates fluctuation in activity structure.

Archaeological Implications of Extending Toolstone Use

The arguments made above link variation in initial tool design, use, maintenance, and recycling strategies to broad characterizations of mobility patterns. Tool design strategies suggest the degree to which future activities can be forecast within the mobility system. Tool maintenance and discard strategies reflect the outcome of that forecast— whether similar or different activities are anticipated.

Initial tool design strategies are evident in the archaeological record, revealed by analysis of specimens broken during manufacture (cf. Chapters 6, 7, 8 and 9). Such analysis also delineates tool production sequences, indicating the energy expended to produce a particular tool form (e.g., heat-treatment may require a considerable effort in gathering firewood, tending a fire, etc., to facilitate continued reduction). Manufacture breakage analysis also allows the discovery of standardized tool forms, which in turn suggest how routinely those forms followed a particular cycle of use, re-use, and recycling. Another important attribute observed in manufacture breakage analysis is tool size and shape, since these limit the potential flexibility of a tool form and its recyclability into different forms.

Tool use histories, evident in archaeological specimens as use wear traces, edge damage patterns, resharpening, refurbishing, and recycling, are another important source of information (cf. Chapter 7). Different tool forms may sustain different rates of resharpening, refurbishing, and recycling, depending on anticipated uses, availability of raw material, and suitability for particular tasks. If tool function and form are related closely (as in a tool form with low flexibility), then we expect use wear and edge damage to be similar across all tools of the same form. On the other hand, heterogeneous wear patterns on tools of the same formal class suggest flexibility for that tool form. How tools break in use also informs on the mechanics of tool use as well as on the "lifespan" of stone tools relative to edge attrition and potential recyclability.

A summary way of examining these patterns is through the definition of *trajectories*, regular patterns in the production, use, reuse, recycling, and discard of tools (Elston 1986c). Trajectories of opalite toolstone use at Tosawihi should be conditioned strongly by opalite abundance. Under conditions of raw material abundance, tools needed for local use may be subject to few design restrictions since they need not be transported. Thus, we can expect an expedient strategy of local toolstone use among tools intended for use at the quarries. Manufacture of tools for use elsewhere should be subject to a different set of design restrictions. Specifically, we expect that tool production and use should follow two distinct trajectories, one of local expedient tool production and use, and one for production of tools intended to be used elsewhere (cf. Bamforth 1986). In Chapter 21 we summarize our observations on trajectories after discussing the manufacture, use, reuse, breakage, and discard patterns of each opalite tool class. Trajectory delineation provides a concise description of overall technological strategies, and it is perhaps at this level that the linkage to general patterns of mobility can be made best.

The Economic Geography of Tosawihi Toolstone

Economic geography studies the distribution and movement of resources, exploring transportation costs, rates of consumption, fall-off rates, the interaction of resources, and the role of commodities in trade and exchange, usually over large areas (cf. Ericson and Earle 1982). There are many suggestions in the existing literature that geographic factors influenced the use of toolstone in north-central Nevada; these include the sharp boundary between use of white chert and obsidian to the west of Tosawihi (Stephenson and Wilkenson 1969), the preference for cherts of mediocre quality around local source areas in the Upper Humboldt Valley (Armentrout and Hanes 1987; Elston and Budy 1990), and ethnographic references to long distance trade in Tosawihi chert among the Western Shoshone (Steward 1938, 1941).

Although we do not address such problems directly here, most of the models concerning strategies of lithic procurement and maintenance developed in Chapter 3 and in the present chapter either refer specifically to a regional scale or easily can be expanded to do so in future investigations. In the meantime, the present study explicitly sets up the necessary baseline data for larger scale investigations.

Toolstone distribution can reveal much about trade, toolstone economics, resource access, settlement, and subsistence throughout large portions of the north-central Great Basin and southern Columbia Plateau. If Tosawihi cherts are as widely distributed in the archaeological record as suspected, then the probability that they were acquired by trade increases with distance, and this must influence any cost/benefit model applied to primary procurement.

The ability to identify Tosawihi chert in sites outside the quarries is thus prerequisite to determining how far and in what volumes it travelled. Likewise, the identification at the quarries of toolstone exotic to them informs as to distance and direction of travel and/or trade. In addition, the ability to distinguish different chert sources within the quarries would make it possible to monitor the distance toolstone was transported from source to workshop/field camp, to investigate whether particular sources and/or camp sites were favored, and to determine how many sources were exploited during a given visit to the quarries. By identifying specific sources among samples of debitage from winter base camps on the Humboldt River, one might come to know if different groups traditionally exploited different parts of the quarries.

Color variation of formed opalite artifacts was recorded along with other descriptive data (cf. Chapter 5), but color crosscuts source to such a degree that it is a reliable means of source identification in only a few instances. Samples taken from selected toolstone sources, together with samples of non-Tosawihi toolstones, form the basis of a small pilot study of source identification through neutron activation analysis (cf. Appendix J). Finally, identification of artifacts at Tosawihi made of cryptocrystalline toolstones, such as Maggie Creek Chert or Elko Hills Chert (Elston and Budy 1990), also would be of great interest. The recent realization by archaeologists (Hofman, et al. 1991) that certain cryptocrystalline rocks fluoresce in distinctive colors under ultraviolet light affords a quick and inexpensive means of identifying rocks from different sources that was applied to samples of debitage from several different sources in the quarries as well as to all cryptocrystalline bifaces and projectile points collected to date. The results of neutron activation and ultraviolet florescence studies are summarized in the following chapter.

Obsidian remains the best toolstone for sourcing studies because many sources have been identified throughout western North America, and chemical source identification is now routine and relatively inexpensive. Consequently, all obsidian artifacts and samples of obsidian debitage were subjected to source identification by means of X-ray florescence (cf. Appendix G; Hughes 1983, 1984).

Chronological Change at Tosawihi Quarries

Virtually all archaeological research is concerned with chronology, and temporal variation certainly is a critical element in the present investigation. Three lines of chronological inquiry (cultural chronology, temporal variation in quarry use, and temporal variation in knapping technology) are especially pertinent to research in the Tosawihi Quarries.

Cultural Chronology

Chapter 18 reviews regional chronologies to provide a framework for discussion of known temporal variation in technology, subsistence, mobility strategy, and stylistic change. Temporal data from the Tosawihi Quarries are used to construct a local chronology of archaeological sites and cultural features in sites, as well as geological surfaces and strata. Sources of temporal information at Tosawihi include stratigraphy, radiocarbon assay, tephrochronology, obsidian hydration, and diagnostic artifact types.

As we discovered during testing, well-stratified deposits containing charcoal exist in the fill and berms of quarry pits (Elston 1989). On the other hand, most residential sites are shallow and unstratified, and hearth and oven features uncommon. Accordingly, radiocarbon dates from residential sites are relatively few, and most dates document episodes of quarrying. Obsidian hydration dating lacks the precision of the radiocarbon method, but the large number of hydration readings is informative, nevertheless. From the obsidian assemblage, all temporally diagnostic projectile points, bifaces, and cores, a sample of flake tools and preforms, and debitage from several proveniences of interest were submitted for hydration dating. Temporally diagnostic artifacts such as projectile points (Thomas 1981) and pottery (Madsen 1986) help constrain the age of the deposits in which they are found within certain limits (between several hundred and several thousand years, depending on the artifact class).

Tephrochronology provides another precise dating method (Bradley 1985:110-112). Chemically distinct tephra (volcanic ash) from the explosive eruption of Mt. Mazama (now Crater Lake, Oregon) was widely deposited over western North America about 7,000 years ago (Davis, J.O. 1978a). Mazama ash is present in deposits exposed in Willow Creek at site 26Ek3251, and on Ivanhoe Creek just upstream of 26Ek3237 (Elston 1989), but not in any sites of the Eastern and Western Peripheries reported here. The chances are, therefore, that all sites described in this report are younger than 7,000 B.P., since Mazama ash, if present, lies far below cultural deposits, or is absent altogether. The presence of Mazama ash in the Tosawihi uplands allows correlations with other Mazama localities in the Great Basin.

Temporal Variation in Intensity of Quarry Use

The intensity of quarry use refers to the amount of time and energy spent in toolstone procurement at the quarry; various factors might influence quarrying intensity. One is exhaustion of the most accessible toolstone. The earliest visitors to Tosawihi may have found high quality toolstone as surface clasts that could be collected at minimal cost. Even if surface material could furnish all toolstone needs (an unlikely proposition), the abundance and quality of such material inevitably would decline. Increasing search costs eventually could make subsurface exploitation profitable without changing output requirements. Other factors involve increasing output requirements for Tosawihi material as functions of reduced accessibility to other sources, change in the overall position of Tosawihi in the annual range, and others previously discussed. As task groups are required to remain at the quarries longer to accommodate more intensive methods of toolstone extraction, they may require an attendant residential group to conduct coincident food gathering and processing in support of the quarriers.

Although surface exploitation may lack archaeological visibility in places subsequently quarried, we assume that intensification will be signaled by increases per unit time in the number of quarry localities, of quarry features within localities, and of quarrying episodes within quarry features. Quarry pit size and depth are likely to grow. The number of camp and workshop sites occupied per unit time should vary directly with intensity of quarry use, and assemblages of such sites should reflect the greater time spent in the vicinity of the quarries by higher frequencies of tools not related to quarrying or lithic processing.

Temporal Variation in Knapping Technology

Technological changes in stone tool manufacture were expected to be difficult to monitor because the basic approach to lithic reduction in the Great Basin has focused on biface production from the earliest times (Elston 1986a). The size and final forms of tools differ, but intermediate stages are similar (Elston and Budy 1990; Novick 1987). Consequently, the most technologically diagnostic elements are likely to be debitage produced during specialized and/or terminal reduction procedures such as fluting (channel flakes), final thinning and shaping (parallel diagonal or collateral thinning flakes), or creation of hafting elements (notch flakes). We mention this important research domain only to say that no temporal variation in knapping technology was evident in technological analysis of assemblages from distinct stratigraphic components at habitation sites or in technological comparisons between quarry and reduction localities.

Paleoenvironmental Reconstruction

Considerable climatic and environmental variation has occurred in the Great Basin since the end of the Pleistocene (Wells 1983; Mehringer 1986). Whether or not these changes were of sufficient magnitude to effect the availability of non-lithic resources at Tosawihi and vicinity adds another dimension to questions regarding prehistoric economy, but one that is difficult to address at this juncture.

Paleoenvironmental data are not well preserved in the shallow, open sites so far investigated at the Tosawihi Quarries. Most sites have failed to preserve plant macrofossils, and pollen weathers badly in unprotected eolian, colluvial, and alluvial sediments. Faunal remains from stratified alluvial deposits provide some clues to paleoenvironmental circumstances. For instance, bison scapulae recovered from quarry pits at 26Ek3208 and 26Ek3200, as well as bison bones at 26Ek3092, help document the distribution of a species poorly known in the western Great Basin (Elston and Budy 1990; Bradley 1985).

As previously mentioned, stratigraphy is often problematic in the shallow deposits of open sites at the Tosawihi Quarries. Of course, deposits filling quarry pits are very well stratified, but such sediments are almost entirely cultural in origin, having little to do with paleoenvironments. Eolian silts and colluvium usually are churned by slope movement and bioturbation. Nevertheless, natural stratigraphy is present in alluvial terrace deposits of sites in the Western Periphery (26Ek3092) and Northern Corridor (26Ek3237 and 26Ek3251).

Discussion

In this chapter we have proposed a series of expectations for the archaeological record of Tosawihi. Beginning with the tenet that hunter-gatherers will attempt to minimize the cost of toolstone procurement, we examined ways in which they might do so: by spatial positioning to minimize transport costs, by labor organization to decrease opportunity costs, by toolstone procurement tactics that maximize the rate of toolstone return within a given unit of time, and by tool design and use strategies which minimize the systemic need for inputs of fresh toolstone. The prehistoric human actions associated with these strategies and tactics should, we suggest, have created the archaeological record at Tosawihi quarries.

Whether such behaviors are discernible in the archaeological record is another question with which we have attempted to grapple. Our hypotheses may outstrip our abilities to test

them. For example, we have outlined above differences between the archaeological record of logistical forays vs. residential encampments. Yet, teasing these differences out of the actual materials themselves is not straightforward. Highly diverse tool assemblages could indeed indicate a residential encampment. They could also equally indicate a site surface with a long history of use. To the best of our abilities, we have attempted to phrase our expectations for the archaeology of Tosawihi in realistic, hence somewhat uncertain, terms. We remain completely unabashed about the tenuous nature of such predictions, for Tosawihi presents a challenge to archaeology. Aside from the sheer volume of archaeological material is a problem of method: how to extract information from a complex archaeological record.

Ensuing chapters show how we have chosen to do so. We first discuss Tosawihi as a lithic terrane—a topic of great importance in our expectations but also necessary for the unfamiliar reader to envision the Tosawihi landscape. The work then turns to analyses of artifactual material, followed by descriptions of the archaeological sites examined. Lastly, we turn to interpreting the archaeology of Tosawihi through a series of synthetic archaeological studies that link the behavioral expectations made in this chapter, their potential archaeological consequences, and the archaeological record of Tosawihi.

Part II. ANALYTICAL DATA CLASSES

Chapter 5

THE LITHIC TERRANE OF TOSAWIHI

Robert G. Elston

Geological forces create toolstone and determine where it is exposed and accessible for extraction. Given a particular technology, the range of search and handling costs for toolstone procurement is controlled by the overall occurrence of lithic raw material, including the relative accessibility of high-quality toolstone and its ratio to lower-quality material. Chapter 3 suggests that hunter-gatherers deal with lithic variability by manipulating mobility and subsistence patterns to insure toolstone procurement with minimal cost.

Lithic terranes can be characterized at various scales, ranging from the immediate foraging radius around a base camp to the entire annual range. We have few hard facts concerning the lithic terrane at the regional scale of people wintering on the Middle Humboldt River, but we assume that the alluvial deposits of the Humboldt River Valley itself are poor in toolstone, if not lacking in it altogether. Toolstone doubtless is available in volcanic hills and mountain ranges to the north, but aside from the Tosawihi Quarries and other opalite sources in the Tosawihi uplands, no other major lithic sources presently are known in the region. The fact that Archaic lithic assemblages in the Middle Humboldt are dominated by Tosawihi opalite suggests dependence on, if not a single toolstone source, then on a group of sources in a small area in a remote part of the region over several thousand years. On a regional scale, such a situation superficially resembles the hypothetical poor lithic terrane previously diagramed in Chapter 3 (cf. Figure 13b).

But the high quality of Tosawihi opalite as toolstone may compensate its relatively high cost. Too, the Tosawihi Quarries lie in the center of the annual range exploited by ethnographic people living on the Middle Humboldt River (Steward 1938). Assuming winter occupation along the Humboldt throughout the Archaic, foragers could have minimized procurement costs with proper scheduling by arranging visits to the quarries at the most propitious times. In any case, the presence of so much Tosawihi opalite in sites remote from the source indicates that prehistoric people found it better to procure much (if not most) of their toolstone from Tosawihi than to exploit other, perhaps inferior materials, or to do much trading for obsidian, major sources of which lie far beyond the range of the Tosawihi Shoshone. We will not know if this is true or why it might be so until we can characterize the lithic terrane of the Upper Humboldt Region more fully. We make a start in this direction by describing the toolstone available at Tosawihi, its geology, mode of occurrence, and attributes that distinguish it from other toolstone.

Bedrock Stratigraphy

Raven has summarized the bedrock geology of central northern Nevada in Chapter 2, describing the emplacement of 50 to 150 m thick massive ash-flow tuffs and other volcanic rocks during the Miocene that now dip 10 to 15 degrees to the southeast. As described, the existence of Tosawihi chert or opalite is due to the hydrothermal alteration of tuff that extended over an area of about 130 km^2 (Figure 4).

Most of the following discussion is based on geological reports of the Ivanhoe Mining District concerned with its past mercury production (Bailey and Phoenix 1944) and its potential as a gold property (Bartlett et al. 1991), and on recent detailed geological mapping of the current Ivanhoe Project (Cornucopia Resources 1987). Slight differences between the names and

map symbols of the geological units used by Bartlett et al. (1991) and Cornucopia Resources (1987) are reconciled. These data have been augmented by our observations of bedrock at quarry localities where backhoe and hand-dug trenches sampled quarry pits. In the following discussion, we ignore most information regarding the distribution and quality of mercury or gold ore which presumably were irrelevant to prehistoric peoples who exploited Tosawihi toolstone. Nor do we dwell on alteration processes such as argillization and propyltilization that, unlike silicification, did not contribute to the formation of toolstone; prehistoric use of bedrock units as toolstone is noted.

The bedrock stratigraphy at Tosawihi, depicted in Figure 20, includes the following units discussed from oldest to youngest:

1) Massive (no recognizable bedding), medium to dark gray, fine to medium-grained orthoquartzite (Ovq) of the Ordovician Valmy Formation in thin interbeds to 2m thick. The upper portion of the quartzite usually is fractured, brecciated, and resilicified, grading upwards to the overlying Tertiary/Ordovician fragmental unit (TOf). This unit is not exposed at the surface, but cobble sized clasts of similar rock are common in alluvial deposits of Velvet Canyon and often were used as hammerstones. Flaked stone artifacts made of quartzite are much less common; most notable is the base of a stemmed point found on the surface at Locality 72 in 26Ek3032.

2) Tertiary/Ordovician fragmental unit (TOf) up to 30 m thick, an angular quartzite breccia comprised of angular to subrounded clasts of quartzite in a matrix of tuff and small quartzite fragments. This unit marks the Ordovician-Tertiary disconformity, and is thought to derive from adjacent quartzite highlands. It is bedded indistinctly, and contains sand grains, clay, and iron oxides in addition to angular quartzite clasts, suggesting that it formed while exposed at the surface before deposition of the overlying volcanic rocks, when it may have undergone some pedogenisis. It does not outcrop at Tosawihi.

3) Lower Tuff (Tt1) a tufaceous unit up to 30 m thick, probably deposited as ash-flow; it does not outcrop at Tosawihi. The Lower Tuff is overlain by andesite or basaltic andesite (Tb).

4) Basaltic andesite (Tb) is apparently a local flow unit, outcropping on the southern slopes of Twin Buttes and Red Hill along Basalt Canyon, and forming the hills and ridges west of the Tosawihi Quarries. It consists of massive black rock (weathering to red), sparsely porphyritic to aphyric with rare phenocrysts of plagioclase feldspar. It tends to form platy outcrops at the present surface, but is more massive below. The platy basalt was used frequently for grinding stones and edging tools, while massive, rounded pieces were favored as quarrying hammerstones and occasional flaked stone items. A paleosol on the basalt is marked by red montmorillinite clay (giving Red Hill its name), grading upward to the overlying Upper Tuff (Ttu). Silicification of the paleosol and immediately overlying tuff produced brightly colored, jasper-like rock that was exploited as toolstone. The basalt pinches out to the northeast and does not outcrop in Velvet Canyon or elsewhere at Tosawihi north of the southern slopes of Twin Buttes and Red Hill.

5) Upper Tuff (Ttu) ranges from massive crystalline tuff to laminated and bioturbated tufaceous siltstone, both white to light pink in color, probably deposited in streams and shallow lakes. The Upper Tuff frequently has been altered completely to clays and contains beds of reworked tufaceous sediments, mudflow or ashflow deposits of quartzite conglomerate or breccia, and sandstone (Tts) that are generally silicified; it may be the source of quartzite clasts in fluvial deposits in Velvet Canyon. The origin of the quartzite is unknown, although size-sorting suggests a source to the east. The Upper Tuff is up to 40 m thick and contains sinter deposits and a near-surface cap (or caps) of massive replacement-type silica (both mapped as Ss), as well as localized contact silicification zones. This silicification created the predominantly opal and chalcedony Tosawihi "chert" or opalite, and formed the principal sources of toolstone. Imperfectly silicified tufaceous sandstones were used for small abrading tools such as shaft smoothers.

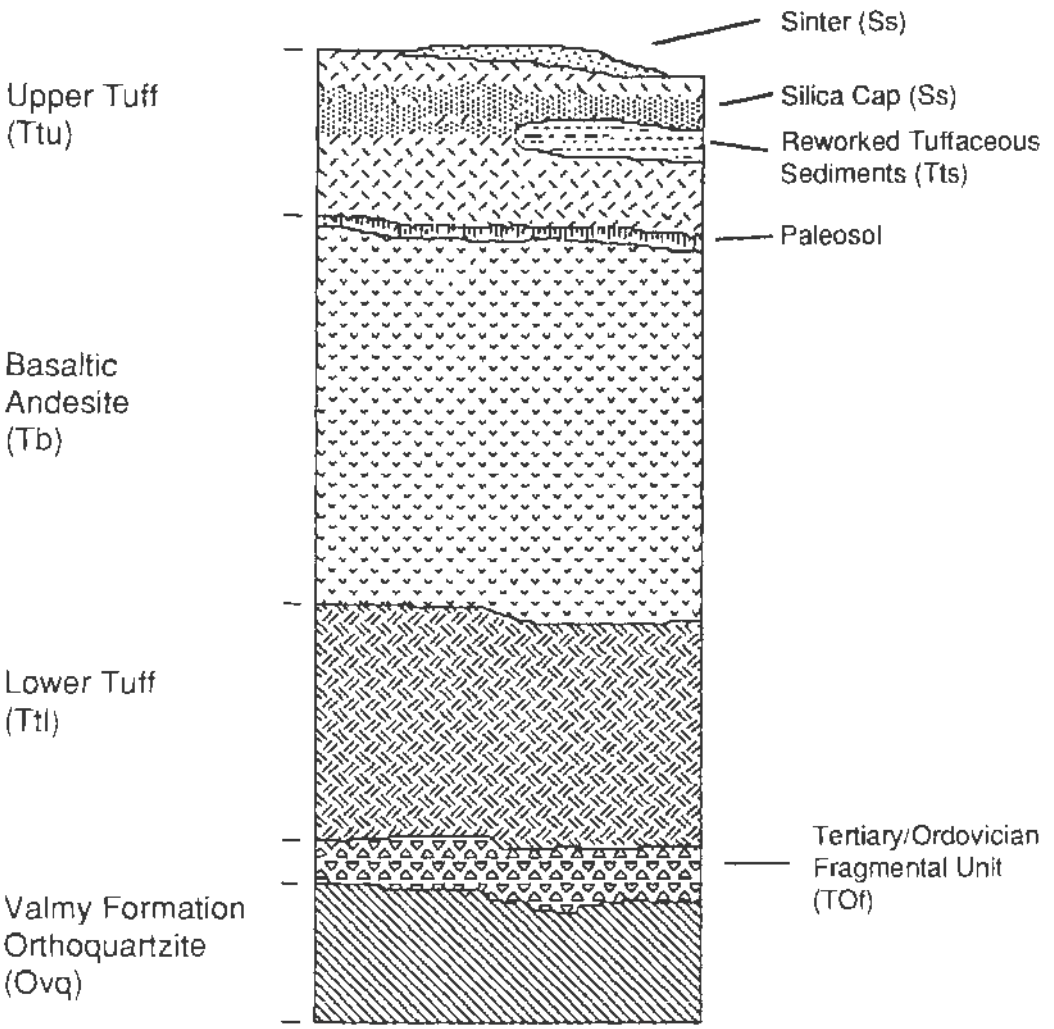


Figure 20. Tosawihi bedrock stratigraphy.

6) Flow banded rhyolite (TRb) overlies the Upper Tuff east of the Tosawihi Quarries, forming Owl Ridge. A similar unit, the Craig Rhyolite (Trc), constitutes the highland to the southeast of Tosawihi. Rhyolite was used for hammerstones and grinding implements.

Formation of Sinter and Opalite Toolstone at Tosawihi Quarries

Silicification occurs in all units of the Upper Tuff, including massive tuff, tufaceous siltstone, and reworked tufaceous sediments. The resulting cherty rocks, or opalite, occur mainly as large sinter deposits associated with vents and as stratified masses of replacement silica in tuff deposits (silica caps). Bartlett et al. (1991:21) suggest that sinter always occurs at or near the surface and that the silica caps always are found below the sinter near the lower tuff/basalt or lower tuff/upper tuff contact; recent geological mapping by Cornucopia Resources (1987), however, discloses a more complex situation. Sinter and replacement silica, both mapped as Ss, are shown as a more or less continuous band in cross sections, in most places a few meters below the surface. The description of a typical section on the map notes that surface sinter deposits are mostly eroded and relatively thin. Layers of tufaceous sediment (Tts), described as "generally silicified," are shown in various positions in the upper half of the Upper Tuff, both above and below sinter/replacement silica units.

Massive sinter deposits are up to several meters thick and are described as "finely laminated chalcedony with lesser amounts of opal, sparse to abundant interlayer cavities, layers of silicified sand and sediment with some mudcracks, and vuggy and brecciated chalcedony which contains clasts of laminated silica...[ranging in color]...from mostly white and light gray to tan, brown, red, blue and purple" (Bartlett et al. 1991:21). Although sinter often grades downward to the underlying silica cap, it also may overlie massive unsilicified crystalline or argillicized tuff abruptly, and frequently contains layers or stringers of this much softer material or of more brittle opal (cf. description of bedrock at 26Ek3208).

The emplacement of sinter often is a complex process. At Steamboat Hot Springs near Reno, Nevada, chalcedonic sinter similar to that from Tosawihi was formed in two stages (White et al. 1964:31-33). In the first stage, opaline sinter was deposited by precipitation of opal directly out of cooling thermal waters on the surface of broad discharge aprons. Opaline sinter typically is very friable when dry, but was preserved because of rapid burial by additional opaline sinter. In some cases, percolating thermal water then deposits additional opal and decreases porosity in the buried sinter to the extent that it is transformed into massive opal. At Steamboat Hot Springs, however, chalcedonic sinter was formed when percolating thermal water deposited chalcedony and quartz instead of opal, replacing opal already formed. At Tosawihi, the association of opal with chalcedony strongly suggests a similar process.

Massive layers of replacement silica, or opalite, at Tosawihi range in thickness from 3 to 35 m. Opalite is a term used by quicksilver miners and mineral collectors to refer to amorphous, cryptocrystalline rock that often hosts cinnabar, but otherwise is not more rigorously defined (Bailey and Phoenix 1944:17). Bartlett et al. (1991:21) describe this material at Tosawihi as "almost entirely composed of chalcedony with some veinlets and vug linings of drusy quartz...[its texture ranges from]...massive to extremely vuggy and brecciated; it typically shows well developed replacement features in the enclosing tuff." The association of opal with chalcedony observed frequently in these beds also implies a two-stage process, or perhaps thermal or chemical zones where different processes dominated.

According to Bartlett et al. (1991:21), the distribution and blanket-like structure of the replacement silica strongly suggest formation near the water table. Bailey and Phoenix (1944:20) believe that "blankets" of opalite replacement silica were formed when thermal waters percolated laterally through layers of porous tuff and replaced the pyroclastic glass with chalcedony. Some

support for the lateral circulation hypothesis is found in the general silicification of tufaceous sediments (Tts), even though they occur at various depths. These units must have been highly porous and therefore conducive to circulating thermal waters.

In practice, it is difficult to distinguish sinter from opalite, and we use the latter term throughout this report to refer to any of the massive chalcedonic rocks that occur at Tosawihi. All appear to have a similar range of quality, as well as similar knapping and heat-treatment properties; this is true even of the silicified tufaceous sediments with quartzite clasts.

Toolstone Occurrence

Erosion has removed overlying unaltered volcanic strata and cut into the beds of sinter and opalite. The silicified bedrock now lies near the surface, thinly mantled with colluvium or fully exposed in stream cuts and outcrops. Potential sources of toolstone include bedrock outcrops, thinly mantled bedrock, opalite talus deposits, and opalite clasts in colluvium and streambeds. Large (up to refrigerator size) relict opalite clasts deposited as Pliocene alluvium are found perched on the landscape as much as 30 meters above the present stream beds, and terraces of probable Pleistocene age containing large opalite boulders are found along Little Antelope Creek several kilometers south of Tosawihi. Bedrock was the preferred source of toolstone; colluvial and alluvial stone appears to have been procured only intermittently, with low-cost, expedient techniques. Presumably, quality of clast material is low enough that it was not worthwhile to exploit it in the vicinity of the quarries, except casually. We suspect, however, that use of streambed opalite increased with distance from the quarry.

Accessibility of bedrock opalite depended greatly on whether the bed was intersected by the surface. The three situations schematically depicted in Figure 21 are the most common, and quarriers were confronted with different sets of problems in each case (cf. Chapter 23).

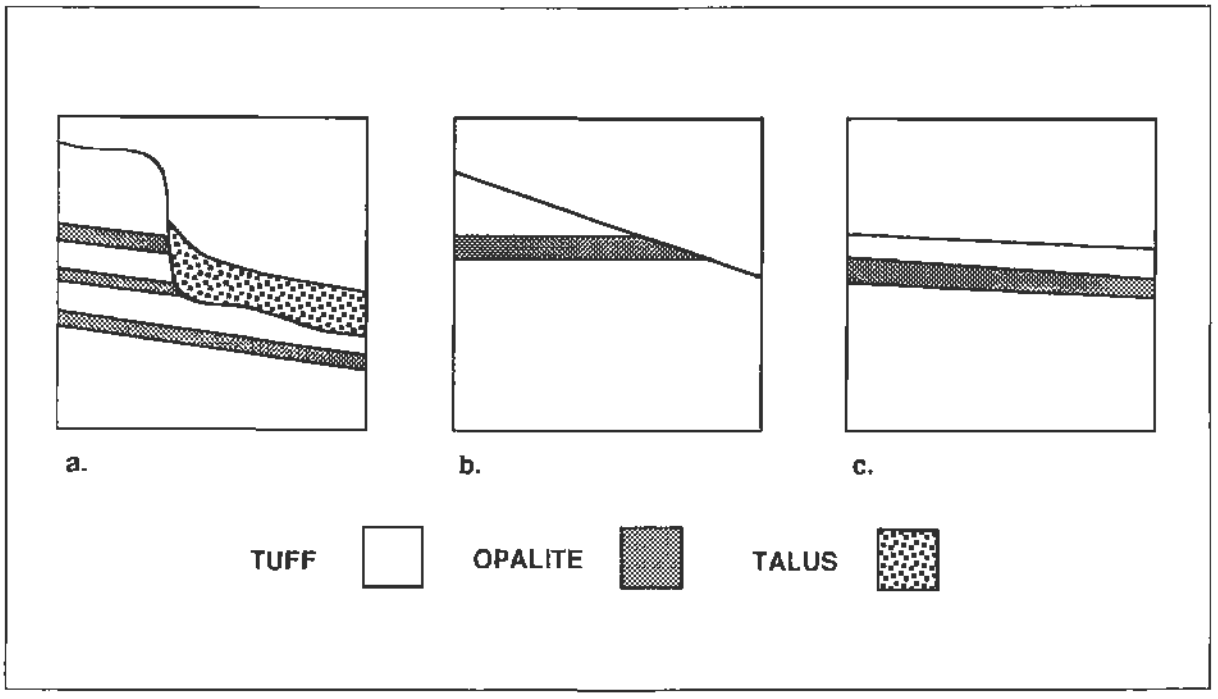


Figure 21. Opalite occurrence. a. surface outcrop; b. intersected by surface slope; c. parallel to surface.

Opalite exposed at the surface is exposed constantly to chemical weathering, winter freezing and thawing, summer heating and cooling, and wildfire. Material in outcrops is thus flawed by extensive cracks and spalls that can extend several centimeters into the stone from the surface. When struck with a hammerstone, such weathered opalite tends to break into small, angular, irregular pieces ("cuboids") and is useless as toolstone. Quarrying surface bedrock requires removal of the cracked and stressed outer material to expose less weathered stone. Only then can quarrying begin, entailing the breakup of the tough, massive inner rock.

One might expect intensive bedrock quarrying only under certain conditions that make the effort worthwhile: toolstone quality must be high, and it is helpful if geologic processes work fast enough to remove weathered rock as it is formed, or if the rock is somewhat protected from weathering on slightly overhanging faces or buried by colluvium. As our experiments show (cf. Chapter 26), quarrying massive opalite bedrock is difficult and costly. Large cracks in the rock provide means of ingress with hammerstones and wedges. Situations in which tuff and opal are interbedded with opalite are favorable as well, since the more easily excavated materials can be removed to isolate masses of opalite that then can be detached with percussion and fire (cf. Chapters 23 and 26).

The most intensive quarrying at Tosawihi occurred where erosion has exposed opalite bedrock in vertical or near vertical outcrops (such as Localities 82 and 30 in Velvet Canyon and its western tributaries), or in places (such as Locality 44) where knobs of opalite bedrock have been isolated by erosion and now are mantled thinly by colluvium and eolian accumulations. The extensive quarries on Butterscotch Ridge were excavated into a smooth slope lacking any protruding outcrops. The presence of opalite talus stripes, however, suggest that bedrock lies close to the surface; perhaps the slope of the ridge intersects several opalite beds in the manner of Figure 20b.

The zones of silicification noted in Chapter 3 (cf. Figure 13) merely reflect the *potential* occurrence of toolstone. Recent areal survey of the region surrounding Tosawihi Quarries (Leach and Botkin 1991) has shown that many of these zones contain opal or other material that is not toolstone quality. On the other hand, not all silicified rock has been mapped geologically, and our recent survey turned up several unmapped zones of silicification, including prehistoric opalite sources with quarry features or other evidence of exploitation.

Toolstone Types: Quality and Variation

The quality of opalite as toolstone varies on two axes: frequency of flaws (vugs and cracks) and degree of chalcedonic silicification. Among the least usable material at Tosawihi is opalite containing myriad tiny open and quartz crystal-filled vugs; it is impossible to flake, although it makes a good hard hammerstone. As previously described, weathered opalite frequently is too cracked and stressed to knap properly; other material contains hidden or partially healed cracks that cause failures during processing.

Although most opalite is "white," it exhibits a wide variety of colors, including opaque salmon pink (typical of the "Pink Pits" Localities 38, 39, and 48 in 26Ek3032), opaque to translucent yellows and tans (as on Butterscotch Ridge), and purple to red and white candy-striped material (as at Locality 159). Varieties of opalite appear to have similar flaking characteristics, however, and no special effort appears to have been made to procure toolstone of any particular color. High quality, fresh toolstone from 26Ek3208 is opaque white to slightly translucent, very pale (ice-like) blue or green, but the subtle colors change to more opaque gray in weathered material found in archaeological deposits. Light opalite exposed on the surface for a long period often acquires a light tan, biscuit-colored patina. Some opalite containing mercury is photosensitive and turns dark gray upon exposure to a few days of sunlight.

The toolstone we call *jasper* in this report was formed by silicification of a paleosol developed on basalt. At Locality 78 in 26Ek3032 and at 26Ek3084, this material exhibits a variety of earth colors (red, yellow, brown), purple, and, where the overlying tuff also was involved, brighter pink, red, and yellow with stripes or spots (as at Locality 19). This material requires a somewhat higher heat-treatment temperature than opalite, is more brittle, and does not produce as sharp an edge.

Opal typically is opaque but shiny, and is quite brittle, tending to fracture into cuboids when struck. Opal often can be flaked by gentler methods, but it contains water and sooner or later dehydrates and falls apart.

Patches of green to brown, subangular chert pebbles and small cobbles occur here and there throughout Tosawihi Quarries and Big Butte Valley. Their origin is unknown, but perhaps they are a lag derived from erosion of once overlying rhyolite bedrock. We have observed prehistoric use of this material only for hammerstones. Small (pea to tennis ball sized), chalcedony-filled geodes are also found in Big Butte Valley. No evidence for prehistoric use of this material except for hammerstones presently is known. Jade-green chert of good quality associated with a large rhyolite outcrop near the confluence of Ivanhoe and Willow Creeks occurs in angular chunks up to five centimeters maximum dimension, but we have seen no evidence for its use; ultraviolet fluorescence suggests that this is not the source of jade-green chert debitage observed in a few samples from 26Ek3170.

Distinguishing Tosawihi Opalite From Other Toolstones

Tosawihi opalite shares many gross physical characteristics with chert and chalcedonic toolstones from other sources, yet study of the economic geography of Tosawihi opalite (cf. Chapter 4) depends on the ability to distinguish it from other toolstones. The following sections summarize findings of ultraviolet fluorescence and neutron activation analyses.

Ultraviolet Fluorescence

Geologists and mineralogists have long known that certain minerals fluoresce when stimulated by ultraviolet light (Raytech Industries 1965). Not visible to humans, ultraviolet (UV) light interacts with atoms in the fluorescent material, changing the energy in the electron shells of atoms and causing them to emit photons in the visible spectrum. The color of the fluorescence depends on the chemical composition of the mineral, and, to a lesser degree, on the wave length of the UV radiation. Compared to daylight or ambient artificial light, the stimulated fluorescent light is faint, and must be viewed in darkness.

Distinguishing toolstones from different sources by their behavior under UV light was recently pioneered by Hofman et al. (1991), who were able to distinguish Knife River Flint, Edwards Plateau Chert, and toolstone from the Alibates source in Paleoindian lithic assemblages from the Great Plains. We applied the same methods to analysis of all "cherty" bifaces and projectile points recovered from testing and data recovery at Tosawihi, as well as to rock specimens from 62 quarry localities well-distributed throughout Tosawihi Quarries. In addition, we examined control samples of chalcedonic toolstones from Susie Creek and Elko Hills between Carlin and Elko, Nevada (Elston and Budy 1990), a sample from Sulphur on the southern margin of the Black Rock Desert (Elston 1986d), and several other less well-provenienced specimens from various Nevada locations.

A Raytech Model LS-88CB UV lamp that can be switched between long (3500 angstrom units) and short (2600 angstrom units) wavelength light, or can provide both simultaneously,

was used as an ultraviolet light source. Uniform viewing conditions were provided by use of a Raytech Viewbox in a darkened room. The specimens were placed in the box, illuminated by the UV lamp through an aperture, and viewed through a separate port.

Our findings from UV screening are simple: all *opalite* samples from Tosawihi localities fluoresce green no matter what their color in visible light. Freshly-broken Tosawihi opalite fluoresces green under shortwave UV, probably due to its uranium content (Raytech Industries 1965:47-48). Under long wavelength UV, Tosawihi opalite is a dark, velvety purple. The value and chroma of the green fluorescence fades over time in specimens exposed on the surface, probably as a reaction to sunlight and perhaps other weathering processes. In weathering on the surface, objects develop peach colored to purplish blotches, eventually achieving a strange, dull rosy purple (DRP). Many specimens thus fluoresce bright green on one face, DRP on the other. The purplish patches seen in UV are often biscuit color in visible light. In other specimens, DRP prevails except for spots or lines of green in chalcedony-filled vugs and veins. Some specimens, DRP in the bottom of the viewing box about 10 cm from the UV source, glow green when held closer to the light. Jaspers from Locality 78 and 26Ek3084 do not fluoresce, but chalcedony-filled veins or vugs glow green. Generally opaque materials either do not fluoresce or do so less brightly than translucent varieties of opalite. Graying under visible light due to mercury photosensitivity, however, has no effect on fluorescence, nor does heat-treatment, with the exception noted below.

No non-Tosawihi control specimens fluoresce green. The specimen from Sulphur, a translucent white chalcedony, is bluish white under shortwave UV, and retains an afterglow for a few seconds. All other controls either are non-fluorescent (including the jade-green chert from Ivanhoe Creek) or fluoresce in the gold-yellow-orange range. Using the criterion of green fluorescence, all archaeological bifaces recovered are made of Tosawihi opalite, but (as we might expect) many projectile points are not.

In examining archaeological specimens from Tosawihi under shortwave UV, I noticed one specimen fluorescing bright orange on the surface with a green core or interior visible through a break. Under long wavelength UV, the exterior remained orange, but the core turned dark purple. Eventually, I discovered several other specimens that fluoresced green with orange patches under shortwave UV and purple with orange patches under long wavelength UV. I noticed that on these specimens, the orange patch was associated with a relict pre-heat-treated surface or a surface created by post heat-treatment flaking. In all cases, the relict heat-treated surface is slightly grayer than post heat-treatment surfaces.

In the specimen with a green core, the orange material forms a rind between 0.5 and 1.0 mm thick, suggesting that some chemical process changed the UV fluorescence characteristics of the material penetrated from the surface inward; this seemed a possible *result* of heat-treatment.

A sample of Tosawihi opalite deliberately over-cooked in heat-treatment experiments acquired a dark gray surface resembling "smoke stain." Under short wavelength UV this dark exterior surface is dull orange, while the interior is dull green with bright green spots. Under long wave length UV the exterior is brighter orange and the interior dark purple. The alteration producing the orange color has penetrated to a depth of about 1 mm. The dark gray surfaces of the experimental and archaeological specimens suggest the deposition of carbon in a reducing atmosphere, a common environment in a heat-treating hearth. Perhaps carbon has diffused inward from the surface, or perhaps oxygen has been removed. Chemical analysis will be required to identify the actual process.

UV screening offers a fast, inexpensive means of identifying Tosawihi opalite in samples of lithic artifacts. Continuing efforts should be made to collect documented toolstone samples from other sources and subject them to UV for comparison. So long as the green-orange distinction between Tosawihi opalite and other toolstones holds up, UV analysis can be applied to address source material fall-off rates and other problems of economic geography.

Neutron Activation

Neutron activation is a technique of trace element analysis (Tite 1972). A specimen is irradiated with neutrons, exciting atomic nuclei of elements that are transformed into unstable radioactive isotopes which then decay, emitting gamma rays. Gamma ray energy and intensity provide identification of constituent elements and their concentration in the specimen to parts per billion. Because of its great sensitivity and accuracy, neutron activation is the preferred technique for trace element analysis of cryptocrystalline toolstone (Luedtke 1978; Luedtke and Meyers 1984).

The basic problem of any chemical analysis striving to distinguish toolstone sources is that variation within a single source may be greater than variation between sources. Our hope was that since Tosawihi opalite had been created by localized hydrothermal activity, its chemistry would reflect constituents of the local heat source and local bedrock mineralogy. We also hoped, though more faintly, that local toolstone sources *within* the Tosawihi Quarries could be distinguished on the basis of trace element chemistry.

As a pilot study, a suite of twenty-one samples was analyzed by Michael D. Glascock of the University of Missouri Research Reactor Facility. The samples were divided into seven groups of three (Table 2). Each of six groups were from different sources within the Tosawihi Quarries and peripheral areas studied in this report. Five were typical white to pink opalite; the sixth group was jasper. The seventh group contained samples from Steamboat Hot Springs (near Reno), Sulphur (southern Black Rock Desert), and Elko Hills (southwest of Elko).

Table 2. Toolstone Samples Submitted for Neutron Activation Analysis.

Sample Group	Sample No.	Locality	Tosawihi Neighborhood or Other Provenience
1	IMRNA 1	26Ek3032, Locality 38	Pink Pits
1	IMRNA 2	26Ek3032, Locality 39	Pink Pits
1	IMRNA 3	26Ek3032, Locality 38	Pink Pits
2	IMRNA 4	26Ek3032, Locality 188	Butterscotch Ridge
2	IMRNA 5	26Ek3032, Locality 188	Butterscotch Ridge
2	IMRNA 6	26Ek3032, Locality 188	Butterscotch Ridge
3	IMRNA 7	26Ek3208, Jasper Quarry	Red Hill
3	IMRNA 8	26Ek3208, Jasper Quarry	Red Hill
3	IMRNA 9	26Ek3208, Jasper Quarry	Red Hill
4	IMRNA 7	26Ek3084	Red Hill
4	IMRNA 8	26Ek3084	Red Hill
4	IMRNA 9	26Ek3084	Red Hill
5	IMRNA 10	26EK3200	Corral Fan
5	IMRNA 11	26EK3200	Corral Fan
5	IMRNA 12	26EK3200	Corral Fan
6	IMRNA 13	26EK3196	Undine Gorge
6	IMRNA 14	26EK3196	Undine Gorge
6	IMRNA 15	26EK3196	Undine Gorge
7	IMRNA 16		Sulphur, Nevada
7	IMRNA 17		Elko Hills, Nevada
7	IMRNA 18		Steamboat Hot Springs, Nevada

Details of the neutron activation analysis are given in Appendix A. Statistical analyses performed by Glascock and his associates used log-transformed values for the eight most discriminating of 30 elements measured (Eu, Cs, Fe, Hf, Sb, Sc, Ta, and Tb). Analyses included bivariate plots, canonical discriminant analysis, and cluster analysis. Discriminant analysis failed to provide much separation of the samples, but cluster analysis (using log-transformed values and average linkage) correctly linked all sample sets except those from Butterscotch Ridge. The greatest distances are observed among three groups of groups: all non-Tosawihi samples, the non-opalite samples from 26Ek3208, and all other Tosawihi samples.

These results seem promising, and warrant further study with larger samples. The possibility of discriminating even a few Tosawihi localities offers the possibility of linking exploitation of particular quarry localities with particular workshop and residential sites.

Chapter 6

BIFACES

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Biface production is the major lithic reduction activity evident at the Tosawihi Quarries, and the focus of most prehistoric human activity in the Tosawihi vicinity. The following analysis attempts to identify the kinds of bifaces produced at Tosawihi and to understand how their production was organized. The analytical database consists of 4,388 whole, incomplete, and fragmentary bifaces collected during survey, testing, and data recovery exercises.

From a general consideration of bifaces, we move to discussion of the research questions, methods, and interpretive models employed in the Tosawihi study. Results of the analysis follow, looking first to the technology of biface production at Tosawihi, then to spatial variation in biface production and biface caches. We conclude with a synopsis of analytical results as they relate to research issues.

Biface Analysis

Bifaces are a major tool class in North American chipped stone assemblages, and their forms and functions, and the technologies that produced them, have received considerable research attention. Paleoindian biface production has been studied extensively (Callahan 1979; Crabtree 1966; Flenniken 1978; Frison 1978; Frison and Bradley 1980; Frison and Stanford 1982), and a century-long inquiry into biface production technology began with Holmes' (1897, 1919) research at the Piney Branch Quarries. Biface analyses have been used to replicate technology (Callahan 1979; Crabtree 1966; Johnson 1981), to determine site function (Pippin and Hattori 1980; Thomas 1983a; Zerga and Elston 1990), to indicate reduction trajectories (Muto 1971a, 1971b; Sampson 1985; Flenniken and Ozbun 1988), to delineate mobility patterns (Goodyear 1985; Sassaman, Hanson and Charles 1988), and to define adaptive strategies (Kelly 1988).

In general, biface studies variously investigate form, technology, function, and context. Analysis of form can reveal spatial or temporal variability in technology, but some forms, especially those representing unfinished pieces, are produced within generalized technologies that persist over large areas and through long periods of time.

Analysis of technology examines the process whereby bifaces are produced, and can characterize production stages at particular loci. Such characterization then can be used to examine the organization of production. Moreover, detailed analyses of particular production techniques can aid identification of local groups of craft specialists, or, in unusual cases, of individual knappers. Investigation of the incidence and nature of technological failures can be used to examine limitations of raw material or the presence of specialist knappers. Estimates of levels of production effort and of heat-treatment contribute to evaluation of biface technology.

Biface functions can be examined at a variety of levels. Bifaces may function as cores or as bifacial tools, or as a combination of the two, in any particular assemblage. Finished artifacts can be examined for traces of use. In combination with estimates of breakage rates among stages of manufacture, the proportions of production stages can inform questions of site function and export form.

Because biface production is a reductive process, it is not possible to reconstruct production sequences in detail unless pieces rejected during manufacture are present in an assemblage. Fragmentary bifaces, however, often are common in archaeological assemblages; numerous studies have focused on analytical methods for interpreting fragments within the contexts of production techniques (e.g., Johnson 1981) and reduction stage (e.g., Amick 1985). Although fragmentary specimens lack the full set of attributes desirable for analytical purposes, they usually retain flake scar patterns and morphological clues as well as at least partial dimensional attributes. These are useful for calculating thinning indices, inferring reduction stage, placing specimens within production sequences, and determining the place of heat-treatment within the reduction sequence. However, one problem with using biface fragments as indicators of production technique is that they most often are the pieces that failed or were rejected for other reasons. In the latter case, reconstruction of intended form through analysis of fragments is susceptible to spurious conclusions; in most assemblages, however, breakage is the most common reason for rejection.

The nature of archaeological deposition inhibits biface analysis to some extent. In most cases, material enters the archaeological record as discarded items, but the locations of manufacture, use, and discard need not correspond. So, determination of production technology, use history, or discard behavior in any given archaeological context (a site, a feature, an excavation level) is subject to interpretive bias.

For these reasons, most biface analyses are undertaken in conjunction with other studies. Debitage, for example, provides a useful adjunct data class; since debitage assemblages often contain flakes from bifaces that left the archaeological locus (Frison 1967; Yerkes 1987). Thus, the biface studies discussed here have been undertaken in concert with analyses of other chipped stone artifact classes from Tosawihi.

Since biface technology is reductive, biface production occurs on a continuum of endeavor and results in a continuum of form. Biface production proceeds from an initial unaltered blank form, whether flake, cobble, or block, to formed artifact. Some researchers invoke continuous variables to document the place of a biface along the continuum, such as width to thickness ratios or mass to area ratios (Johnson 1981; Sassaman 1988; Amick 1985). Such techniques have the advantage of being objective and thus replicable, but they can suffer from dependence on maximum (not overall) dimensions, from inability to account for variation in original blank form, and from arbitrary division of the production continuum. Experimental flintknapping has shown that the reduction continuum can be divided into analytical units. Sometimes such divisions are arbitrary, but they often correspond to changes in knapping techniques or to approaches to strategic knapping problems (Young and Bonnichsen 1984; Callahan 1979; Crabtree 1972; Patten 1980). Attributes unique to these segments on the production continuum allow bifaces to be assigned to technological production categories or stages. Combinations of attributes generally include width to thickness indices, shape of cross-section, and extent of reduction (as suggested by flake scar patterning). The subjectivity of such schemes has been criticized, but they offer the flexibility to assign varying weights to attributes; we adopt them here precisely for these reasons.

Research Questions

A fundamental question asks what biface forms were produced at Tosawihi. Although it is obvious immediately to the Tosawihi visitor that bifaces were a product of quarrying, it is necessary to examine their forms in order to determine their production and transport costs and to address their potential uses as tools and cores. A related topic focuses on consistency of biface size and shape. Were bifaces produced at Tosawihi standardized in size or shape? Did standards change through time? Standardization of size or shape during a particular period of time suggests relatively regular, predictable uses for bifaces in the mobility system (Kelly 1988;

Parry and Kelly 1987). Perhaps specialized production for exchange or for a regular pattern of tool use by the quarriers themselves is indicated (cf. Chapter 4).

The techniques and knapping options employed by Tosawihi knappers engaged in biface production demand understanding, as does their use in any particular time period. Bifaces serve as cores or as tools; understanding how Tosawihi bifaces were produced should clarify the reasons for their production. If they functioned as tools *at* Tosawihi, some specimens should show traces of use wear. If they functioned primarily as tools *away from the quarry area*, then reduction techniques should show purposeful shaping of the core to regularize its shape. On other hand, if Tosawihi bifaces are an incidental result of successive flake removals from cores (so that they are byproducts and flakes products), then the reduction sequence should reflect opportunistic flake removals and the size of exported bifaces should be large enough to provide blanks for tool manufacture. Thus, our analyses seek to determine the technology and sequence of biface production.

Biface production requires an estimable labor investment. Prehistoric flintknappers may have selected production techniques to minimize labor costs. Costs may differ, for example, depending on the nature of the toolstone: tabular cobbles may require little reduction to produce bifaces when compared to large blocky cores. By examining where different production techniques were used (e.g., near or away from toolstone sources), we may begin to assess whether variation in production is related to transport costs, to toolstone occurrence, and to other activities. We also wish to know if bifaces were produced for local use and, if so, to identify those uses.

In sum, the research questions addressed through the Tosawihi biface study are intended to elucidate toolstone procurement patterns. As discussed earlier (cf. Chapter 4), these patterns can be linked to forager mobility strategies. Our ability to discern procurement patterns depends on data the availability of which is a function of the analytical methods we employed.

Methods, Models, and Techniques

The Tosawihi biface analysis began with consideration of methods and techniques. Although general trends of biface production were evident from examination of the collections, we wondered how best to determine systematically the ways bifaces were produced. It was clear from the outset that replication experiments could provide insight into appropriate analytical techniques, as well as providing a controlled database from which to develop and test such techniques. Thus, our analyses began with replications of Tosawihi bifaces.

The replication program began informally during fieldwork. There is no lack of raw material at Tosawihi, so the pastime of flintknapping became a favorite after-shift activity. Some of the products were saved, and, as they frequently became reference sources for discussion of the archaeological bifaces, a more formal replication program was initiated. The replications were used primarily for interpreting debitage recovered in the course of the project, but also provided data for use in biface analysis. Causes of manufacturing failure, recognition of mode of production, and variation in blank type were investigated.

The high incidence and wide distribution of heat-treated bifaces and other tools, as well as heat-treated debitage, indicated that heat-treatment of toolstone was a common practice at Tosawihi. Heat-treated toolstone is relatively common in North America (e.g., Holmes 1919), and its study suggests that each toolstone source requires unique treatment procedures to achieve the benefits of increased compliance and predictability. In order to recognize heat-treated Tosawihi opalite better, understand the effects of heat-treatment on the flaking qualities of the opalite, and infer the level of effort involved in heat-treatment, we initiated the heat-treatment experiments discussed in Chapter 26.

Experimental flintknapping and heat-treatment continued over the course of biface analysis. Archaeological biface data collection occurred during two separate periods of laboratory work, associated first with testing and then data recovery phases of the project. Results of the first biface analysis, and the experimental program, led to refinement of subsequent archaeological data collection. Thus, some attributes recorded for second phase analysis were not observed on first phase bifaces. Limitations of this sort are noted in the following discussions when they are germane. The following description of attributes recorded refers to the most evolved attribute set.

How (and even *if*) bifaces were used at Tosawihi is an issue central to this study. Because bifaces generally are regarded as multipurpose cutting and occasionally scraping tools, limited experiments using hafted and unhafted bifaces replicated wear traces caused by cutting and scraping meat, hide, and bone. Wear traces on experimental bifaces then were compared to traces on the archaeological specimens most likely to have been used. Procedures for this work follow those for the functional analysis of flake tools described in Chapter 7.

Biface Attributes

Recorded biface attributes are described below and the data recording form we used appears as Figure 22.

Provenience

Site, locality, reference, and specimen numbers constitute provenience data in the artifact database. Refitted fragments were recorded as single pieces and were given special specimen numbers.

Metric information

Dimensions were recorded in millimeters for maximum length (along the axis of the blank when this could be determined), maximum width perpendicular to the axis, and maximum thickness. Weight was recorded to the nearest tenth of a gram.

Raw Material

Tosawihi opalite occurs in a variety of textures, qualities, and colors. Most specimens were designated non-specific "opalite," but we distinguished three specific combinations of attributes, designating them "chalcedony," "jasper," and "opal." Opalite most often is opaque, colored cream, white, or grey; most other colors occur less frequently. It is quite hard and flakes very well. It is worked most easily when heat-treated, when it has the characteristic waxy look and feel of other heat-treated silicious materials. Chalcedony is semi-translucent and amorphous, has excellent flaking characteristics, and usually is white, occasionally with a pink, yellow, or green tint. Jasper is brittler and softer, in dark, dull shades of red, purple, yellow, and brown, often mottled. This material resembles opalite, but it seems to heat-treat at

BIFACE ANALYSIS RECORDING FORM (638-1989) CLASS=7 TYPE=____(SEE VAR. #14)

1. SITE NO _____ 2. LOCALITY NO ___ 3. REFERENCE NO _____ 4. SPECIMEN NO ___

AREA _____ UNIT _____ FEATURE _____ LEVEL _____

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5. LENGTH _____
6. WIDTH _____
7. THICKNESS _____
8. WEIGHT_____

9. MATERIAL COLOR

1. White	5. Black	9. Blue/Pink
2. Beige	6. Grey	10. Pink
3. Yellow	7. Purple	11. Red
4. Brown	8. Blue	12. Green

10. MATERIAL TYPE

1. Opalite	5. Jasper
2. Obsidian	6. "Opal"
3. Basalt	7. Other
4. "Chalcedony"	

11. MATERIAL QUALITY
1. Excellent
2. Good
3. Poor

12. CORTEX
1. Present
2. Minimal
3. Absent

13. BLANK TYPE
1. Flake
2. Cobble
3. Indeterminate

14. TRAJECTORY

1. Quarry	4. Indeterminate
3. Small Biface	5. Possible Biface Trajectory

15. SMALL BIFACE OUTLINE

1. N/A	5. Sq.-Based
2. Lanceolate	6. Elongate
3. Oval	7. Irregular
4. Triangular	8. Indeterminate

16. SMALL BIFACE HAFTING ELEMENT

1. N/A	5. Edge Grinding
2. Notch(es)	6. Absent
3. Sq. Base	7. Multiple
4. Cont. End	8. Possible

17. REDUCTION STAGE

10. Blank	35. Mid 3	
2. Indet 2	39. Late 3	
20. Early 2	4. Indet 4	
25. Late 2	40. Early 4	
3. Indet 3	45. Late 4	
30. Early 3	50. 5	
	60. Indet Stage	

18. FRAGMENT TYPE

1. Complete	7. Prox. missing
2. Proximal	8. Dist missing
3. Distal	9. End missing
4. End	10. Edge Collapse
5. Medial	11. Outrepassé flake
6. Lateral	12. Other
	13. Indeterminate

19. MANUFACTURE FAILURE

1. None	8. Cone
2. Lat hinge	9. Edge Collapse
3. Long hng.	10. Perverse
4. Out., end	11. Bending
5. Out., lat	12. Thermal
6. Frac plane	13. Multiple
7. Mat. flaw	14. Indeterminate

20. THERMAL ALTERATION
1. Blank from HT Core
2. HT Blank
3. HT during Reduction
4. Therm. altered post-manuf.
5. Possibly Altered
6. Not Thermally Altered
7. HT Stage Indeterminate

Figure 22. Biface recording form.

a slightly higher temperature. Opal often is quite shiny, less dense, and softer than other opalites. Obsidian, basalt, and a few other unusual materials also are present in the assemblage in small proportions.

Twelve material colors were recorded based on field and laboratory observations. The color of Tosawihi toolstone varies from source to source and often within source. We recorded only very general color categories. During analysis, color designations were combined to form an index of color diversity, contrasting white and non-white groups of artifacts. The frequencies of white, beige, and grey specimens were divided by the total in order to yield a relative measure of color diversity.

Similarly, material quality was recorded only in general terms. Obsidian and chalcedony quality usually was designated "excellent" while other materials seldom received that designation. Very little material was considered to be "poor."

Cortex is uncommon on pieces of Tosawihi raw material because weathered cortical surfaces are rare in the bedrock quarry sources. Stream-rolled cobbles account for almost all cortex recorded on opalite pieces. More common on basalt and obsidian, cortex was recorded as present, minimal, or absent.

Blank Type

Blank type describes the general morphology of the specimen on which biface reduction was initiated. *Flake Blanks* exhibit the traditional attributes of lithic reduction flakes, i.e., points and cones of percussion, compression rings, and often feathered terminations. Flake blanks are exclusive of primary or secondary flakes with cobble cortex. *Cobble Blanks* are alluvial or colluvial cobbles, or primary or secondary flakes derived therefrom, with weathered or incipient cone cortex. Cobble cortex is the key defining attribute. *Indeterminate Blanks* are specimens reduced beyond the point where original surfaces are visible.

Trajectory

Discrimination of trajectory responded to an observed dichotomy between large bifaces produced from relatively large quarried flake blanks and small bifaces made on small flake blanks. The latter may have been produced during the reduction of large bifaces; if so, large bifaces may have functioned as cores for the production of small bifaces. Trajectory was recorded to test this dichotomy; the determination was largely subjective, without standardized dimensional measures, but we observed four discriminations:

Large ("Quarry") Trajectory: larger-than-palm-sized specimens with proportionately large widths and thicknesses.

Small Trajectory: smaller-than-palm-sized specimens with proportionately small widths and thicknesses.

Indeterminate Trajectory: overall size intermediate between large and small trajectories; also fragmentary specimens.

Possible Biface Trajectory (recorded only during second phase biface study, so pertaining only to approximately half the assemblage): specimens exhibiting bifacial modification, but so minimally that a definite biface classification is not justified. Morphologically, most are intermediate between cores (or modified chunks) and bifaces, but more closely resemble bifaces.

Small Biface Outline

Outline planar shape was recorded for small bifaces. Outline variants include *Lanceolate, Oval, Triangular, Square Based, Elongate, Irregular, Indeterminate, and Not applicable (NA).*

Small Biface Hafting Element

Hafting modifications at the proximal/hafted end of the biface were described. Variants include *Notches, Square Base, Contracting End, Edge Grinding, Absent, Multiple, Possible, and Not applicable (NA).*

Reduction Stage

Experimental flintknapping and examination of the archaeological assemblage indicated that a stage model could classify Tosawihi bifaces reliably. Biface stages employed here generally follow Callahan's (1979) definitions for Stages 1 through 5 and are applied to all specimens. Where attributes indicated that a reduction stage had been initiated, the specimen in question was classified to that stage. Callahan's scheme is defined primarily by flake scar pattern, so became the most important observation in determining stage (Figure 23). Generally, flake scar patterns indicate whether primary or secondary thinning has been initiated. Flake scar pattern also is observable on fragmentary specimens, so they, too, can be assigned to stage. Width to thickness ratio and shape of cross-section were secondary considerations, affecting stage determination when specimens that were reduced less than most Stage 3 bifaces, but had been made on thin flake blanks, were assigned to Stage 3. Another secondary observation was the regularity of edge morphology and proportional symmetry of specimens. In spite of the numerous variables defining biface stages, there is considerable variation among specimens within each stage; Figure 24 illustrates the range of sizes and flaking patterns among Stage 3 bifaces. For this reason, we have subdivided Callahan's Stages 2, 3, and 4.

Blanks are Stage 1 bifaces, flakes removed from bedrock outcrops, cores, or bifaces which show no reduction modification. Our ability to recognize them as biface blanks is constrained by our ability to recognize them as having been "selected." That observation follows only from context and is limited to large flake blanks. Thus, large non-reduced flakes recovered away from quarry and core reduction activity, away from the reduction of very large bifaces, essentially out of contexts within which they could have been produced, are considered to have been selected and transported for the purpose of biface production.

Edge Prepared bifaces are Stage 2 bifaces. In this stage, biface blanks are reduced to produce a scalloped bifacial edge. Most of the reduction occurs near the edge, with no attempt to begin the thinning process. Edge preparation creates an edge suitable for platform preparation during primary thinning, and begins to shape the blank into a generally ovate form. A large amount of toolstone mass and irregularities often are removed during this process. This stage has been sub-divided into early and late.

Primary Thinning is Stage 3 biface reduction. This reduction thins the specimen by removing flakes to or slightly across its longitudinal center. Symmetrical shaping and edge straightening is begun as well. Stage 3 reduction results in a symmetrically shaped and lenticular biface, ready for further thinning or immediate use. This stage has been divided into early, middle and late.

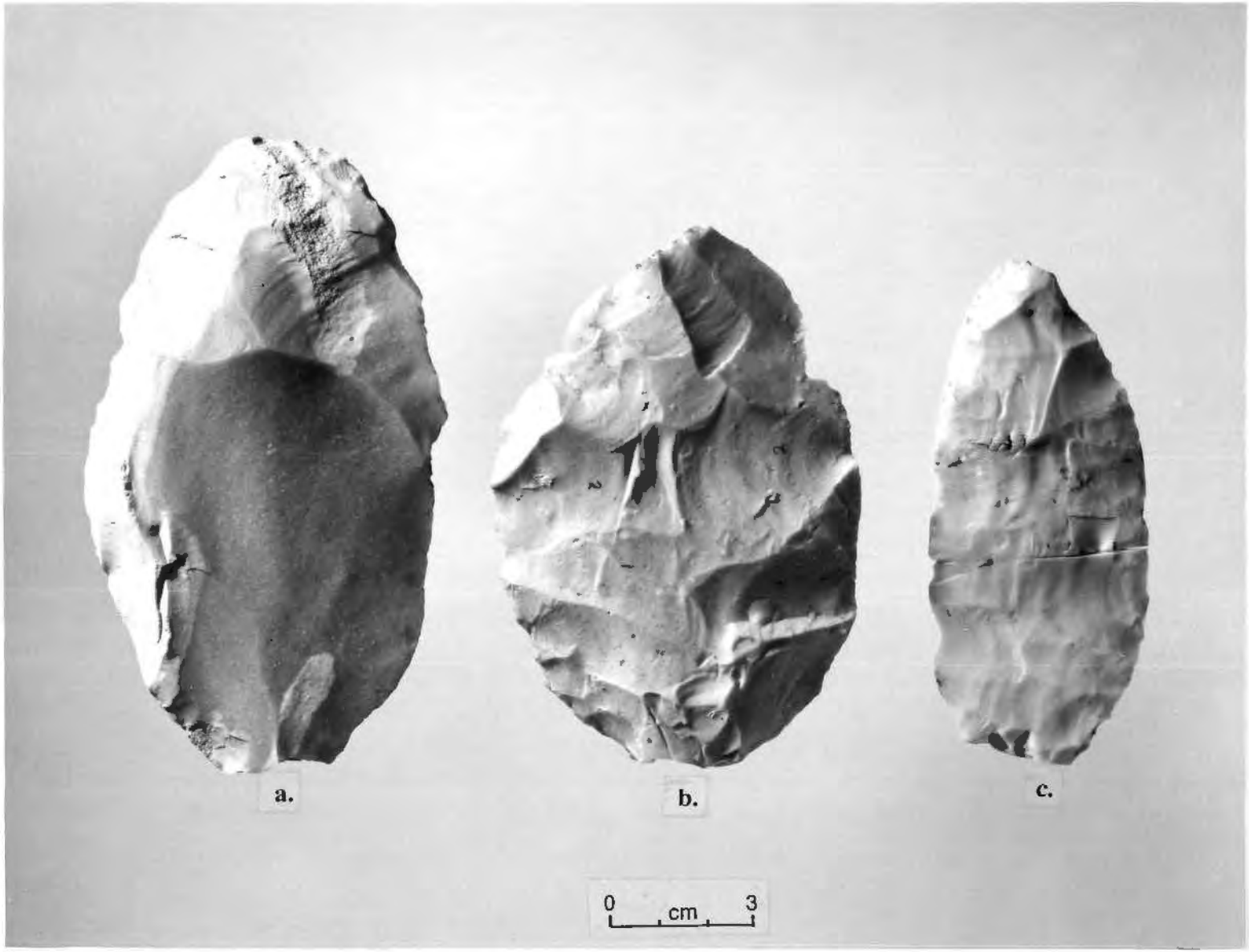


Figure 23. Biface stages according to Callahan's Staging Scheme. a. Stage 2 biface; b. Stage 3 biface; c. Stage 4 biface.

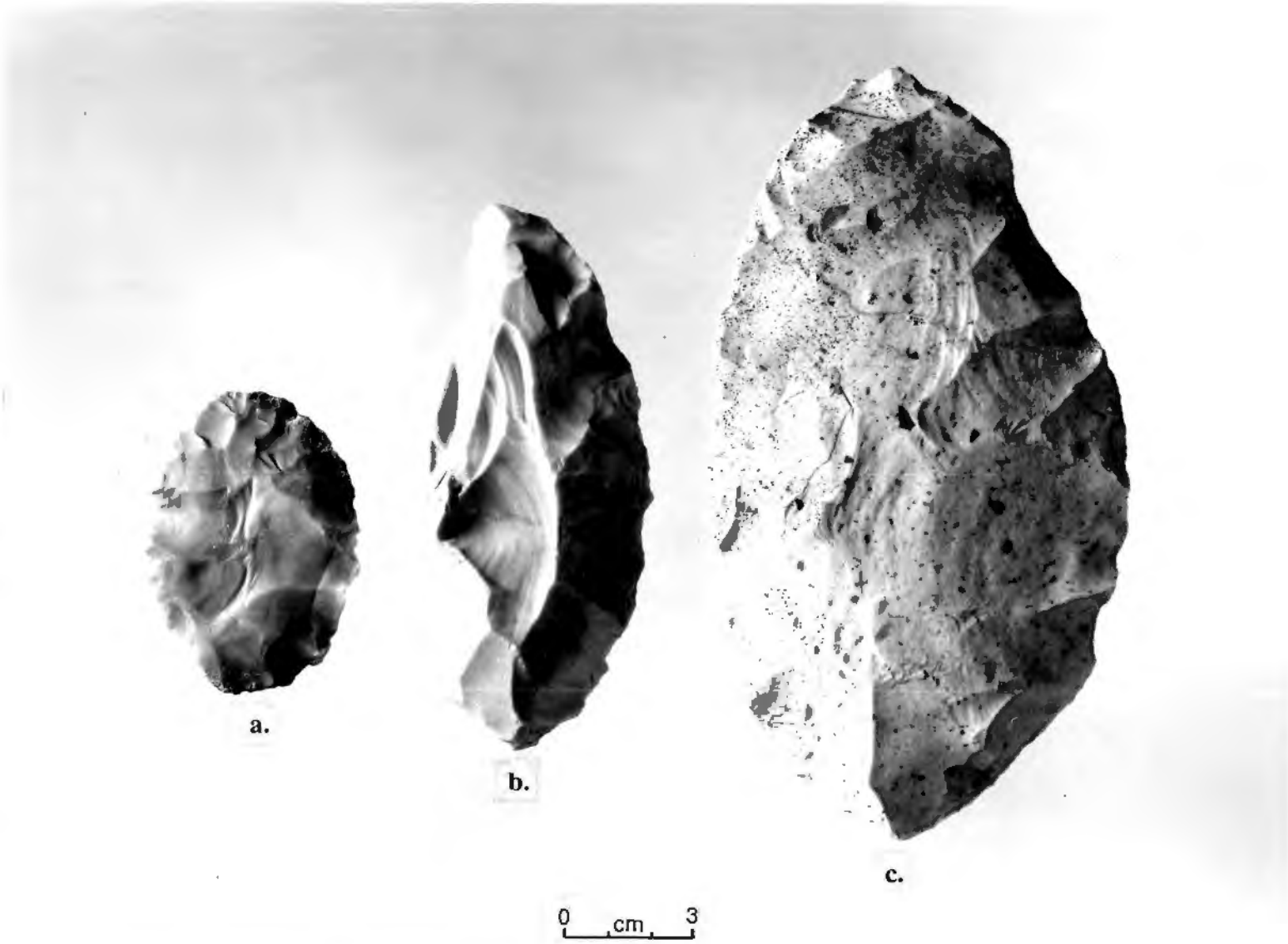


Figure 24. Variation among Stage 3 bifaces.

Secondary Thinning is Stage 4 reduction; it serves to flatten the lenticular cross-section of the biface, further straighten the edge, and improve symmetry. Stage 4 negative flake scars often cross the longitudinal center of the specimen to flatten the central ridge. This stage has been divided into early and late.

Shaping refers to a Stage 5 biface. A Stage 5 biface is essentially at the end of the biface production trajectory, but at a point where it is not modified in any way that allows specific functional classification. Final shaping may be executed by pressure or percussion, but may only refine the symmetry of the pointed ovate.

Indeterminate stage indicates that the reduction stage cannot be classified with confidence; bifaces in this class are primarily small fragments.

Fragment Type

We recorded fragment types as reflections of the completeness of specimens and as guides to the morphology of breakage. Analytically, *Proximal Missing*, *Distal Missing*, and *End Missing* are considered nearly complete specimens, while all other designators, save *Complete*, refer to fragments. The latter include *Proximal End*, *Distal End*, *End* (when orientation is not possible), *Medial*, *Lateral*, *Other* (designates a type not listed), and *Indeterminate* (usually a small fragment without recognizable orientation or form).

Manufacture Failure Type

Manufacture failure attributes describe manufacturing breaks (cf. Crabtree 1972; Flenniken 1978; Cotterell and Kamminga 1979, 1987). We recorded such failures as *None, Lateral Hinge, Longitudinal Hinge, End Struck Outrepassé, Lateral Struck Outrepassé, Fracture Plane*, (natural or cultural), *Material Flaw* (usually vugs or nonsilicified areas), *Cone*, *Edge Collapse* (a large expanded crescent shaped notch similar to an outrepassé failure), *Perverse Fracture* (truncating the biface), *Bending Fracture* (also usually truncating the biface and including evidence of end shock, lateral snap, and transverse shock; cf. Crabtree 1972; Johnson 1979, 1981; Rondeau 1981), *Thermal Fracture* (including that caused by intentional heat-treatment and unintentional thermal alteration), *Multiple*, *Other*, and *Indeterminate*. Hinge fractures that might prompt biface discard are often large and deep, cutting into the mass of the biface. Multiple hinges also obstruct further thinning (Figure 25c). Outrepassé removals cause failures if they plunge through the greatest mass of the biface edge (Figure 25b), often leaving a large, expanded, crescent-shaped notch at the edge. Large cones that contribute to failure result from heavy, often repeated, hard hammer percussion in association with quarry activity and the reduction of large cores. Cones act as fracture planes to halt or redirect energy during reduction, thereby causing repeated inadequate flake removals.

Thermal Alteration

Thermal alteration improves flaking quality and alters the appearance and texture of opalite, rendering the surface of flake scars produced after heat-treatment glassy and lustrous (Figure 26). The detection of luster resulting from heat-treatment and, more importantly, the detection of *differential* luster, allows determination of the stage in biface reduction at which a specimen was heat-treated.

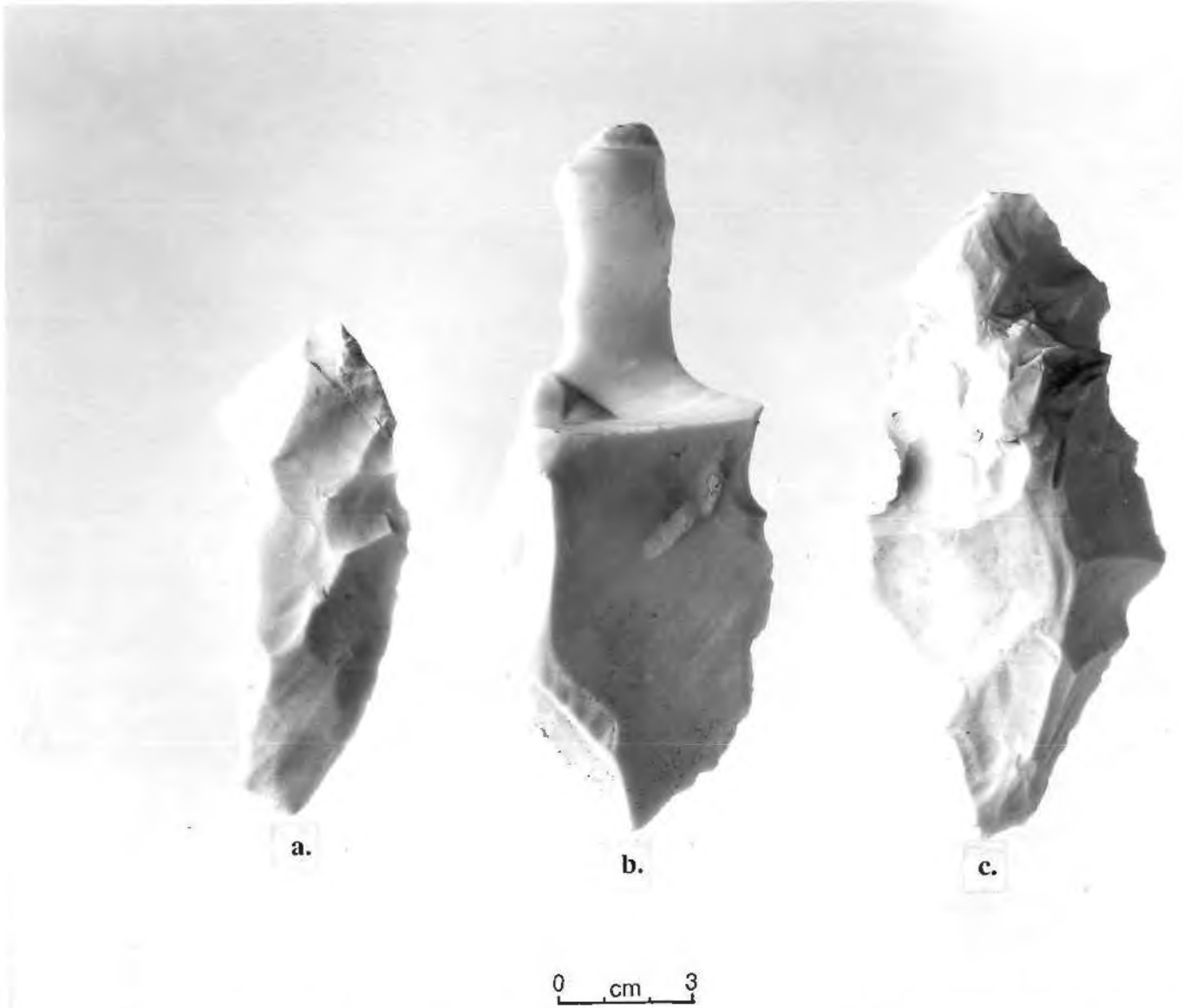


Figure 25. Biface failure types. a. edge collapse due to thermal failure; b. failure in longitudinal thinning (end struck outrepassé); c. complete biface exhibiting stacked step fractures resulting in discard.

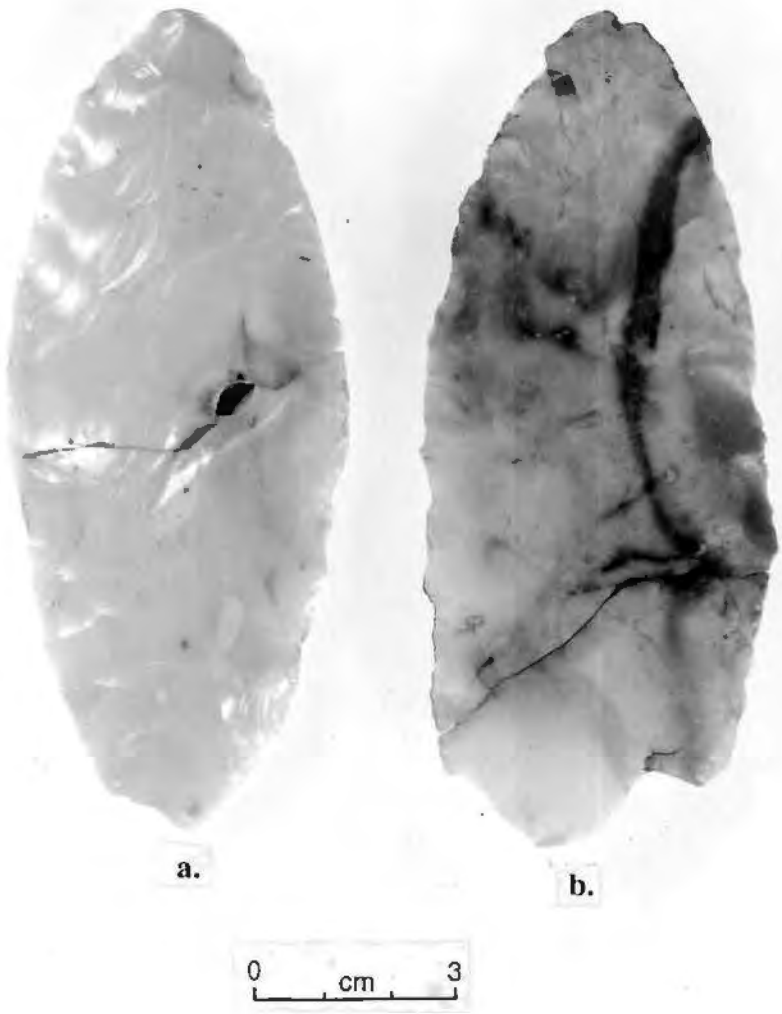


Figure 26. Heat-treatment of opalite. a. lustrous, heat-treated biface; b. non-lustrous biface.

A *blank from a Heat-Treated Core* is usually recognized only among Stage 1 or Stage 2 bifaces because the observation requires the original ventral surface of the flake blank to be visible; a small number of Stage 3 and Stage 4 bifaces *may* retain remnant ventral surfaces. For example, an otherwise unreduced blank from a heat-treated core will exhibit a lustrous ventral surface and a dull or less lustrous dorsal surface.

A *Heat-Treated Blank* is heat-treated after removal from a raw (non-heat-treated) core. A heat-treated blank should have non-lustrous original dorsal and ventral surfaces. A Stage 2 or early Stage 3 biface heat-treated as a blank should exhibit differential luster between the non-lustrous original dorsal and ventral surfaces and the lustrous reduction scars.

A biface *Heat-Treated During Reduction* is recognized by differential luster of reduction scars. Lustrous scars produced during Stage 3 reduction, overlapping dull (non-lustrous) ones produced during Stage 2 edge preparation indicate the specimen was heat-treated at the end of Stage 2 reduction.

Bifaces that were *Thermally Altered Post-Manufacture* have been unintentionally exposed to heat (often direct flame) through human and/or nonhuman processes. Evidence of unintentional thermal alteration is not always obviously different from the results of intentional heat-treatment, but is often recognized by the presence of angularly patterned surface crazing or potlids resulting from direct exposure to flame. Heavily discolored surfaces (black and brown discoloration) also indicate exposure to flame or intense heat without the benefit of heat buffering sediments.

Bifaces of *Indeterminate Heat-Treatment Stage* were heat-treated intentionally, but the point along the reduction continuum at which treatment was undertaken cannot be identified. This category usually is confined to later stage bifaces which have been considerably reduced.

Possibly Heat-Treated bifaces have a somewhat lustrous appearance, but classification is inconclusive. Analytically, they are not considered to have been heat-treated, but comprise a separate analytical data set for comparison with heat-treated bifaces.

Not Thermally Altered bifaces show no evidence of thermal alteration.

Redirection and/or Reworking

This variable records attempts to rework truncations or hinges that otherwise would have rendered the reduction effort a failure. Biface forms which appear to have resulted from successful reworking or redirection were recorded as such. The attributes include *None*, *Attempt to Repair Truncation*, *Attempt to Repair Hinge*, *Reworked to New Form*, and *Other*.

Use Wear Analysis

The attributes recorded for use wear analysis of bifaces are the same as for flake tools, as described in detail in Chapter 7.

Analytical Results

The Tosawihi biface collection is considered first as one assemblage, regardless of specimen provenience. From this vantage we observe raw material use and selection, formal

characteristics, production technology, and use of bifaces. Distribution in the Tosawihi vicinity is examined by geographic subarea. Finally, we consider bifaces made from non-local materials. Biface caches are discussed as a special case.

General Assemblage Results: Toolstone Sources and Color Diversity

Most bifaces are made of opalite; other materials, present in very low proportions, include jasper, opal, obsidian, chalcedony, and basalt in decreasing frequency (Table 3).

Table 3. Toolstone Material, Proportional Composition, All Bifaces (n=4388).

General Toolstone Type	% of Assemblage
Opalite	**96.8**
Jasper	1.3
Opal	0.6
Obsidian	0.5
Chalcedony	0.4
Basalt	0.3
Other	0.1
Non-opalite total	**3.2**

In principle, toolstone color can be used as a measure of the diversity of toolstone sources exploited. The most common colors of Tosawihi opalite are white, grey, and beige, grouped here as a generally "white" category. Toolstone color diversity in the general biface assemblage is relatively uninformative (Table 4).

Table 4. Toolstone Proportional Color, All Materials (n=4388).

Color	% of Opalite Biface Assemblage
White	63.1
Beige	12.9
Gray	11.8
Total: white, beige, gray	**87.7**
Pink	3.2
Brown	2.5
Yellow	1.7
Purple	1.3
Red	1.2
Green	0.8
Black	0.8
Blue	0.5
Blue/Pink	0.2
Total non-"white"	**12.2**

General Assemblage Results: Reduction Stages

Reduction stage is the single most salient attribute of the assemblage. The biface collection contains the entire range of reduction stages (Table 5). Middle Stage 3 bifaces are most common, comprising 27% of the assemblage, with 22% of the bifaces being of stages earlier than mid Stage 3 and 36% being later. Approximately 10% of the assemblage was classed as indeterminate. It is likely that many of the indeterminate specimens would be assigned to Stages 4 or 5, since bifaces are most likely to break during later stage manufacture (Amick 1985; Johnson 1981). The reduction stage at which they were exported from Tosawihi probably varied from early Stage 3 to Late Stage 4, with most pertaining to middle and late Stage 3 (cf. Chapter 21).

Table 5. Biface Reduction Stage and Heat-Treatment.

Stage	Heat-Treated n	Heat-Treated % of stage	Non-Heat-Treated n	Non-Heat-Treated % of stage	Indeterminate or Accidental Heat-Treatment n	Indeterminate or Accidental Heat-Treatment % of stage	TOTAL n	TOTAL % of assemblage
Stage 1	0	0.00	17	100	0	0	17	0.39
Early 2	4	11.43	28	80	3	8.57	35	0.80
Late 2	31	25.83	75	62.5	14	11.67	120	2.76
Indeterminate 2	0	0.00	3	75	1	25	4	0.09
Subtotal 2	35	22.00	106	66.67	18	11.32	159	3.65
Early 3	133	17.16	574	74.07	68	8.77	775	17.81
Mid 3	385	33.28	643	55.58	129	11.15	1157	26.59
Late 3	312	49.13	252	39.69	71	11.18	635	14.59
Indeterminate 3	241	48.49	199	40.04	57	11.47	497	11.42
Subtotal 3	1071	34.95	1668	54.44	325	10.61	3064	70.42
Early 4	239	54.69	155	35.47	43	9.84	437	10.04
Late 4	61	63.54	26	27.08	9	9.38	96	2.21
Indeterminate 4	91	70.54	22	17.05	16	12.40	129	2.96
Subtotal 4	391	59.06	203	30.67	68	10.27	662	15.21
Stage 5	6	54.55	3	27.27	2	18.18	11	0.25
INDETERMINATE	225	51.37	155	35.39	58	13.24	438	10.07
TOTAL	1728	39.72	2152	49.46	471	10.83	4351	100.00

Many other attributes of bifaces are systematically related to reduction stage. As a consequence, many analytical results for single variables are sensible only when reduction stage is used as a controlling variable in analysis. Thus, many of the following results are presented in crosstabulation with reduction stage.

General Assemblage Results: Biface Dimensions

Initial qualitative examination of the Tosawihi biface collection indicated there might be two sizes of bifaces present, perhaps due to different production technologies or goals of biface production. During data collection, each biface was classified "small" or "large." The

production trajectory validity of the size distinction was examined with metric data collected during analysis. The frequency distributions of length, width, and thickness approximate a continuous normal distribution, so the distinction between small and large trajectories is artificial and was not carried further.

However, the two biface size classes are not distributed randomly across reduction stages (Table 6). Early stages of reduction and large sizes are always associated (chi-square = 162.38; df=2, p<.001). Analysis of variance was used to examine how dependent biface dimensions are upon stage. Only pieces assigned to a reduction stage and having complete dimensions (i.e., complete and laterally fragmented pieces for length and weight, complete and proximal or distal missing pieces for width and thickness) and reduction stage data were employed in this analysis. Results showed that dimensions are significantly (p<0.000) dependent upon stage, when stages are considered as early (Stages 1 and 2), middle (Stage 3), and Late (Stages 4 and 5). Average dimensions and standard deviations for length, width, and thickness, as well as weight, are presented for each production stage in Table 7 Dimensional patterning by area is discussed later.

Table 6. Cross-Tabulation of Large and Small Biface Trajectories Against General Reduction Stages.

Parentheses enclose significant (P<.05) adjusted standardized chi-square residues (cf. Everitt 1977).

	Stages 1 and 2	Stage 3	Stages 4 and 5	Total
Quarry	122 (2.1)	2131 (14.9)	253 (-17.3)	2506 71.9%
Small	32 (-2.1)	607 (14.9)	339 (17.3)	978 28.1%
Total	154	2738	592	3484
%	4.4%	78.6%	17.0%	100.0%

Table 7. Dimensional Data for Complete Opalite Bifaces.

Length and Weight are for complete bifaces.
Width and Thickness are for pieces with complete w/th dimensions.

Stage	n Length/ Weight	Weight Mean	Weight sd	Length Mean	Length sd	n Width/ Thickness	Width Mean	Width sd	Thickness Mean	Thickness sd
1	010	188.5	88.8	114.1	16.4	12	70.9	9.7	24.9	8.7
Early 2	22	236.3	148.9	107	26.8	23	73.3	13.4	29.9	11.5
Late 2	39	258	218.5	110.6	28.7	56	69.2	17.8	28.2	12
Indeterminate 2	1	63.6	-	60	-	1	49.2	-	21.5	-
Early 3	250	231.9	165.1	107	25.3	347	67.7	16.6	29.5	10.6
Mid 3	203	182.6	137.1	106.8	29.8	369	60	18	21.9	9
Late 3	35	128.2	88.4	108	36	126	50.7	17.8	14	5.7
Indeterminate 3	6	85.1	78.2	74.8	34.5	14	45.8	14.1	16.3	7.7
Early 4	15	140.7	92.6	125.7	39.1	93	45.3	15.1	10.5	3.9
Late 4	1	18.9	-	71.9	-	36	42.5	14.7	8.1	2.4
Indeterminate 4	1	13.7	-	41.9	-	5	30.3	7.8	6.9	1.7
5	4	41.5	20.1	107.2	13.8	8	37.1	11	7.4	2.9
Total	587					1090				

* all measurements are in mm

Some bifaces recorded in the small trajectory group are formally different from the bulk of the specimens (Figure 27); they generally are of late stage, and have a variety of intentionally shaped bases. They may have been intended as small knives, but many probably were preforms for large projectile points which sustained a percussion flaking stage before final pressure flaking (cf. Chapter 9). Few are complete, however, so evaluation of size with respect to possible point type is not feasible. We have included them in the discussion here because, although they could have been either knives or projectile point preforms, they cannot be differentiated reliably from generic bifaces.

Although a range of flake blank sizes was employed in the manufacture of bifaces, size patterning is not marked in the assemblage. For instance, length does not change substantially throughout the reduction sequence, while other dimensions, as well as weight, exhibit a general decrease from early to late stages (Table 7). As might be expected when intended products are of similar size but blank sizes vary, the greatest variation in size occurs in the earliest stages. Small numbers of complete bifaces in some stage classes precluded statistical examination of the differences between individual stages, prompting us to combine bifaces into two groups, early and late stage. The early stage group is composed of Stage 1, Stage 2 and early Stage 3, while the late stage group is composed of middle and late Stage 3 and Stage 4.

T-tests confirm the general observation that only length does not differ significantly across reduction classes. Weight, width, and thickness all differ significantly and in the expected fashion (early stages are larger than later stages).

General Assemblage Results: Heat-Treatment

The compliance of Tosawihi opalite increases greatly with heat-treatment. Although late stage biface production can be accomplished without heat-treatment, the increased compliance resulting from heat-treatment makes it far easier. Heat-treatment also tends to decrease manufacture breakage rates, because it permits increased control with decreased force. On the other hand, heat-treatment of opalite can be too much of a good thing since lower force has greater potential to remove flakes or to break the biface, and, after heat-treatment, the material is more brittle. Hence, heat-treatment permits less force in flaking but requires greater precision in work.

Clearly, heat-treatment and reduction stage are related (Table 5). While some Stage 2 bifaces are heat-treated, the proportional frequency of heat-treatment increases dramatically between middle and late Stage 3, suggesting that it regularly occurred at this point in the reduction sequence. Sixty-three percent of the late Stage 4 bifaces were heat-treated, suggesting that thermal alteration was an integral part of biface production (Ataman and Bloomer 1990). Bifaces of indeterminate stage (mostly fragmentary) frequently are heat-treated; this suggests that most are from late Stage 3 or later biface reduction.

General Assemblage Results: Manufacture Failures and Fragment Types

Manufacturing failure reflects several details of biface production (Table 8). More than 90% of the Tosawihi bifaces are fragmentary. Most are items broken during manufacture and discarded (Sassaman 1988). Analysis of breakage patterns reveal the most common failure points in the reduction sequence. This, in turn, provides insight into specific knapping techniques.

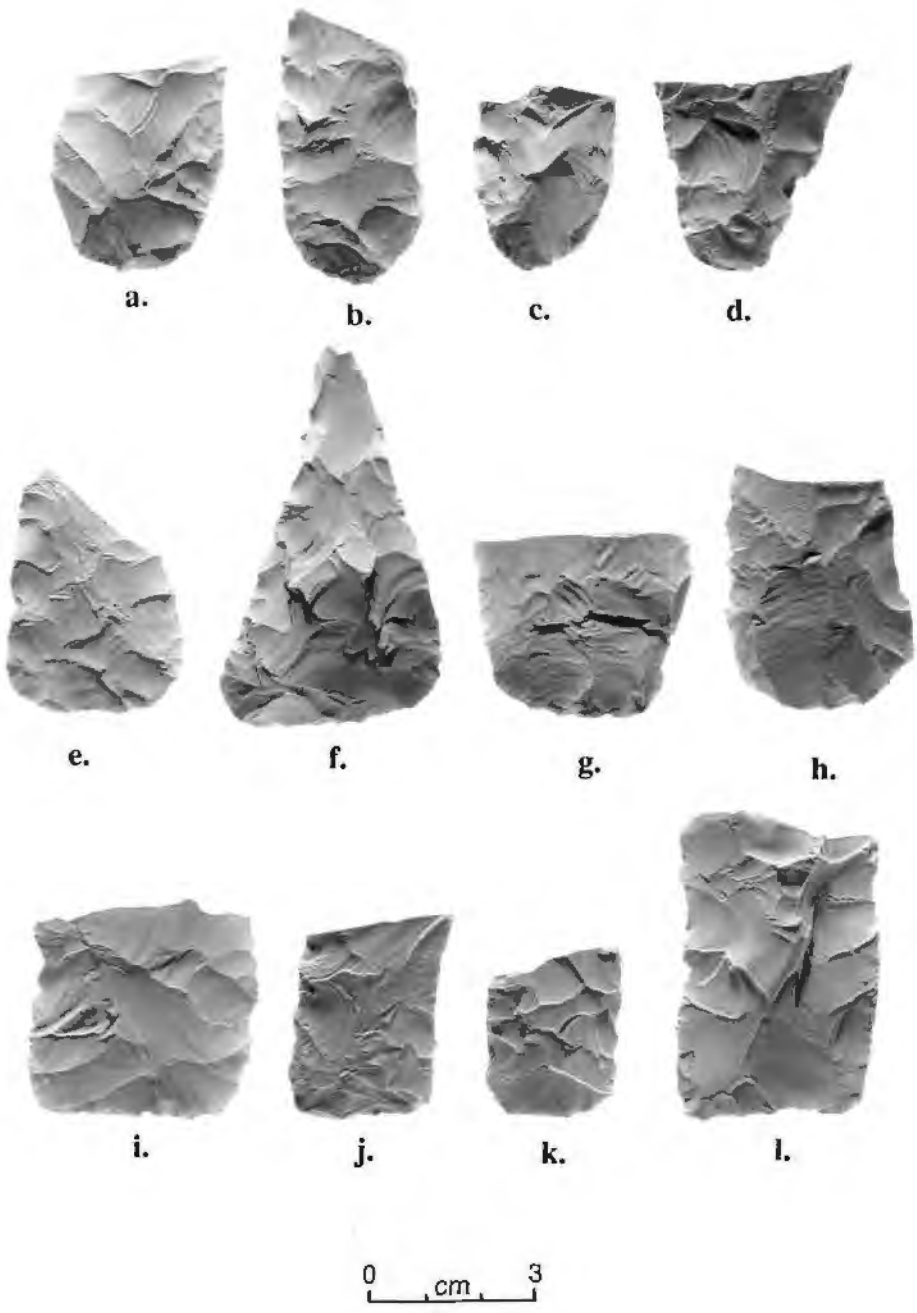


Figure 27. Selected small bifaces which may have served as large point preforms or small knives.

Table 8. Biface Manufacturing Failure Types.

Failure Type	Indeter-minate	BIFACE STAGE 1	2	3	4	5	Total
None	4	11	41	291	15	3	365
Lateral hinge	2	1	2	54	0	0	59
Longitudinal hinge	0	0	1	19	0	0	20
Outrepassé end	0	0	0	18	0	0	18
Outrepassé lateral	3	0	1	16	2	1	23
Fracture plane	2	0	2	19	1	0	24
Material flaw	7	0	16	104	7	0	134
Cone	0	0	0	2	0	0	2
Edge collapse	15	0	3	41	2	0	61
Perverse fracture	7	0	1	49	17	0	74
Bend break	198	4	49	1206	404	4	1865
Thermal fracture	40	0	1	93	12	1	147
Multiple causes	116	0	38	971	181	1	1307
Indeterminate	3	1	2	33	2	0	41
Other	41	0	2	148	19	1	211
Total	438	17	159	3064	662	11	4351

The proportion of complete bifaces in each stage decreases through the reduction sequence. Stage 1 bifaces (blanks) are the least frequently broken (less than 40%). Bending fractures account for most of the observed breakage.

More than 75% of the Stage 2 bifaces are fragmentary. Most breakage types were observed on Stage 2 bifaces; material flaws, bending fractures, and multiple fracture types appear fairly often. Multiple fracture types are of particular interest, since they often result from general failure of the specimen during knapping. For example, a material flaw may set up a series of other weakness zones, causing bending breaks, edge collapses, and other kinds of breaks to coincide.

Stage 3 bifaces have the greatest variety of breakage types, perhaps due to the size of the sample. Bending breakage is common, as are multiple breakages. In general, the proportion of fractures due to material failure (e.g, fracture planes, material flaws) diminishes in Stage 3; the biface already has withstood initial shaping, so raw material flaws generally have been discovered. Breakage due to flintknapper error (e.g., misapplied force) becomes much more common in Stage 3 reduction, as shown by increasing proportions of perverse fractures, bending fractures, and outrepassé removals. Breakage from thermal stress also increases, reflecting a greater incidence of heat-treatment in this stage.

These trends continue into Stage 4, where relatively little breakage can be attributed to inherent material flaws and much more is due to knapper error. However, outrepassé and hinge fractures are rare on Stage 4 bifaces, probably since facial thinning was well controlled by the time this stage was reached. Stage 5 breakage is limited primarily to bending fractures.

Overall, there is a pattern of decreasing breakage from material flaws and a corresponding increase in the occurrence of non-specific breakage and breakage attributable to knapper error or misapplied force. Pieces with multiple breakage patterns also increase. Many of the bifaces having multiple fragmentation types broke because of thermal stress. Thermal stress weakens a biface by making it more brittle and creating internal fracture planes. Subsequent attempts to continue working a thermally stressed biface causes multiple failures: fracture planes break, edges collapse, and previously unseen material flaws create uncontrollable fractures. A common effect of thermal failure is a curved plane of weakness which becomes a bending break when the biface fractures. When thermal failure is the primary cause of a bending break, the break surface is often a twisting fracture surface similar to a perverse fracture plane.

Although bending breaks can be due to misapplied force or thermal failure, they also can be caused by trampling (Frison and Bradley 1980:43-44). Later stage bifaces are especially prone to this kind of breakage since they generally are thinner (cf. Amick 1985:143-144). Overall, bending breakage increases through Stage 4, and then decreases in Stage 5. The causes of the bending breaks in each stage may differ; in Stages 1 and 2 they can be due to misapplied force, in Stages 3 and 4, to misapplied force and failed heat-treatment, and in Stage 5, to misapplied force and accidental breakage by trampling.

Breakage patterns are useful indicators of reduction techniques (Amick 1985; Johnson 1981). In the Tosawihi biface collection, breakage patterns indicate the procurement and initial testing (and often rejection due to failure) of opalite. Testing does not end with the successful procurement of a blank, or even with its initial edging during Stage 2; rather, it apparently is most crucial (if perhaps unintentional) during Stage 3 reduction. In Stage 3 reduction, flaking shifts from edge shaping to facial thinning, so the influence of different kinds of material flaws which may not have appeared in edge flaking determines the success of the reduction. At the same time, bifaces become thinner during Stage 3 and often are heat-treated; both create additional opportunities for catastrophic breakage. In Stage 4, the incidence of heat-treatment is higher and the average biface thinner than in earlier stages, both of which can increase breakage. In addition, it is likely that much Stage 4 reduction was accomplished with a soft hammer, which also has been linked to higher breakage rates (Amick 1985). The increase in unbroken Stage 5 bifaces, on the other hand, may be due to discard of superfluous finished tools, but our sample (n=11) is small.

General Assemblage Results: Use Wear Analysis

A sample of 44 bifaces was selected for use wear analysis, chosen from later stage specimens having characteristics of finished tools (regularized edges, pressure flaked lateral margins, and dulled edges). The high incidence of heat-treatment in the sample made analysis more difficult, since heat-treatment on opalite tends to obscure use wear polishes or to mimic them. As a result, edge abrasion and striations were our primary criteria for determining use.

Seventeen of the 44 specimens exhibited use wear traces. The motion of use on 14 of these reflected cutting, 1 had been used for scraping, and 2 were indeterminate. Use, or lack of it, could not be determined for 27 items. The hardness of the material manipulated was identified for nine specimens (Table 9).

Table 9. Determinable Function of Stage 4 and Stage 5 Bifaces.

Hardness	Scraping n	Cutting n	Indeterminate (n)	Total
Soft	0	0	0	0
Soft/Medium	0	2	0	2
Medium	0	0	0	0
Medium/Hard	1	6	0	7
Hard	0	0	0	0
Indeterminate	0	6	2	8
Total	1	14	2	17

Use wear analysis suggests that late stage Tosawihi bifaces with characteristics of finished tools were used occasionally as cutting tools. No traces of wear from hafting nor fragments of hafting material were visible on the Tosawihi bifaces examined. Hafting traces

are observable only rarely because they are obscured by various post-depositional processes (cf. Beyries 1988). There are ethnographic and archaeological examples of hafted bifaces from the Great Basin and other areas which appear to be knives for skinning and butchering (Fowler and Liljeblad 1986; Hester and Follett 1976; Hester 1974) and ethnographic accounts document their use (Goddard 1903). In spite of these reports, some researchers suggest that bifaces do not function well for butchering (e.g., Hester et al. 1976). Experiments carried out in the course of this project, however, demonstrate that they work extremely well for skinning, if somewhat less well for initial incisions and deboning.

Although these data suggest that some bifaces may have been used as knives, probably very few were finished or used as knives at the quarries (Figure 28). The use of bifaces as cores for the production of flakes is another explanation for the intended function of bifaces leaving Tosawihi. These hypotheses are discussed in Chapter 21.

General Assemblage Results: Summary

The Tosawihi biface collection is dominated by local opalite, jasper, chalcedony, and opal. Basalt occurs locally, but only a small number of basalt bifaces (n=11) are present in the assemblage. Nonlocal cryptocrystalline raw material is also rare (n=26), and consists primarily of exotic obsidian. In any case, the general assemblage results are strongly conditioned by the local availability of toolstone, and regularities in how it was used.

The single most important feature of the biface assemblage is its strong patterning. The pattern is created by the selected techniques of biface reduction. Almost all attributes are associated positively with biface reduction stage. Heat-treatment, fragmentation and manufacture failure, biface dimensions, and reduction stage are interrelated. Heat-treatment occurs within and increases in proportion by stage from reduction Stage 2 through Stages 3 and 4. Fragmentation due to material flaws decreases in proportion through Stages 2, 3, and 4; that due to poorly controlled application of force during knapping and to heat-treatment occurs during Stages 3 and 4. Not surprisingly, biface dimensions diminish with increased reduction stage. Thus, reduction stage is probably the single most important variable in the Tosawihi biface assemblage.

Areal Comparisons

The general assemblage results discussed above indicate that biface production was an important focus of prehistoric use of the Tosawihi vicinity. For a variety of reasons, probably including transport costs and procurement maximization (cf. Chapters 3, 4), stage/ size variation in the biface assemblage is a function of distance from toolstone sources. Stage/size variation may also correspond with other resource opportunities presented by the Tosawihi landscape (cf. Chapters 2, 5, 20).

Each area is discussed in terms of biface reduction techniques and the overall organization of biface production, transport, and use in the Tosawihi vicinity.

26Ek3032 contains over 200 distinct cultural localities. Most toolstone sources in the Tosawihi study area lie within the site; eight which were investigated contain bifaces and form the subject of later discussion.

The Eastern Periphery also contains several toolstone sources. The quality of surface toolstone varies from poor to good, but the average material quality of bifaces is good to excellent.

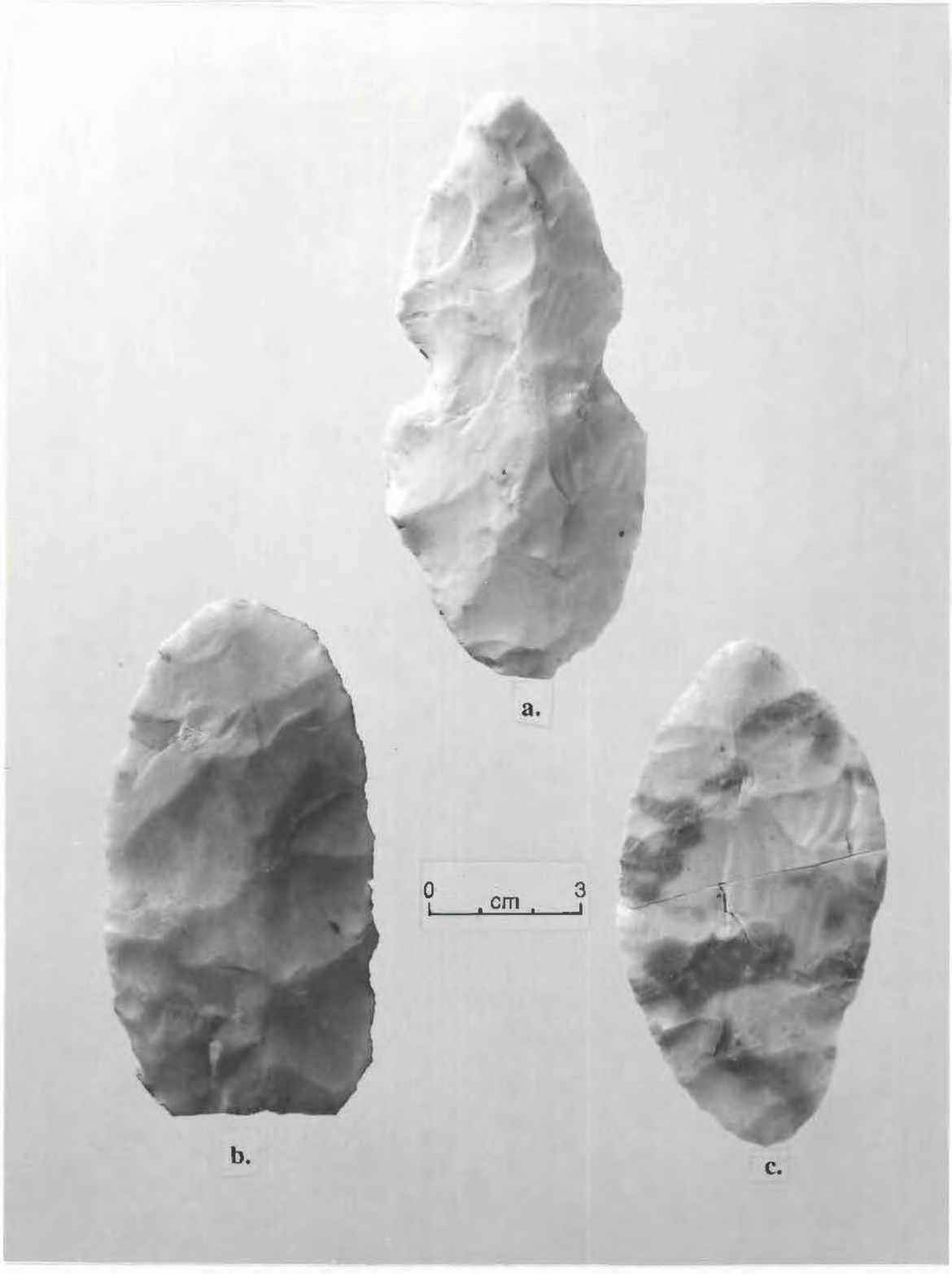


Figure 28. Examples of possible finished bifacial tools.

This suggests that some bifaces from this area may have been quarried elsewhere (probably in 26Ek3032) or that local, higher quality toolstone (probably from subsurface deposits) was exploited selectively.

The Western Periphery contains few toolstone sources, yet the biface sample is larger than from other subareas. Most bifaces appear to have been transported as partially reduced pieces, then reduced further and processed here.

The Northern Corridor contains no toolstone sources; cryptocrystalline bifaces within it most likely were transported at least 6 km. About 80% of the bifaces recovered were collected from two sites, 26Ek3237 and 26Ek3251. The latter lies at the northern edge of the subarea near the confluence of Ivanhoe and Willow Creeks, approximately 12 km from 26Ek3032, adjacent water and other riparian resources.

Areal Comparisons: Material Sources and Color Diversity

All four subarea biface assemblages are dominated by local cryptocrystalline material (opalite, jasper, chalcedony, and opal). Basalt, locally available, is rare in the assemblages (Table 3), as are other non-local materials; no assemblage contains more than 2% non-local raw material. The number of material types within each area (source richness) is highly correlated with assemblage size, precluding interareal comparison of variety on the basis of material type variety (Jones et al. 1989).

The number of toolstone colors represented in each assemblage also correlates with logarithmically transformed values of subarea assemblage size, so that no interpretation based on color variety is possible. However, when colors are considered as "white" (the most common opalite color, including the material color values of white, grey, and beige) vs. "other", differences emerge (Table 10). 26Ek3032 has a significantly ($p=0.05$) higher proportion of non-"white" bifaces than expected under a chi-square model of independence between color and subarea. The Northern Corridor also has a substantial proportion of non-"white" bifaces, but does not differ significantly from the expected value under a chi-square model of independence. The Eastern Periphery has a significantly higher than expected proportion of "white" opalite bifaces. The Western Periphery does not deviate significantly from expected chi-square values.

Table 10. "White" vs. Other Material Colors,
Locally Available Cryptocrystalline Materials Only, by Subarea.
Significant ($p<0.05$) adjusted standardized residuals marked with asterisks.

Color		26Ek3032	East	West	North	**Total**
"White"	n	191	1180	2090	383	3844
	%	74.9	91.8	88.4	85.7	88.4
	adj. std. resid.	-6.9*	4.6*	0.1	-1.9	
Other	n	64	105	274	64	507
	%	25.1	8.2	11.6	14.3	11.6
	adj. std. resid.	6.9*	-4.6*	-0.1	1.9	

The proportion of "white" to non-"white" material in each subarea in part may reflect the toolstone sources represented in each area's biface collection. 26Ek3032, (the Quarry area) contains numerous "non-white" toolstone sources. Not surprisingly, the biface assemblage appears to have a greater proportion of these materials when compared to the other subareas. Toolstone sources in the Eastern Periphery are predominantly white; consequently, the biface

assemblage is dominated by "white" toolstone. Sites in the Western Periphery have few toolstone sources nearby, and bifaces recovered in this subarea probably were derived from sources in the Quarry area. In contrast to the general pattern of color proportions reflecting local toolstone availability, assemblages from the Northern Corridor exhibit a slightly greater proportion of white toolstone than do sites in the West; bifaces probably derived from sources in the Quarry area as well as a wider range of other sources outside of Ek3032. Northern Corridor sites may also include bifaces made on the multi-colored stream cobbles found along Ivanhoe and Willow Creeks.

Areal Comparisons: Reduction Stages

The reduction stages of local cryptocrystalline bifaces are not distributed randomly across the four subareas. There is a strong positive association between early reduction stages and proximity to toolstone sources (chi-square=70.97, df=12, $p<0.001$). A dot plot (Figure 29; Cleveland 1985) and examination of adjusted standardized residuals (Figure 30; Everitt 1977) to determine significant ($p=0.05$) deviations from chi-square expected values are useful in elucidating additional patterns.

In the main quarry area, 26Ek3032, there are significantly more Stage 1, Stage 2, and early Stage 3 bifaces than late Stage 3 and Stage 4 bifaces. In the Eastern Periphery, which is adjacent the toolstone sources of 26Ek3032 and contains some sources of its own, there are significantly more Stage 2 and early and middle Stage 3, and fewer late Stage 3 and Stage 4 bifaces, than expected under a chi-square model of independence. The Western Periphery, which is further removed from sources in 26Ek3032, contains fewer Stage 1, 2, and early Stage 3 bifaces and more late Stage 3 and Stage 4 bifaces than expected. The Northern Corridor has fewer early Stage 3 bifaces and more Stage 4 and Stage 5 bifaces than expected. A rough seriation of the four areas, based upon reduction stage, follows the order of presentation above, from earliest to latest biface reduction: 26Ek3032, Eastern Periphery, Western Periphery, and Northern Corridor.

Areal Comparisons: Biface Dimensions

Variation in biface sizes between and within subareas was examined. Comparison of size variation is complicated by the interrelationship between reduction stage and biface size, discussed above, so reduction stage was a necessary controlling variable in these analyses. As discussed above, with increasing distance from toolstone sources, the proportion of later stage bifaces increases at the expense of earlier reduction stage bifaces. If stage were *not* controlled in comparing biface sizes, biface dimensions would decrease in the same order as the proportion of late stage bifaces increases.

Examination of mean dimension values for bifaces in Stages 2, 3, and 4 for each subarea (Table 11) shows that even when reduction stage is held constant, the trend is one of diminution in size at greater distances from toolstone sources. For example, Northern Corridor stage 3 bifaces are smaller than Stage 3 bifaces from the Western Periphery. In turn, the latter are smaller than their counterparts from the Eastern Periphery. Stage 2 bifaces follow this trend, but are always larger than Stage 3 bifaces.

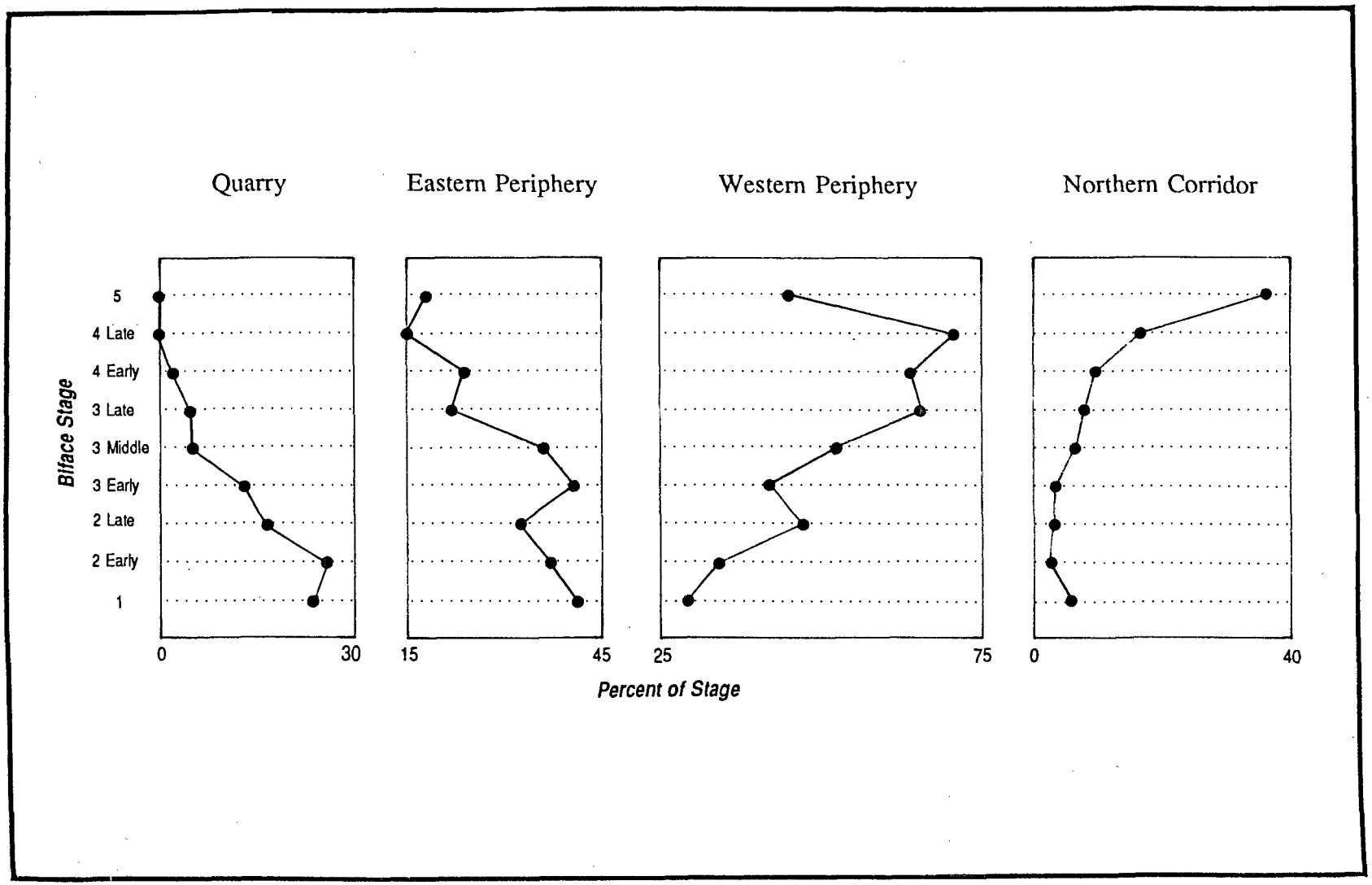


Figure 29. Proportions of each stage in subarea.

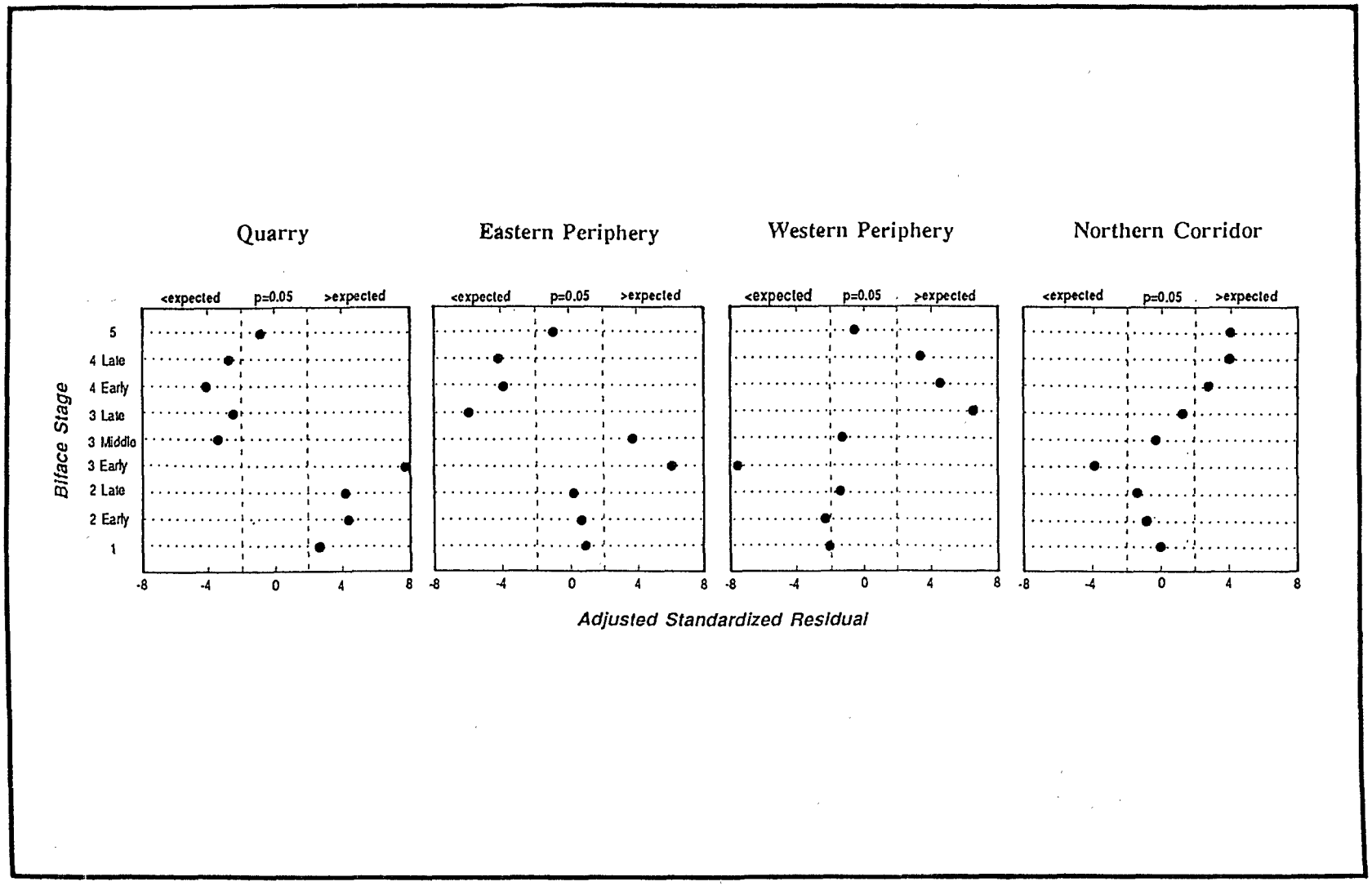


Figure 30. Adjusted residuals of stage by area.

Table 11. Size Variation in Bifaces of Local Cryptocrystalline Silicates, by Subarea and Reduction Stage.

Subarea	Reduction Stage		Length* (mm)	Width** (mm)	Thickness** (mm)	Weight* (g)	Width:Thickness Ratio
26Ek3032	2	mean	122	79	32	337	2.7
		sd	35	13	11	262	0.8
		n	13	20	20	13	20.0
	3	mean	114	67	28	234	2.6
		sd	21	13	10	141	0.8
		n	52	80	80	52	80.0
	4	mean	161	72	17	231	4.2
		sd	5	10	2	35	0.7
		n	5	6	6	5	6.0
East	2	mean	111	69	28	222	2.8
		sd	24	12	12	117	1.1
		n	27	31	31	27	31.0
	3	mean	113	68	26	230	2.9
		sd	24	17	11	142	0.9
		n	250	372	372	250	372.0
	4	mean	106	53	11	105	5.0
		sd	34	14	4	86	1.0
		n	7	35	35	7	35.0
West	2	mean	97	66	26	228	2.7
		sd	26	21	12	229	0.8
		n	20	27	27	20	27.0
	3	mean	98	55	21	162	2.9
		sd	32	18	10	161	1.0
		n	181	376	376	181	376.0
	4	mean	91	40	9	51	4.6
		sd	48	12	3	55	1.2
		n	5	81	81	5	81.0
North	2	mean	98	59	33	201	2.0
		sd	25	8	18	112	0.8
		n	2	2	2	2	2.0
	3	mean	69	38	15	99	3.0
		sd	23	17	11	123	0.9
		n	11	28	28	11	28.0
	4	mean	-	32	7	-	4.7
		sd	-	9	2	-	1.0
		n	0	12	12	0	12.0

*Complete specimens only
**Complete specimens and specimens missing ends

Statistical separation of the dimensions of bifaces within the same stage reduction but in different subareas is possible, yet it is not very enlightening. We performed t-tests at a predetermined significance level of p=0.05 to contrast the dimensional variates between subareas. For most dimensional variables, there were no significant differences between a

subarea and its adjacent neighbors. For example, t-tests showed no significant difference in most mean dimensions when Eastern Periphery Stage 3 bifaces were contrasted with Western Periphery Stage 3 bifaces. Yet, there is a significant difference between the Western Periphery Stage 3 bifaces and Stage 3 bifaces from the Quarry (26Ek3032) area. Significant t-test contrasts were found only when such nearest neighbors were skipped, and even these are not wholly consistent across all size measures. Northern Corridor bifaces, however, are consistently (and significantly) smaller than those from the Eastern Periphery and the Quarry areas.

A second statistical analysis was performed to examine whether variation in the overall mean dimensions of bifaces is explained best by subarea, reduction stage, or both. A multiple analysis of variance was performed contrasting subarea and reduction as factors, and using biface dimensions as response variates. The results of this analysis (not presented here) showed that both reduction stage proportions and subarea were influential factors, so size variation cannot be ascribed to either factor singly.

Outside 26Ek3032, most bifaces were found away from toolstone sources, indicating large-scale transport of bifaces around the Tosawihi landscape. As discussed above, both placement relative to toolstone sources and reduction stage determine (in a statistical sense) the diminution of biface sizes from Quarry to East to West to North. This pattern is wholly sensible given the costs of transport (cf. Chapter 4, Chapter 26): the mass of material transported should be reduced to the greatest possible extent to minimize energetic costs. Thus, one expects increasing standardization of transported bifaces at greater distances from toolstone sources. We now turn to examining whether standardization of biface sizes is evident in the assemblage. A shift in focus is required, since now we are comparing the sizes of bifaces at different stages within each subarea, rather than sizes in the same reduction stages from different subareas. If standardizing of size (and not form, since form has no direct relationship to transport cost) occurred, then we expect the sizes of stages to become increasingly similar at greater distances from toolstone sources.

Since weight ultimately determines transport cost, we examined its variation between stages from the same subarea, again using t-tests at a predetermined significance level of *0.05*. The mean values for adjacent stages (2 vs. 3, 3 vs. 4) were contrasted. Stage 4 bifaces from the Northern Corridor are a null set, and thus could not be contrasted.

No significant differences were found between Stage 2 and Stage 3 bifaces. Significant differences were found between Stage 3 and Stage 4 bifaces in the Eastern and Western Peripheries.

The lack of difference in Stage 2 and Stage 3 bifaces suggests that within each subarea, both stages are a "standard transport weight." The standard transport weight should vary with distance from source, because the costs of transport increase in linear fashion. For example, one might be willing to transport 10kg for 1km, but not for 10km, since it is 9 times as costly to travel the additional distance. The decrease in biface size with distance from toolstone sources, therefore must be more a function of distance than of stage proportions.

The differences between mean weights of Stage 3 and Stage 4 suggest that Stage 4 biface transport operated under different constraints. We can only surmise what these may have been, but one likely possibility is that Stage 4 bifaces were more important as potentially useful tools than as commodities for transport away from Tosawihi.

In any case, insofar as weight is indicative of standardization and our most distant subarea from toolstone sources was still within a transport-production radius for Stage 3 bifaces, the mean weight of Stage 2 and Stage 3 bifaces from the Northern Corridor reflect maximum sizes of bifaces removed from Tosawihi. The grand mean for both stages is 115g, although there is considerable variation around this (standard deviation = 123g). This provides a very rough estimate of biface sizes removed from the Tosawihi vicinity.

Areal Comparisons: Heat-Treatment

The incidence of heat-treatment varies considerably in the four subareas (Table 12) and the proportion of heat-treated bifaces generally increases through the reduction sequence. Using counts of definitely heat-treated bifaces against all other categories (including possibly heat-treated), general reduction stages 2, 3, and 4, and the four major subareas, chi square values indicate that all these relationships are non-random, that the incidence of heat-treatment, biface reduction stage, and subarea are interrelated and interdependent:

stage/ht	$\chi 2 = 158.39$, df = 2, $p<.001$
subarea/ht	$\chi 2 = 369.14$, df = 3, $p<.001$
subarea/stage	$\chi 2 = 139.65$, df = 6, $p<.001$

The greatest incidence of heat-treatment and the highest proportion of later stage reduction were found at the greatest distance from toolstone sources. The least amount of heat-treatment and the highest proportion of early reduction stages were found nearest to toolstone sources.

Within each subarea, the incidence of heat-treatment was compared with chi-square tests to general reduction stages 2, 3, and 4:

Quarry	$\chi 2 = 2.23$, df = 2, $p <.328$
East	$\chi 2 = 34.12$, df = 2, $p <.001$
West	$\chi 2 = 58.50$, df = 2, $p <.001$
North	$\chi 2 = 5.25$, df = 2, $p <.073$

Table 12. Proportions of Heat-Treated Bifaces by Stage in the Four Subareas.
(Possible heat-treated specimens not considered heat-treated.)

	SUBAREA			
Stage	Quarry	East	West	North
1	0	14.29	0	0
2	6.90	11.50	28.90	40.00
Early 3	3.88	12.30	24.09	29.63
Mid 3	8.62	21.29	43.16	54.05
Late 3	13.33	27.86	59.62	61.22
Early 4	20.00	35.24	63.21	64.29
Late 4	0	75.00	58.82	50.00
5	0	50.00	60.00	100.00

The results from the East and the West indicate that in these two areas, stage and heat-treatment are associated, while in the Quarry and the north they are not. Figure 31 illustrates heat-treatment proportions by stage in each subarea. The proportion of heat-treated bifaces in the Eastern Periphery is lower than in the West and the North, especially in the earliest stages of manufacture. All three of these areas are very different from the Quarry subarea, where there is little heat-treatment at any stage of reduction. Overall, heat-treatment is most common in the North, where it is more common in earlier stages.

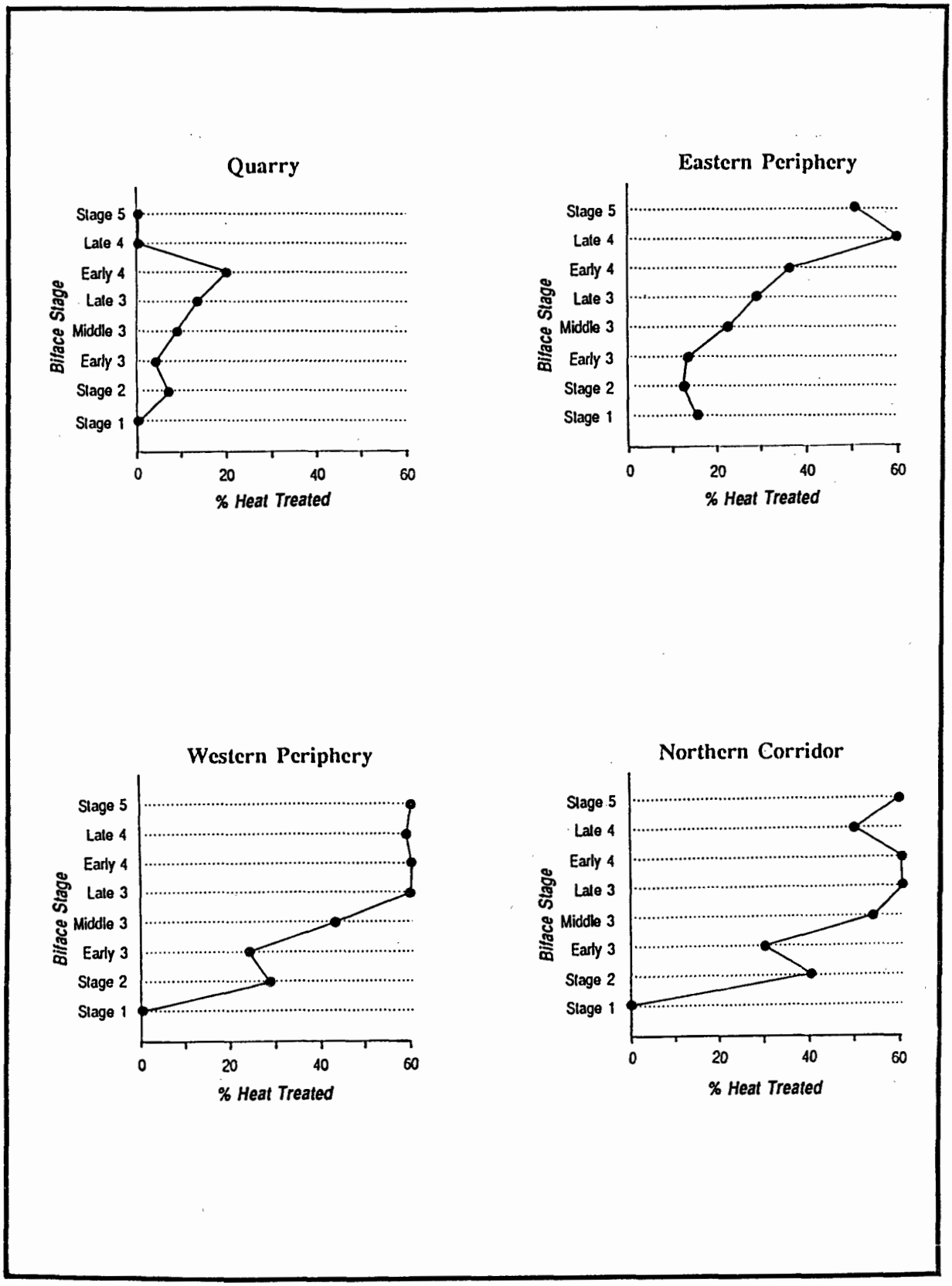


Figure 31. Dot plots of the proportions of heat-treated opalite bifaces of each stage in the four subareas.

Overall, heat-treatment was undertaken most often between middle and late Stage 3 (cf. Chapter 21). Heat-treatment was carried out only infrequently where toolstone was extracted; generally, early stage bifaces were moved to residential sites for further reduction and (often) heat-treatment, but in the West and North, bifaces often were heat-treated as early as Stage 2 or early Stage 3. Thus, the Eastern Periphery has a much higher proportion of heat-treated bifaces and late stage reduction than the Quarry, but fewer than either the West or North, from which it also differs in other details, probably because it contains toolstone sources. In the West and North, further removed from toolstone sources, heat-treated bifaces are more common. The higher proportion of heat-treated Stage 2 bifaces in these assemblages is not expected and suggests that, although bifaces sometimes were transported before processing through Stage 3, the greater risk attending this decision often was mitigated by heat-treating the artifacts before the move.

Areal Comparisons: Biface Breakage and Failure

Biface breakage rates and types are dependent on stage, as discussed above. The probability of any single biface breaking during production increases with its continued reduction. The Quarry subarea has the highest proportion (30%) of unbroken bifaces. However, many of these are very early stage bifaces probably rejected for their material quality or initial proportions. The broken 70% are dominated by early stage fracture types.

Breakage from misdirected blows, typical of later stage reduction, is more common in the Eastern Periphery than in the Quarry. Outrepassé removals, edge collapses, perverse fractures, and thermal failures are much more frequent in the east. This parallels the greater proportions of later stage bifaces in the Eastern Periphery than in the Quarry.

Similarly, the Western Periphery is dominated by manufacture failures, a function of the even later reduction of bifaces. Bifaces probably were transported more often into the Western Periphery already reduced to late Stage 2 or early Stage 3. This is supported by the lower proportion of hinge failures, common in the early reduction of large blanks, in the West. However, the proportion of other early fracture plane and material flaw related failures is fairly constant across the Quarries, the Eastern Periphery, and the Western Periphery. By this token, the reduction of early stage bifaces occurs in all three subareas, even though fewer large flake blanks are reduced in the West.

Biface breakage and failure in Northern Corridor assemblage are quite different. Northern Corridor bifaces have fewer hinge fractures, while outrepassé failures associated with later reduction are correspondingly higher. The proportions of bifaces broken solely by thermal failure also are lower in the Northern Corridor, but the association of heat-treatment with some other breakage type (e.g., breakage due to the creation of internal fractures by heating) is higher. Once again, the Northern Corridor biface assemblage, more distant from toolstone sources, represents later stage reduction than do the other subareas.

Basalt and Obsidian Bifaces

The Tosawihi assemblage also contains 11 bifaces made of basalt and 25 of obsidian. Little basalt or obsidian was recovered from the Quarry (Table 13), but both materials are found in the other subareas; most obsidian bifaces were recovered from the East.

Table 13. Frequencies of Basalt and Obsidian Bifaces from the Four Subareas.

	Quarry	East	West	North	**Total**
Basalt	0	3	3	5	11
Obsidian	1	12	7	5	25
Total	1	15	10	10	36

The basalt bifaces are made on flakes detached from local raw material; cobbles and angular chunks of tabular and massive basalt are common in the Western Periphery and Northern Corridor. Manufacturing techniques similar to those used in opalite biface reduction produced the small assemblage.

Tosawihi basalt is relatively fine-grained and flakes well, although edges produced on basalt flakes are neither as durable nor as sharp as those produced on opalite. This affects the tasks for which basalt tools are most suited. Intended forms of basalt bifaces probably varied. In at least one case, a basalt biface seems to have been used as a quarrying tool; in another, a biface probably served as a large projectile point preform. It is unlikely that basalt bifaces served as cutting tools when so much sharper, more durable material was readily available.

In contrast, the obsidian bifaces are quite different from their opalite counterparts. They are made from small nodules that result in tools much smaller than the average Tosawihi biface (Figure 32). Their fragmentary nature makes their intended forms difficult to infer, but rather than serving as preforms for large bifacial knives or as cores for the production of flake blanks, most probably were large projectile point preforms. Few are complete, but they manifest manufacturing techniques different from those used to produce opalite bifaces.

Examination of other tool categories (points, preforms, flake tools) indicates that obsidian was preferred over opalite for the manufacture of projectile points. Obsidian is particularly well suited to point manufacture because it pressure flakes easily without heat-treatment. Evidence for the *in situ* manufacture of obsidian projectile points was found at a number of sites, and, in fact, little of the obsidian debitage collected reflects biface manufacture. At Tosawihi, as elsewhere in the Great Basin (cf. Chapter 8), Rosegate and Desert Series points are pressure flaked directly on unworked flake blanks, while varying proportions of points of earlier (and larger) point types may exhibit evidence of an intervening percussion flaking phase. In those cases, points broken in manufacture usually would be indistinguishable from small bifaces.

Comparison of the sizes of obsidian bifaces and the target points for which they may have been intended is difficult because most obsidian bifaces in our sample are broken. However, hydration rinds are available for most the obsidian bifaces in the assemblage (cf. Chapter 19; Appendix M); few are as thin as those recorded for Rosegate and Desert Series points. The majority of sources determined by X-ray fluorescence (Appendix N) are from Brown's Bench, the source from which the only two sourceable stemmed points were derived.

One small, apparently reworked, obsidian biface tip from an unknown source resembles examples of fluted point fragments from the Dietz site (John Fagan personal communication; Willig 1988:Figure 11a-d). Three hydration rim measurements (6.1, 6.4, 3.6) place the piece within the range recorded for many of the Early Archaic and Stemmed Series obsidian points in the assemblage. This biface has an impact fracture on the ventral surface and the distal portion of a negative scar originates from its proximal end (Figure 32a; Figure 33); it may be a Western Clovis point (Willig and Aikens 1988). Thus, we suggest that the obsidian bifaces from Tosawihi represent primarily percussion flaking stage preforms for the production of large, Early Archaic (or earlier) projectile points.

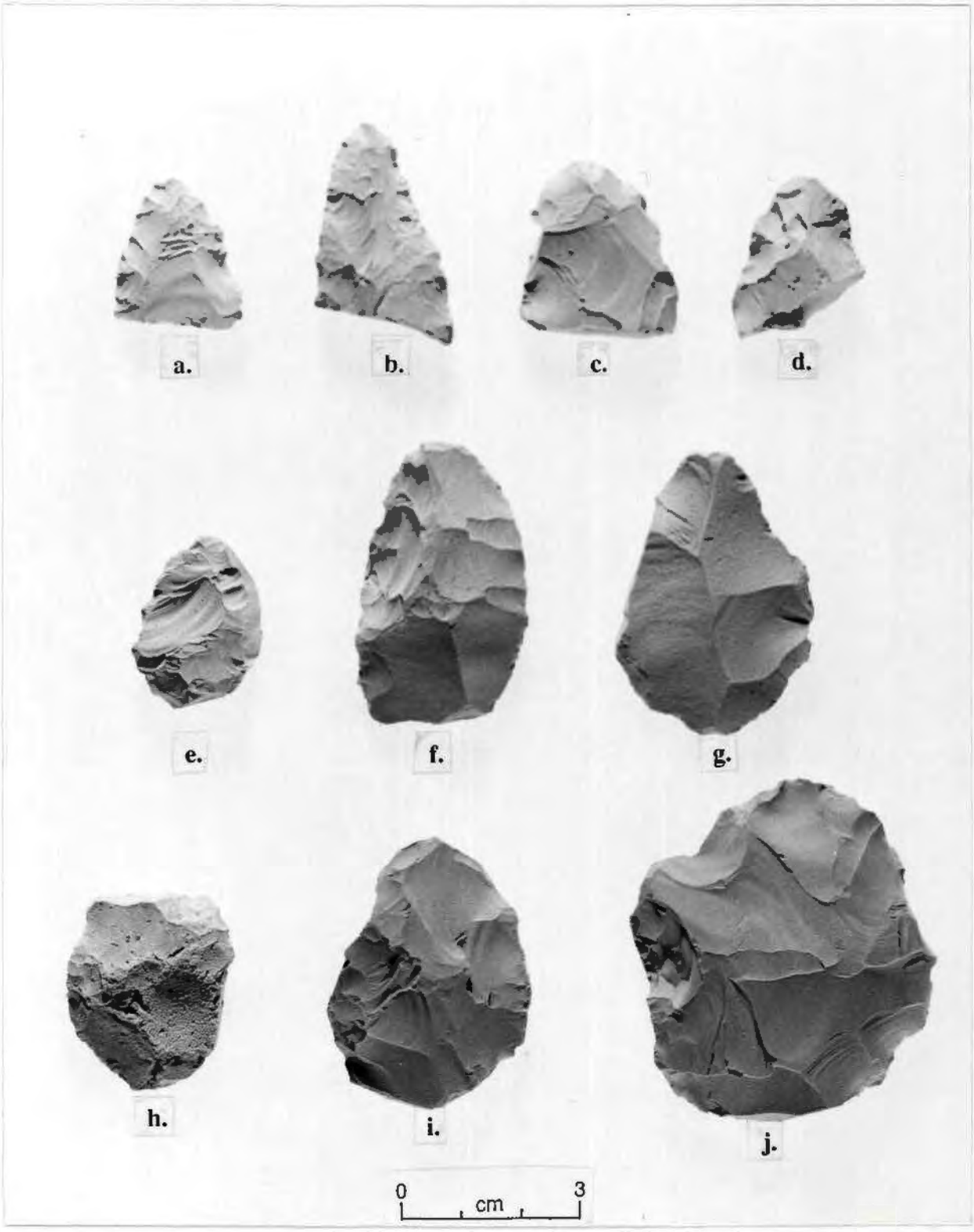


Figure 32. Selected obsidian bifaces.

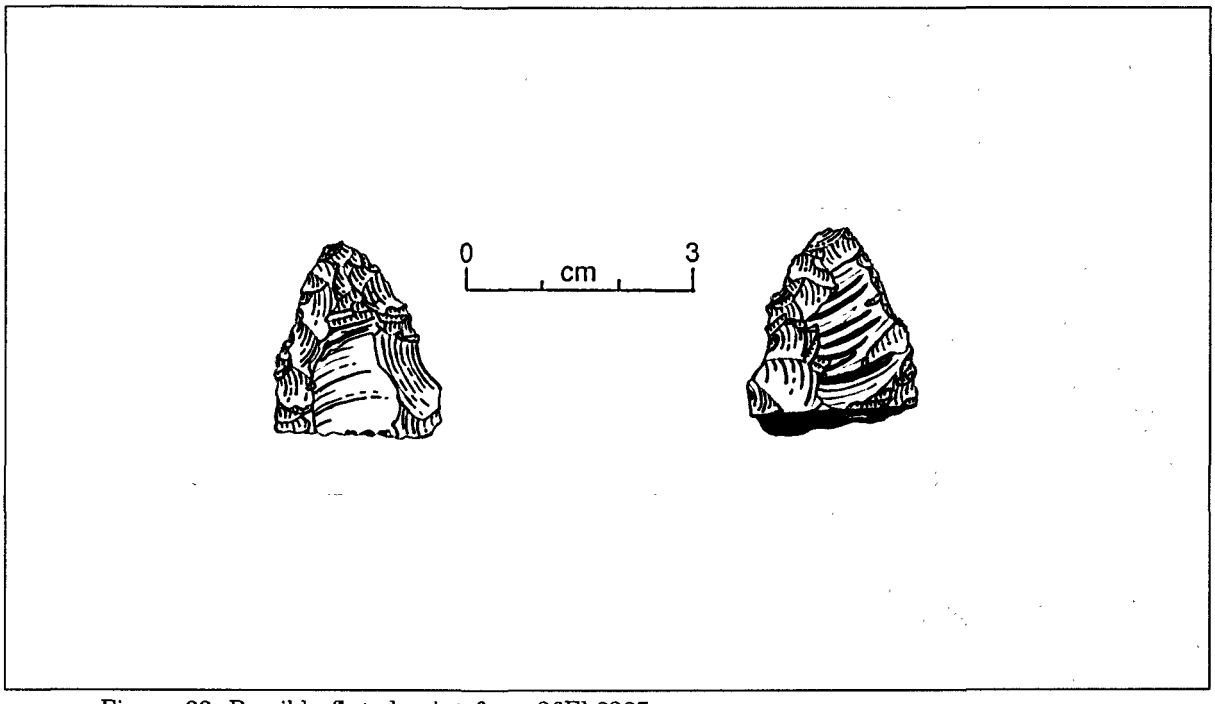


Figure 33. Possible fluted point from 26Ek3237.

Caches

During her initial Tosawihi investigations in 1977, Mary Rusco discovered a cache of six large bifaces lying on the surface in 26Ek3032. During the course of our more recent work, we have recovered four additional caches, bringing the total number of cache finds to 84 bifaces.

Cached goods are not uncommon in the Great Basin. Ethnographic accounts of caches refer primarily to foodstuffs (Fowler and Fowler 1971), but dry cave finds indicate that a wide variety of objects and commodities were cached (Heizer and Kreiger 1956; Thomas 1985; Ingbar 1985), including snare kits, fishing kits, duck decoy manufacture and repair equipment, sewing kits, basket-making kits, stone tool making kits, etc.

Caches of unfinished lithic tools most often contain point preforms (Pavesic 1985; Scott et al. 1986; Hester 1974), sometimes mixed with finished points. Caches of large unfinished bifaces are less frequent, but are reported from the Northern and Southern Plains (Miller et al. 1991; Tunnell 1977) as well as from the Great Basin (Janetski et al. 1988). These biface caches differ from those at Tosawihi in that they occur at considerable distances (up to 200 km) from raw material sources.

At Tosawihi, cache bifaces were found in the Quarry, East, and West in a variety of depositional circumstances ranging from surface finds (probably exposed through erosion) to storage in a crack at a small rockshelter, as described in later chapters. Biface caching at Tosawihi may have been a function of over-production, or of purposeful storage for a return foray; or, they may contain special trade objects, or merely the less successful products of a quarrying episode (cf. Chapter 4). The general quality (Figures 34, 35) of cache bifaces, and their careful storage, suggests that the latter possibility is unlikely. Cache bifaces probably were produced and stored for retrieval during times less suitable for quarrying.

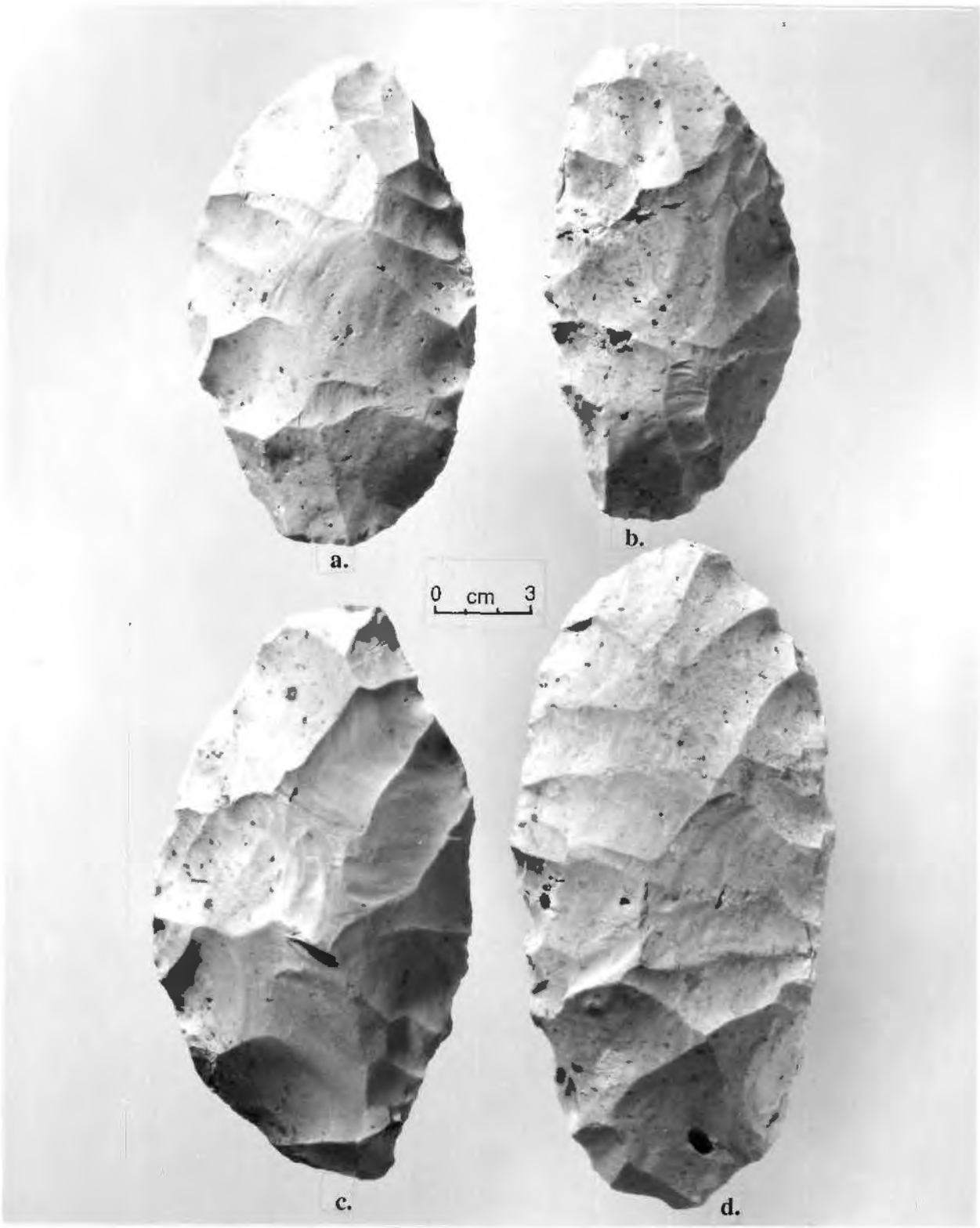


Figure 34. Cache bifaces from 26Ek3095.

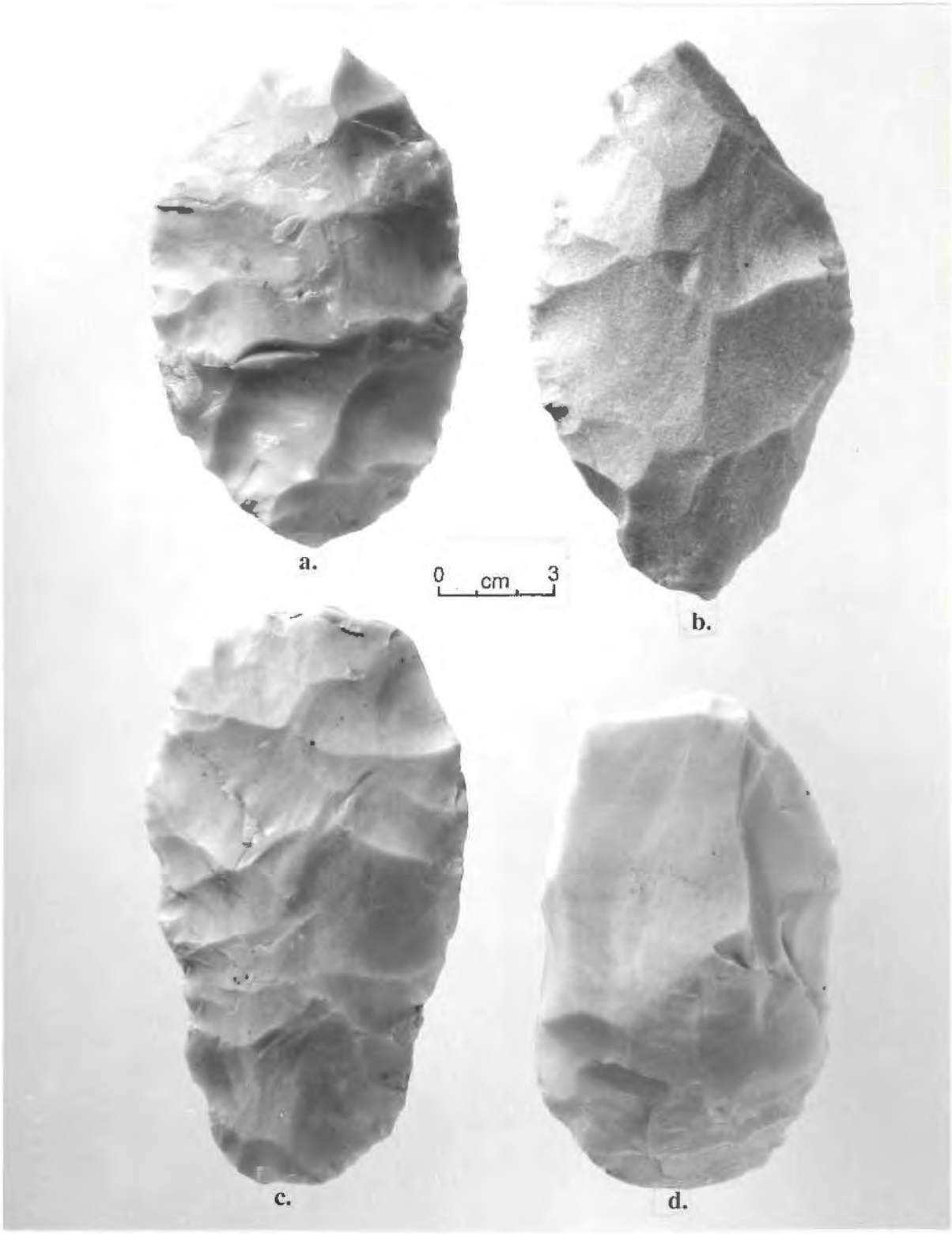


Figure 35. Selected cache bifaces from 26Ek3170.

Almost all the cache bifaces are complete; only one has been heat-treated. Neither within caches nor between them do the bifaces conform to standardized sizes (Table 14a). A cache from the Western Periphery contains the largest bifaces, and exhibits the greatest variation in size. The mean sizes of cache bifaces are larger than for the Tosawihi assemblage as a whole, perhaps because they represent successful production rather than discard of production failures.

Table 14. Attributes of Cache Bifaces.

a. Mean Sizes of Complete Cache Bifaces (in mm)

Site	n	Mean Length	sd	Mean Width	sd	Mean Thickness	sd	Mean Weight	sd
26Ek3032	6	159.8	6.7	72.5	9.9	17.9	1.2	221	43.9
26Ek3095	7	170.7	33.7	87.3	19.8	28.7	9.7	465.1	280.1
26Ek3170	10	135.7	16.3	82.6	13.8	21.5	3.8	277.1	134.7
26Ek3192	38	126.9	16.2	79.4	8.6	23.3	4.1	245	89.7
26Ek3197	14	135.1	7.6	75.4	4.9	30	5	284.7	26.1
Total	75	136.3	21.7	79.3	10.8	24.4	5.9	275.3	130.3

b. Stages of Cache Bifaces.

Site	Stage 1	Late 2	Early 3	Middle 3	Late 3	Indet. 3	Early 4	Total
26EK3032	0	0	0	0	2	0	4	6
26EK3095	0	0	1	6	0	1	2	10
26EK3170	1	0	0	8	1	0	0	10
26EK3192	1	0	15	21	4	0	0	41
26EK3197	0	3	9	5	0	0	0	17
Total	2	3	25	40	7	1	6	84
%	2.38	3.57	29.76	47.62	8.33	1.19	7.14	100.00

Four cache bifaces are made from materials other than opalite (Table 15). The diversity of material color in the cache assemblage is very low; 96.5% are "white". Three caches contain large proportions of pieces made on a distinctive grey brecciated opalite which could be from a single source.

Table 15. Raw Material Types Represented in Caches.

Site	Opalite	Grey Breccia	"Quartzite"	Jasper	Total
26Ek3197	0	17	0	0	17
26Ek3192	24	17	0	0	41
26Ek3032	4	0	2	0	6
26Ek3095	3	6	0	0	9
26Ek3170	9	0	1	1	11
Total	40	40	3	1	84

Most cache bifaces (77%) are reduced to early or middle Stage 3, although the Rusco cache are all late Stage 3 or early Stage 4 bifaces. Since that cache also included a raw

material type uncommon in the other caches, it is possible that it was made by a different group at a different time. It contains two unworked flake blanks, three late Stage 2 bifaces, seven late Stage 3 bifaces, and six early Stage 4 bifaces (Table 14b); this stage distribution is earlier than for the assemblage as a whole, where 23% are early Stage 3 and 34% middle Stage 3.

As noted above, the biface caches were recovered from three of the four project subareas. The distributional pattern of these caches in terms of dimensions and stages does not fit the patterns observed for the bulk of Tosawihi bifaces. We might expect to see the highest proportion of larger, earlier stage bifaces in the Quarry area and smaller, later stage bifaces in the West, but the reverse seems to be true. Bifaces in the one cache from the West, located farther from toolstone sources than the other caches, are the largest of all (although not with the earliest stage profile); the cache from the Quarry (where toolstone sources are most common) has the latest stage profile.

Technological Characteristics

Contributed by Mark W. Moore

The caches provide insight into biface production at Tosawihi quite distinct from that provided by the general biface assemblage. For the most part, cache bifaces are complete and probably are internally contemporaneous. The nature of the caches allows us to see the results of successful reduction strategies and to identify possible time-sensitive specialized reduction techniques.

Technological characteristics of the five caches were examined in order to address two questions: What distinctive knapping techniques produced the bifaces found in the caches? How much technological variability is present among caches? Our cache analysis employed replication experiments and negative flake scar analysis.

Knapping techniques used in manufacture were replicated and the experimental and prehistoric products compared. This allowed a high degree of confidence in reconstructing prehistoric knapping techniques from negative flake scars, and generated insights into why such techniques may have been employed.

A biface can be seen as a stratified knapping product on which most recent flake scars overlap previous flake scars. By identifying which scars overlap others, the analyst can reconstruct the order of flake removal. Once data on the order of flake removal are combined with data on flake scar patterning and orientation, fabricator type, and morphology of experimental products produced using specific knapping techniques, reconstruction of knapping techniques can be made. Methods used to determine the order of flake removal are as described by Moore (1990).

Bifaces with Stage 1 remnant surfaces bearing any one of the following traits are manufactured from flake blanks: contact point (point of percussion), cone of force, pronounced and unidirectional compression rings, hinge termination, feathered edges/termination, or curved ventral surface (profile). If a Stage 1 remnant surface is not obscured and none of these traits is present, the blank is assumed to have been a block. A block that once contacted the bedrock along a stress plane can bear compression-like rings, but they usually are diffuse rather than strongly directional. Nevertheless, the appearance of a ventral surface of a flake blank and a bedrock contact surface can be similar, and this may have resulted in misclassification in some cases. Moreover, when reduction has obscured the ventral surface of the flake blank, it often is not possible to distinguish the two types.

The type of fabricator responsible for a flake scar (soft hammer versus hard hammer) was determined by the presence or absence of prominent negative point and cone of percussion or of pronounced compression rings. These traits are associated with hard hammer percussion, but the appearance of hard and soft hammer scars can be so similar as to prompt misclassification in some cases. Distinguishing soft hammer percussion scars from hard hammer percussion scars is an issue discussed in more detail in Chapter 21. Although not quantified, examination of experimentally produced opalite bifaces showed that the two criteria noted above could be used successfully to distinguish hard and soft hammer percussion scars on biface surfaces.

Definition of Knapping Techniques

Serial, Selective.

Although opportunities for successful flake removal from an evolving biface are limited by surface morphology, such opportunities sometimes can be increased through the use of ordered percussion knapping techniques; ordered manipulation is not required for bifacial reduction, however. Following Huckell (1978:43) and Bradley (1974:193), non-ordered flaking is referred to in this study as "selective," rather than "random," and ordered flaking is referred to as "serial." We use "selective" flaking as a catch-all for percussion flaking techniques in which no consistent order of flake removal is noted. The presence of such patterning allows better assessment of the contemporaneity of caches and specialization of production.

Side-by-Side Percussion.

Side-by-side percussion involves removing a series of two or more flakes next to one another from the same face of a biface (Figure 36).

Skip Patterned Percussion.

Skip patterned percussion involves first removing at least two flakes from one edge of a biface spaced so that they fail to overlap or overlap very little (Figure 36). Subsequent percussion flakes are removed from the same edge, utilizing the area of high mass left between the previous flake scars for flake propagation.

Margin Contouring.

A biface margin is defined here as the portion of the biface extending approximately one-half the distance from the edge to the center line. Margin contouring refers to the process of topographically regularizing the biface margins (cf. Young and Bonnichsen 1984:65).

Alternate Percussion.

Alternate flaking involves removing flakes serially down an edge, alternating faces with each flake removal. The scar resulting from a flake removal from one face is used as the platform for flake removal from the alternate face, resulting in a characteristic wavy edge. Alternate flaking often is used as an edging technique (Callahan 1979:Table 11h).

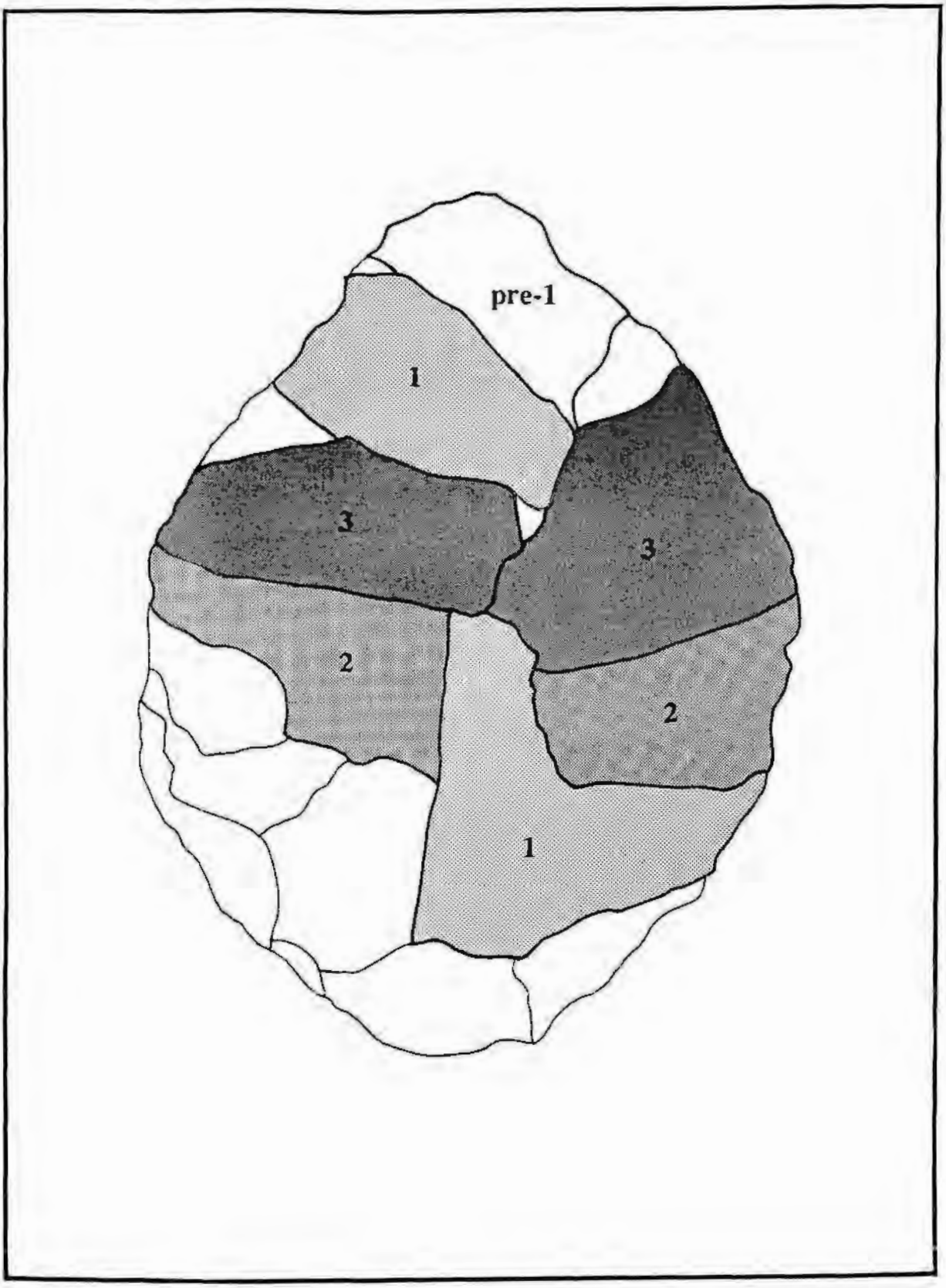


Figure 36. Cache biface from 26Ek3095 showing evidence of side-by-side (right margin) and skip-patterned (left margin) flaking series on a single biface.

Edge Run.

Edge running involves removing a flake down the edge of a biface, resulting in a tranchet-like scar (Shafer 1985:299, 302-303; Callahan 1979:Table 11h; Figure 37c). This scar is used as a platform for additional flake removals. An edge run flake always is removed using an end of the biface as the platform.

Flat Facet Flake Removals.

Flat facet platforms are squared or nearly squared edges used as platforms in percussion thinning or contouring (Figure 38). A flat facet may be a naturally occurring squared edge, an extremely steep negative scar remnant from earlier reduction, or an edge-running negative scar (e.g., Callahan 1979:Table 11h).

Percussion Flattening Scars.

Percussion flattening involves removing flakes in such a way that the biface is thinned radically, providing a flat—not lenticular—cross section. Percussion flattening may be accomplished by only one or two major removals from each face; flakes removed in percussion flattening always travel past the center line, and often terminate near the opposite margin (cf. Callahan 1979:Figures 19c, 89, 39). Scars from percussion flattening normally are partially obscured by later stage contouring and thinning scars.

General Results

Cache 3197.

Cache 3197 consists of early stage bifaces from what appears to be a single discrete source of grey brecciated opalite. Most of the cache was produced from blocks of opalite, with the remainder made on flake blanks (Table 16). The morphologies of the dorsal surfaces of flake blank bifaces suggest the flakes were produced in extraction or in percussion flattening rather than from prepared cores.

Many flake blanks are wider than long ("side struck;" Crabtree 1972:15) and often end in a hinged termination (Figure 37a, b). Such hinged termination negative scars have been observed on bedrock within quarry pits and it appears that some flake blanks were obtained in this way. Following extraction, blocks normally were flattened by percussion flaking from flat facet platforms, sometimes using side-by-side percussion (Table 17). No attempt was made to edge the bifaces completely prior to caching. An edge running technique, to produce flat facet platforms, is common (Figure 37c). Bifaces in cache 3197 were reduced exclusively by hard hammer percussion (Table 19).

Cache 3192.

Cache 3192 consists of early and middle stage bifaces from at least four discrete opalite sources. Most of the bifaces were produced from flake blanks; however, dorsal morphologies suggest the flakes were produced in extraction or from percussion flattening, rather than from prepared cores (Table 16). Most of the flake blanks are wider than they are long ("side struck;" cf. Figure 37a, b). Following procurement, most flakes and bifaces were flattened, sometimes by using flat facet platform. A side-by-side removal technique was frequent, and a skip-patterned technique occasional (Table 17). Many of the bifaces were edged prior to caching. Edge



Figure 37. a, b. Bifaces on "side struck" flake blanks; c. biface exhibiting edge run flake scar.

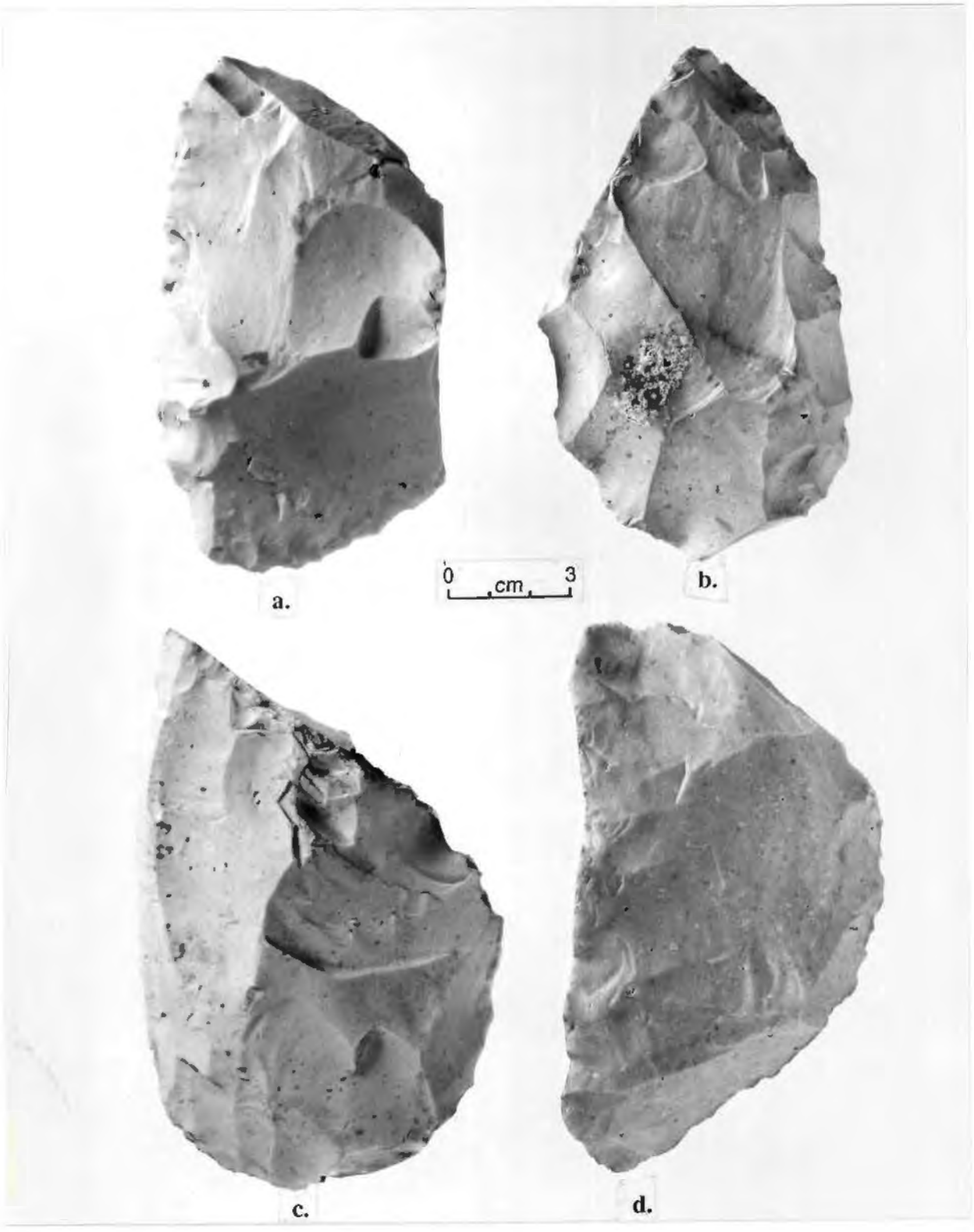


Figure 38. Bifaces exhibiting flat facet flake removals.

running was practiced occasionally to produce flat facet platforms. Bifaces in Cache 3192 were reduced by hard hammer percussion, soft hammer percussion, and a mixture of the two (Table 19).

Cache 3032 (Rusco Cache).

Cache 3032 consists of later stage bifaces from at least two discrete raw material types, one of which appears to be a fine grained quartzite. Blank types could not be determined. All the cache 3032 bifaces have signs of percussion flattening. Serial techniques were commonly utilized in thinning, with skip-patterned thinning more common than side-by-side (Table 17). All the bifaces are completely edged or nearly so. None shows signs of flat facet platform thinning, although one has an unutilized flat facet platform in the form of edge run scar. Bifaces in Cache 3032 were reduced by soft hammer percussion, hard hammer percussion, and a mixture of the two (Table 19).

Cache 3095.

Cache 3095 consists of later stage bifaces from at least two discrete opalite sources. Most of the cache was produced from blocks of opalite, with the remainder made on flake blanks (Table 16). A few bifaces were percussion flattened. Percussion flaking was common, using a patterned technique, most frequently side-by-side, occasionally, skip-patterned (Table 17). A few bifaces show flake removals from a flat facet platform; none derives from edge running. All are edged entirely or nearly so. Bifaces in Cache 3095 were reduced by soft hammer and by a mixture of hard and soft hammer (Table 19).

Cache 3170.

Cache 3170 consists of predominately later stage bifaces from at least three discrete opalite sources. Most of the cache was produced from blocks of opalite, with the remainder made on flake blanks (Table 16). One flake blank may have been struck from a prepared core, or may have been recycled from earlier reduction. The latter flake blank is longer than it is wide. About half the bifaces were percussion flattened. Percussion flaking was common, using a patterned technique, most frequently side-by-side, with some skip-patterned flaking (Table 17). A few bifaces show flake removals from a flat facet platform, some of which derive from edge running. All the bifaces are edged entirely or nearly so. Bifaces in Cache 3095 were reduced by hard hammer, soft hammer, and a mixture of the two (Table 19).

Inter-Cache Comparisons

Block Blanks, Flake Blanks.

Differentiation between block blanks and flake blanks becomes more difficult as biface stage increases because initial morphologies become obscured. Hence, the earliest stage caches perhaps comprise more accurate indicators of blank type employed in biface production. The reduction technology responsible for the 3197 and 3192 caches utilized both block and flake reduction (Table 16).

Table 16. Proportions of Blank Types Present in Caches.

Site	% Flake Blank	% Block	% Indeterminate
26Ek3197	31	56	13
26Ek3192	46	37	17
26Ek3032	0	0	100
26Ek3095	14	29	57
26Ek3170	20	30	50

Flake blanks in both of these caches are thick and usually are wider than long. Typical dorsal morphology is simple, consisting of one or more bedrock contact surfaces. Hence, it appears that these large flakes were removed directly from bedrock, or derived from initial contouring of large blocks. They do *not* appear to derive from flake core reduction. Replication experiments suggest that a "side struck" flake results from an attempt to remove a large flake without the benefit of a constricted area of high mass for propagation. As a result, the propagating flake fans out rather than continuing straight along an area of high mass. Flakes struck under these conditions frequently end in hinge terminations, a characteristic noted on many flake blanks from Caches 3197 and 3192 and on several flake scars in bedrock observed in Tosawihi quarry localities.

One flake blank in Cache 3170 is relatively thin and has a multifaceted platform; it may have been struck from a prepared core. It is too small, however, to have been used to produce a biface typical of the cache.

Serial-Selective.

All the caches are dominated by selective percussion flaking techniques; however, serial flake removal techniques are present to varying degrees in all the caches. Generally, the earlier the stage of the bifaces, the fewer the number of episodes of serial flaking. Consequently, caches 3197 and 3192—the earliest stage caches—show the lowest numbers of serial removals; and caches 3032, 3095, and 3170—the latest stage caches—have the highest numbers of serial removals.

Side-by-Side.

The side-by-side percussion technique is the most commonly utilized serial technique used to produce the biface caches (Table 17).

Table 17. Proportions of Side-by-Side and Skip-Patterned Flake Removals on Cache Bifaces.

Site	% Side-by-Side	% Skip-Patterned
26Ek3197	100	0
26Ek3192	93	7
26Ek3032	43	57
26Ek3095	78	22
26Ek3170	83	17

Side-by-side percussion occurs most frequently in earlier reduction. Whereas Caches 3197 and 3192—the earliest stage caches—have the lowest absolute amount of serial flaking (Table 17),

they also have the highest incidence of side-by-side thinning: serial flaking at Cache 3197 is entirely side-by-side, 97% at Cache 3192. The presence of skip-patterned flaking in Cache 3192 may owe to the presence of later stage bifaces within the same cache. Nevertheless, side-by-side thinning is the most common serial thinning technique utilized in all caches save 3032.

Skip Patterned.

The skip patterned percussion technique is the least applied serial technique used to produce cache bifaces. It is most frequent in later reduction, but, with the exception of Cache 3032, is used infrequently (Table 17). Cache 3032 has the most Stage 4 bifaces, and the high incidence of skip patterned flaking within it probably is a function of the high number of Stage 4 bifaces. The skip/patterned thinning technique may in fact be a characteristic of late stage Tosawihi bifaces, and the incidence of skip/patterned flaking may increase dramatically in later reduction stages not represented in the caches.

Margin Contouring.

All the bifaces from the Tosawihi caches have margin contouring scars. Margin contouring scars derive from edging, platform preparation, and removal of margin irregularities. While scars of these types normally are present in all kinds of bifacial reduction, Young and Bonnichsen (1984:65-66) imply that different knappers may use margin contouring techniques differently; thus, variation in the types of margin contouring scars may reflect variations in reduction technology. No attempt was made in the present study to define variation in margin contouring.

Alternate.

Alternate flaking, commonly thought of as an edging technique (e.g., Flenniken and Ozbun 1988:232), should have occurred most frequently in the earlier stage caches. Cache 3095, however, a later stage cache, showed the greatest amount of alternate flaking. This may be due to post-stage 2 edging. Alternate flaking was not common in any case (Table 18).

Table 18. Proportions of Specialized Knapping Techniques Present on Biface Caches.

Site No.	% Patterned	% Flat	% Sq. Edges	% Alternate	% Edge Run	% Overstrike
26Ek3197	38	56	75	6	44	6
26Ek3192	54	66	39	10	17	10
26Ek3032	67	100	-	-	17	33
26Ek3095	71	29	14	29	-	30
26Ek3170	80	50	20	10	30	-

Flat Facet Platforms.

Removing flakes from flat facet platforms is a common knapping technique in the Tosawihi caches, particularly in the earlier stage caches (3197 and 3192). Several bifaces in Cache 3197 have many contouring and thinning scars. However, these bifaces are not edged; instead, all the flakes were removed from flat facet platforms (Table 18). This is somewhat contrary to Callahan's (1979:67) stage classification in that, facially, Stage 3 bifaces are produced prior to satisfying the Stage 2 edging criteria.

Replication experiments suggest that hard hammer percussion is best conducted from flat facet platforms. Non-heat-treated opalite falls at about 4.3 on Callahan's (1979:16) lithic

grade scale, and consequently is quite hard and unelastic. When attempting to remove a large flake with a hammerstone (local Tosawihi hammerstones are rather hard, consisting primarily of basalt, quartzite, opalite, or rhyolite), the edge consequently must be "thick" and the blow applied at some distance from the edge; applying a hard hammerstone blow to the thin edge of a raw opalite biface often results in platform collapse. Flat facet platforms are desirable, then, because they allow the application of non-marginal hammerstone blows. Complete edging, therefore, may remain undesirable as long as a hard hammer fabricator is being used. Switching to soft hammer percussion allows for the application of marginal blows and marks a switch in reduction technique, particularly in terms of platform (and edge) morphology.

Edge Run.

The edge running technique is most common in early stage Cache 3197, but also is present on later stage bifaces in Caches 3192, 3032, and 3170. The high use frequency of the edge running technique in Cache 3192 probably is the result of an attempt to set up flat facet platforms for further flake removals, and is therefore an extension of the flat facet platform technique.

Edge running is present in the later stage caches, where it appears to prepare platforms for soft hammer rather than hard hammer percussion. The edge running facets on these later stage bifaces rarely are as steep as the flat facets commonly used as platforms in earlier reduction.

Percussion Flattening.

Percussion flattening was practiced to varying degrees in all the biface caches. Replication experiments suggest the degree of percussion flattening necessary depends on the morphology of the object reduced; generally, flake blanks require less flattening than blocks. There appears to be no relationship between general stage of the cache and amount of flattening.

Hard Hammer, Soft Hammer.

The degree of hard hammer percussion appears dependent on reduction stage; the earlier the stage, the more hard hammer percussion was employed. Consequently, all the flake scars on Cache 3197 bifaces were produced by hard hammer percussion (Table 19). Cache 3192, containing a mix of early and late stages, also has a high proportion of hard hammer percussion scars. Since a shift to soft hammer percussion appears to occur near the end of Stage 2, all hard hammer scars may be eliminated by the middle of Stage 3. Consequently, late stage caches—particularly 3170—have a high percentage of soft hammer scars. Both hard hammer and soft hammer scars can be observed on the same biface if the earlier hard hammer scars have not been eliminated by soft hammer percussion. Cache 3095 may have been reduced entirely by soft hammer, but it seems more likely early stage hard hammer scars were eliminated by later stage reduction.

Table 19. Proportions of Cache Bifaces Produced using Hard and Soft Hammer Percussion.

Site	% Hard Hammer only	% Soft Hammer only	% Hard and Soft
26Ek3197	100	0	0
26Ek3192	44	7	49
26Ek3032	17	17	67
26Ek3095	0	14	86
26Ek3170	10	50	40

Summary

Caches provide multiple examples of the end product of a single knapping technology. Chronological ambiguity is not a problem when assessing knapping strategies exemplified by cached objects produced at a discrete time by individual knappers working within the constraints of the same technology (Young and Bonnichsen 1984:136). Theoretically, differences in thinning techniques observed among caches can permit differentiation among technologies, and therefore among chronologically distinct or culturally distinct assemblages. In order to make the latter case, however, the caches must be comparable in terms of stage, and there must be no overlap in at least some manufacturing techniques among the caches. The Tosawihi caches do tend to overlap by stage, and nearly every knapping technique is present in every cache. Consequently, while some differences among caches may be due to chronological and cultural technological differences, this cannot be demonstrated; in fact, the overlap in discrete techniques between caches is more remarkable than the differences, and most caches appear technologically similar.

Three techniques repeated in most of the biface caches may be peculiar to Tosawihi reduction technology. The first of these, skip/patterned percussion thinning, seems to have been practiced in middle to late Stage 3 and beyond, and increases in frequency as biface thinning continues. The second, percussion thinning from flat facets, was common in early bifacial contouring and thinning, and is associated strongly with hard hammer percussion. Flake removal from flat facets may be a technique at least partially dictated by the nature of the opalite. The third technique, edge running to provide a flat facet platform, represents an extension of flat facet flake thinning into Stage 3 reduction.

Thus, with the exception of the Rusco cache, the cache bifaces recovered at Tosawihi are quite similar. In terms of raw material, three caches contain high proportions of grey brecciated opalite, rare in the assemblage as a whole, and the remainder is almost exclusively good quality white opalite with no distinctive characteristics. It is not possible to determine if the raw material was derived from common sources; Tosawihi opalite is quite variable, however, and biface assemblages recovered from most sites demonstrate more material variety than do any of the caches.

Technological characteristics are quite similar among all but the Rusco cache, and distinctive knapping techniques were used in each. It is possible that the bifaces were produced by a single technological tradition, perhaps within a limited range of time. The early nature of reduction stages and the lack of heat-treatment suggest that the bifaces cached at Tosawihi were stored in a form not yet prepared for export from the quarries (cf. Chapter 21) or, conversely, that they represent a special export form (perhaps for long-distance trade).

Bifaces in the Rusco cache, on the other hand, are made from material different from those in the other caches and have been reduced more extensively. It is unlikely that this cache is related to the others; perhaps these bifaces were stored for quick retrieval during a short visit to the quarry.

Conclusions

Biface Technology and Reduction Trajectory

The production of opalite bifaces at Tosawihi followed a nearly technologically homogenous reduction trajectory. Although idiosyncratic variability in reduction techniques can be observed from biface to biface, the consistent technical pattern within particular reduction

stages, the similarity in size and morphology of bifaces, and the recurrent use of heat-treatment in a particular range of reduction stages underscore this homogeneity.

Evidence from complete Stage 1 and Stage 2 bifaces indicate that biface reduction often was initiated on large flake blanks produced through large block core reduction or direct quarrying. The reduction of colluvial and stream rolled cobbles is minimal in the assemblage as a whole, but more common near cobble sources such as drainages. The reduction of opalite blocks into bifaces is represented, but can be distinguished reliably only among early stage bifaces and debitage.

Reduction passed from Stage 1 blank procurement through Stage 2 edge preparation for the initiation of primary thinning. Edge preparation techniques vary with the morphology of Stage 1 blanks. Thick, square edges necessitate extensive reduction, while thin edges require minimal preparation prior to primary thinning. At Tosawihi thick edges often were thinned by the removal of large interior flakes from almost 90 degree platforms, probably with hard hammer percussion. This technique can be contrasted with that of alternate flaking for the production of a scalloped edge. Reduction experiments show that removing large interior flakes with large platforms and bulbs serves to remove a large amount of toolstone mass from the biface edge with relatively few blows and to begin creation of a lenticular cross-section. With reduction in edge mass, alternate flakes then can produce the desired edge morphology more effectively. Many of the cache bifaces discussed above were not made using this technique because their thin edges and symmetrical shapes required very little edge preparation before primary thinning.

Primary thinning (Stage 3) followed the initial reduction and edge preparation of biface blanks. During this stage, bifaces were shaped to ovoid form and thinned to produce a lenticular cross-section. Much early phase primary thinning may have been done with hard hammerstones. Although we did not quantify either the instances of negative flake scars or the frequency of debitage produced with soft hammers, the overall morphology of many bifaces and biface thinning flakes indicate that soft hammer billets probably were used during the later stages of reduction and possibly to some extent in earlier phases of primary thinning. Antler billets found at quarrying locations where primarily early stage reduction was practiced support this contention. The high proportions of heat-treated Stage 3 and Stage 4 bifaces in the assemblage indicate that heat-treating occurred most often during Stage 3 reduction (Table 5) and was an integral part of the reduction trajectory; that heat-treated Stage 3 bifaces are significantly smaller than non-heat-treated Stage 3 bifaces supports this.

Secondary thinning occurs in Stage 4. Approximately 60% of Stage 4 bifaces were heat-treated. Since the remainder of the Stage 4 bifaces are raw, it is clear that heat-treatment was beneficial, but not essential, to secondary thinning. Experimental reduction of heat-treated opalite increased compliance, allowed better controlled reduction, and required less impact force. The reduction of raw opalite with elk antler and moose antler billets rapidly wore down billets, indicating their potentially short uselife. Increased compliance and the concomitant decrease in required force undoubtedly would serve to prolong the uselife of antler billets. The reduction of billet wear might have been a benefit of heat-treatment, depending on the relative value of billets and their ease of procurement.

Stage 5 is represented by only 11 specimens. These pieces are thin, well shaped, and symmetrical, and nine examples have edges finished by pressure flaking. We consider them to be finished tools. Pressure flaking also is apparent on 44 of the 673 Stage 4 and Stage 5 bifaces, indicating that some of them also may be finished tools.

Results of biface and debitage analyses indicate that lithic production in the vicinity of the Tosawihi Quarries was directed primarily towards the export of a range of biface forms (cf. Chapter 21). But from the relatively frequent occurrence of heat-treated bifaces and the presence of Stage 4 and 5 bifaces, it seems that middle Stage 3 bifaces represent probably only 50% of the intended export products. Some biface reduction would have continued away from

Tosawihi. Reduction experiments indicate that the greatest reduction in mass occurs during initial edging (Stage 2) and primary thinning (Stage 3). So, the reduction of opalite bifaces to early or middle Stage 3 near the quarries was probably to minimize transport costs and maximize usable toolstone transported (Elston 1988b; 1990).

Heat-treatment occurred most often in the Western Periphery and the Northern Corridor; the incidence of activities unrelated to lithic reduction was high there, indicating a relationship between heat-treatment and diversified activity. Heat-treatment of bifaces before the last stages of reduction is apparent, and perhaps was undertaken near the quarries when time allowed. Debitage analysis indicates that in the Western Periphery no more than 25% of the debitage in any assemblage resulted from the reduction of heat-treated bifaces. Although our detailed analysis of debitage involved a limited number of samples, we can assume that a portion of the bifaces produced in the West were heat-treated before they left the area where the toolstone was quarried. The study of reduction assemblages collected from sites farther from the Quarries could yield ratios of raw to heat-treated debitage and provide some indications of proportions of raw versus heat-treated biface reduction. If the quantity of raw debitage is minimal at most reduction locations more distant from the Quarries, probably many more bifaces and flake blanks were heat-treated at the Quarries than was apparent from examined reduction debris.

Our examination of Rossi Mine (Rusco 1982) and Rock Creek (Clay and Hemphill 1986) collections indicated that as much as 95% of Tosawihi opalite debitage assemblages from those sites was heat-treated. Tosawihi bifaces reduced at those locations were either heat-treated in the Tosawihi vicinity, at the Rossi Mine or Rock Creek locations before reduction, or somewhere in between. Evidence from Tosawihi biface caches indicates that cached bifaces are usually large, early and middle Stage 3, non-heat-treated items. The function of caches remains uncertain. If cached bifaces represent standard toolstone storage for quick retrieval and transport, then they differ somewhat from the predominant postulated export forms (cf. Chapter 21), since they are earlier in stage and less often heat-treated than bifaces leaving the Tosawihi vicinity. Cache bifaces may have had a different intended purpose (e.g., as long-distance trade items). If, on the other hand, a cache might be retrieved and its contents further processed (including heat-treatment) on the spot, then caches indicate production beyond immediate need. Caching may have been intended to meet more than one contingency and probably was predicated on the bases of restricted stays in the quarry area, transportability, and target use of the procured material.

The foregoing discussion has presented the results of the biface analysis absent temporal context. Our chronological data give a general idea about the periods during which sites were occupied, but distinct reduction episodes over time cannot be compared. We realize that some variability in biface production may be the result of temporal variation in technology. Still, the patterns of biface production technology at Tosawihi are remarkably clear and consistent, and appear to have been relatively homogenous for a long period.

Spatial Variability in Biface Production

The spatial organization of biface production is evident in variability among biface assemblages of the Quarry, East, and West subareas. Tosawihi bifaces range from large raw Stage 1 and Stage 2 bifaces to small heat-treated Stage 5 bifaces. The distribution of staging and heat-treatment reflects the spatial variability in reduction activities occurring in and around the Quarries. This variability is patterned, indicating patterns in the organization of production across the southern margin of the Quarries; it also may be representative of the reduction variability over the entire (to date unsampled and unanalyzed) expanse of the Tosawihi Quarries.

The Quarry subarea is not well sampled, but is distinct in hosting reduction of the largest raw bifaces. Most of that reduction continued through Stage 2 to produce edge prepared

(Stage 2) and some early Stage 3 bifaces. Heat-treatment and late stage reduction occurred only rarely within the Quarry. The Eastern Periphery includes some quarrying activity, but primarily was an area of early stage biface reduction. Reduction loci usually are discrete, with relatively low frequencies of material and technological diversity. Biface production usually was initiated on blanks, Stage 2, and early Stage 3 bifaces. Reduction generally was carried further than at the Quarry, but still resulted in a high proportion of raw Stage 3 bifaces. Heat-treatment was infrequent compared to the Western Periphery.

The West incorporates a number of large residential/reduction loci and a few quarry locations. The West is no farther from Quarry locations than some sites in the East, but biface production in the West often began at later stages, continued farther into the trajectory, and more frequently incorporated heat-treatment. Too, the diversity of reduced materials was greater, indicating wider ranging sources of toolstone procurement.

The Organization of Biface Production

Several lines of evidence reflect how lithic production at Tosawihi was organized. Transport costs appear important because the vast majority of bifaces are greatly reduced in mass at or near toolstone sources. Even within a few hundred meters of sources there is a consistent pattern of later stage reduction with increasing distance. Over a larger landscape, this is apparent in inter-area comparisons. Package size for transport may be approximated as that of a middle to late Stage 3 or Stage 4 biface (mean weight 128.2-182.6 g). The early stage bifaces found at sites farthest from the Quarry are significantly smaller than the same stage bifaces recovered immediately adjacent toolstone sources.

Even sites on Willow Creek, at the north end of the Northern Corridor, still are within the sphere of biface production rather than of use. Early stage biface fragments, production debris (a significant proportion of it raw, rather than heat-treated), and absence of extensive biface use attest to this. In contrast, primarily late stage bifaces and heat-treated debitage are encountered at sites along Rock Creek and at Rossi Mine.

Standardization of biface form reflects consistent demand. The forms exported from Tosawihi appear to be middle Stage 3 to Stage 4 heat-treated bifaces (cf. Chapter 21). However, we cannot assess this issue adequately in the Tosawihi vicinity, where we remain in the sphere of production. How morphological and spatial patterns of biface manufacture relate to chronology, resource distribution, strategies of toolstone procurement, organization of production, and site location and residentiality are discussed in Chapters 19, 20, 24, 25 and 26.

Chapter 7

FLAKE TOOLS

Kathryn Ataman

Chipped stone tools other than bifaces and projectile points often comprise an important component of prehistoric assemblages. When their function is considered, they can provide information about the diversity and intensity of prehistoric activities, especially where they comprise a large fraction of an archaeological assemblage. Flake tools may have formal shapes, in which an edge is modified to a specific form, or they may be minimally altered. The Tosawihi assemblage includes both formal tools and tools with little edge modification.

Minimally altered flake tools often are referred to as "expedient tools" or "utilized flakes," implying that they were prepared with little effort and were intended for short-term use. This is not necessarily true. Tool utility depends on the relationship between morphology and planned function. An unretouched flake may require no manipulation after selection, but its production, as well as its selection for appropriateness, may require as much strategy as the production of more formal tools. Too, flake tool utility may equal that of the formal tool (Jones 1981; Frison 1979; Lewenstein 1987; Walker 1978; Hester et al. 1976).

Hunting and gathering technologies often employ simple flake tools (MacCalman and Grobbelaar 1965; Jones and White 1988; Callaway, Janetski and Stewart 1986; Powers 1976; Miller 1979; Gould et al. 1971; White and Thomas 1972; O'Connell 1977); such tools probably were used throughout prehistory and in almost every kind of economy (Wendorf 1968). They exhibit a wide range of shapes; some had specific, limited functions, while others were used for a variety of tasks. Variation in form owes in part to mechanical limitations of the size and shape of individual flakes and to efficient patterns of use, and in part to cultural preference (Close 1979).

It often is impossible to distinguish deliberate or use-induced retouch from post-depositional retouch (Howes 1980; Young and Bamforth 1990), so we have included in our sample only pieces on which retouch is unequivocally deliberate. The great abundance of flaked stone debris at Tosawihi, its largely surface context, and the likelihood that it has withstood several millennia of post-depositional damage, have led us to be quite conservative in identifying flake tools. Trampling, for instance, can produce macroscopic and microscopic edge damage mimicking deliberate and use-induced retouch (Knudson 1979; Tringham et al. 1974; Flenniken and Haggarty 1979); we have tried to avoid including such pieces in our analysis, predictably biasing our favor of more heavily retouched pieces. Use wear analysis was conducted on samples of debitage to serve as partial control for this problem.

Flake tools were classified according to overall morphology and outline of working edge. While sharing some morphological attributes, pieces assigned to the same class may or may not have shared a common function. Establishing functional typologies is thorny; not only are such typologies difficult to compare to more traditional (morphological) regional typologies, but degrees of stylistic variation and standardization are observed. In addition, functional analysis based on use wear traces is conclusive only for a portion of any analytical assemblage, owing to variation in post-depositional modification; this inhibits interpretive accuracy and precision. Nonetheless, functional terms (e.g., "scrapers") are useful because they describe morphological classes; although we use such terms expediently in the present discussion (e.g., "end-scraper" instead of "convex-edged flake with continuous, abrupt to semi-abrupt retouch"), we disavow the implied functional assessments.

Use wear analysis was conducted on somewhat more than half the flake tools recovered from the quarries, but, as noted above, the results have not affected the classification used here.

In the pages following, consideration of the functions of pieces in a tool class is embedded in the class description, and correspondences between form and function are discussed. A sample of unretouched flakes also was examined for use wear traces to identify the use-frequency of unmodified flakes.

Research Aims

The intent of the analysis reported here was to examine the morphological and functional variability, as well as the intensity of use, of the recovered tool assemblage. More diverse and more intense activities, and diverse raw materials, generally are expected at sites occupied for relatively long periods by larger groups. Fewer activities, whether intensive or ephemeral, indicate more limited occupation; such sites may represent short term camps or special purpose sites. Brief visits by small groups of quarriers unaccompanied by their families should not have produced assemblages as large or diverse as those produced by a number of families over a season of quarrying. Degree of tool curation, too, characterizes the nature of the occupation; exotic raw materials and highly formalized, hafted, or intensively used tools probably indicate longer term occupations.

Tool production technology is also part of our analysis. Whether flake tools are produced on selected by-products of biface manufacture rather than on blanks from flake cores indicates whether flake tool production was independent of biface production or was an opportunistic strategy. Variation in production strategies among tool types and from site to site is used to examine the standardization and organization of lithic technology. Variability within morphological types and among subareas is examined in this chapter; locationally specific variability is discussed later.

Investigation Techniques

Analytical Definitions and Data Collection Structure

Our flake tool sample includes 864 pieces from 52 sites and localities (including 3 non-site, discretionary surface collections). Forty variables (provenience, metrics, raw material type, blank characteristics, tool and edge morphology, and macroscopic and microscopic edge damage characteristics) were recorded. Recording of provenience, metrics, and raw material variation common to several artifact categories is described in Chapter 6; categories specific to the flake tool data class are discussed below.

Blank Morphology

Five variables describe tool blanks (selected flakes); they include extent of retouch, blank type, blank shape, fragment type, and nature of thermal alteration. The latter observation was intended to record the reduction stage at which heat-treatment was carried out. This stage is difficult to assess where reduction has removed most of the original surface of blanks, but *general* stages frequently can be recognized. We segregated tools made on blanks produced from heat-treated cores, tools heat-treated as flakes, and tools heat-treated after initial blank reduction; we also recorded post-manufacture alteration, *possible* instances of heat-treatment, and evidence of heat-treatment carried out at an indeterminate production stage.

Retouch

Retouch observations recorded five variables: retouch type (percussion or pressure), direction (direct, inverse, or bifacial), extent of retouch along the worked edge (continuous, localized, or intermittent), degree of invasiveness, and number of edges retouched.

Tool Morphology

Four variables describe morphology: plan (concave, convex, straight, irregular, convergent, or multiple) and profile (straight, sinuous, alternating, or irregular) of the main retouched edge, edge angle, and morphological type. Edge angle was recorded only as acute (<35°), medium (>35°<55°), or obtuse (>55°). Twenty-two morphological types were identified, and they can be grouped into more general tool classes (cf. below).

Three categories of scraper (flakes with continuous abrupt or semi-abrupt retouch serving to strengthen or regularize a usually convex edge) are included. Side-scrapers and end-scrapers were segregated by the orientation of the retouched edge on the blank; and a category of miscellaneous and fragmentary specimens also was established.

Four categories of pointed tools were defined; the class subsumes specimens commonly called perforators, awls, drills, and gravers. To evade functional ascriptions, morphologically descriptive terms were used; we recognized elongate and short symmetrically pointed tools, asymmetrically pointed tools, and trihedral tools.

Pieces exhibiting notches have been assigned to a single tool class, irrespective of whether notching is singular or multiple. Too, three categories of flake tools exhibit bifacially worked edges; we sorted them on the basis of edge profile (straight, slightly sinuous, and coarsely sinuous). They are distinguished from bifaces in that the flaking often is not invasive, the plan often is circular, and the edge frequently is regularized; none of these attributes commonly characterizes bifaces.

Modified flakes ("retouched flakes," "edge-damaged flakes," or "expedient tools") have been segregated by the extent and location of retouch. We recognized five categories: flakes with continuous retouch on one edge, those with continuous retouch on multiple edges, those with localized retouch, crudely retouched flakes or chunks, and flakes with variable retouch patterns on multiple edges.

Microdenticulates are small tools with a fine-toothed edge; we separated them from notches and other denticulates because of their distinctive, fine, and regular denticulation. Discoids are large, shaped, and often battered pieces flaked around their entire perimeter. Flaked/battered tools are large, irregular tools with both flaked and battered edges which appear distinct in technology (and perhaps in function) from the hammers and choppers discussed elsewhere. Pressure flaked tool fragments may be pieces of flake tools, bifaces, preforms, or projectile points, but they are too fragmentary to classify. "Other" tools include unique, distinctively-shaped specimens.

Edge Damage and Microscopic Wear Traces

Macroscopic and microscopic wear patterns also were observed and recorded. Macroscopic wear was sought on all flake tools, while microscopic characteristics were recorded for 578 pieces (66.9% of the assemblage). Based on these observations, tool-use was inferred for all the pieces examined microscopically. The techniques used to assess tool function are described in detail in the following section.

The sample of flake tools considered in this analysis includes tool classes examined in entirety and some classes from which only a few pieces were selected; some classes were not examined at all. We concentrated on scrapers, pointed tools, notched items, and miscellaneous retouched flakes, because most specimens fall into one or another of these classes. Many broken pieces were excluded from study, as were tools too large for microscopic scrutiny and tools of especially coarse raw material which conceals wear traces.

Microwear studies rely on comparison of macroscopic and microscopic wear traces on prehistorically used edges to those on experimental tools used to simulate prehistoric tasks. Accordingly, experiments were undertaken to observe how opalite tools function and wear when used to accomplish a variety of tasks and to provide a comparative wear-pattern collection. We undertook limited experiments using Tosawihi opalite, and extrapolated our results to other flint and chert materials to infer direction of motion, intensity of use, and hardness of the worked material. The experiments were conducted with facsimiles of tools in the Tosawihi assemblage, including bifaces, scrapers, pointed tools, and miscellaneous retouched and unretouched flakes. The experimental tools were made from a variety of Tosawihi opalites; they were manufactured utilizing techniques similar to those which produced the tools in the archaeological assemblage, and both raw and heat-treated blanks were employed. Fifteen tools skinned, butchered, filleted, and removed sinew for intervals of ten minutes to 2.5 hours; seven tools cut, scraped, and perforated fresh hide for 15 minutes to 3 hours; and, six tools sawed and grooved soaked antler for 15 minutes to one hour.

The results indicate that raw opalite yields durable, sharp edges that develop use wear polish more slowly when working soft materials than do other, more fine-grained or amorphous flints or cherts. For example, an opalite tool used to butcher deer meat for 2.5 hours exhibited very little polish visible at 100x magnification, while my own experience indicates that similar activities using finer-grained materials produce polish after shorter periods of use. Work on harder materials, however, develops polish at a faster rate; macroscopically visible gloss was produced on opalite tools after 1.5 hours of scraping soaked deer hide.

Heat-treated materials are slightly more brittle and have less durable edges than untreated stone. No advantage was noted in the use of heat-treated opalite tools, although in manufacture they are easier to flake. Heat-treatment does, however, affect the appearance of the tool surface under the microscope and often limits identification of function to general levels of interpretation.

The approach to function analysis we used represents an adaptation (Grace et al. 1988) of Keeley's (1980) method of microwear analysis whereby we assume that the distribution and level of development of microwear polish produced by use reflect tool function, but that *the appearance of the polish itself* is not diagnostic of function; edge damage and tool morphology also are incorporated into inferences of tool function. The chief variables considered by this approach include edge shape, edge angle, degree of edge rounding, distribution of polish and striations (in the case of obsidian, striations only), and degree of polish. Such an approach has been tested using tools made of English chalk flint (Grace et al. 1988), and then modified and tested on obsidian tools (Ataman 1989) with results that compare favorably to other blind tests; motion of use was interpreted successfully in 90% of the cases.

Microwear studies can characterize tool function in a number of ways; from general to specific, these include initial identification of use, identification of use-edges, motion of use, hardness of material worked, intensity of use, and the nature of the worked material. Longitudinal or transverse use, for example, in combination with edge form and the location of edge damage reflects motion of use, type and degree of edge damage reflects hardness of the contact material, and polish and edge rounding reflect intensity of use.

Function inferences commented on intensity of use when wear traces were sufficiently interpretable; tools with less interpretable traces were characterized only as used, unused, or indeterminate. Many tools were classed as indeterminate but very few as unused, probably because our segregation of flake tools from debitage was biased towards more heavily used tools.

Post-depositional surface modification also can preclude functional determination. Mechanical damage caused by trampling, weathering, and excavation and post-excavation procedures can make wear traces uninterpretable (Levi-Sala 1986; Plisson and Mauger 1988; Keeley 1980). Post-depositional traces on opalite can be detected by the presence of polish on high spots and interior surfaces. On obsidian, the random orientation and distribution of striations are indicators of post-depositional mechanical damage. Our suite of analytical techniques sometimes permitted low level interpretations (e.g., whether or not a tool had been used) on post-depositionally altered pieces, but more specific inferences could not be made with confidence.

A Type "S" trinocular Nikon metallurgical microscope with light incident attachment was used for microscopic analysis. Most tools were scanned at 50x and 100x magnification, and 200x and 400x magnifications were used to inspect specific features. Before examination, specimens were cleaned with alcohol using cotton swabs; when necessary, previously applied catalog numbers were removed with acetone.

Type Descriptions

Scrapers

Three types of scraper were defined by orientation of the working edge on the tool blank: side-scrapers (n=39), end-scrapers (n=97), and miscellaneous and fragmentary scrapers (n=52) (Figures 39-41). Apparent functional variability within type is discussed later in the chapter.

Side scrapers are longer (mean length=69.8 mm) than end-scrapers (mean length=58.6 mm) but similar in width and thickness (Table 20). None differs much from the average size of all flake tools. Most (83%) are made of opalite; jasper and obsidian comprise much smaller fractions, and other materials form about one to three percent of the total (Table 21). The material diversity of scrapers, measured by color, is similar to that of all flake tools (Table 22).

Table 20. Mean Dimensions of Complete Flake Tools.

Tool Type	Total	Length (cm) Mean	Length (cm) SD	Width (cm) Mean	Width (cm) SD	Thickness (cm) Mean	Thickness (cm) SD	Weight (gm) Mean	Weight (gm) SD
Side Scraper	22	69.8	24.5	43.1	16.8	12.4	4.8	52.2	48.1
End Scraper	67	58.6	21.1	44.2	15.0	6.3	5.5	38.9	49.5
Misc. Scraper/Frag.	24	67.2	27.2	51.3	19.0	2.3	6.5	55.1	45.6
Sym. Pointed Tool (elong)	13	3.5	13.5	22.9	12.7	7.1	2.3	6.3	4.9
Sym. Pointed Tool (short)	6	1.4	11.4	30.9	6.3	8.5	2.7	10.1	9.0
Assym. Pointed Tool	15	43.4	13.0	32.5	13.0	7.9	3.5	11.6	8.8
Trihedral Pointed Tool	5	85.6	14.2	30.8	12.0	20.1	5.8	52.3	33.7
Notch/Denticulate	25	68.4	21.1	52.4	17.7	15.6	9.0	60.0	63.0
Bif. w/slightly sinuous prof	6	54.3	15.5	43.3	11.4	11.3	3.3	30.8	16.3
Bif. w/coarse sinuous prof	2	80.7	8.6	59.3	4.4	19.3	3.6	79.0	32.0
Flake w/cont. retouch (one edge)	36	48.1	19.9	41.2	16.9	9.7	5.9	26.7	66.0
Flake w/cont. retouch (multiple edges)	14	68.1	24.1	51.2	20.8	12.0	6.7	46.1	59.1
Flake w/localized retouch	50	58.8	22.3	44.7	16.3	11.0	5.6	33.8	35.5
Crudely retouched flake/chunk	6	70.1	31.2	49.7	10.8	15.0	9.5	73.9	68.6
Flake w/var. retouch pattern (multiple edges)	26	56.7	22.4	42.7	19.7	10.2	5.3	30.1	36.4
Microdenticulate	4	41.0	6.7	19.1	6.5	4.0	1.9	3.8	1.8
Discoidal tool	8	102.6	33.4	93.9	29.0	24.6	16.3	382.3	366.8
Chopping Tool/Hammer	5	116.2	49.5	71.4	16.6	31.5	11.3	324.9	288.7
Other	3	81.8	19.6	39.6	11.1	22.4	9.6	71.9	67.3
	337								

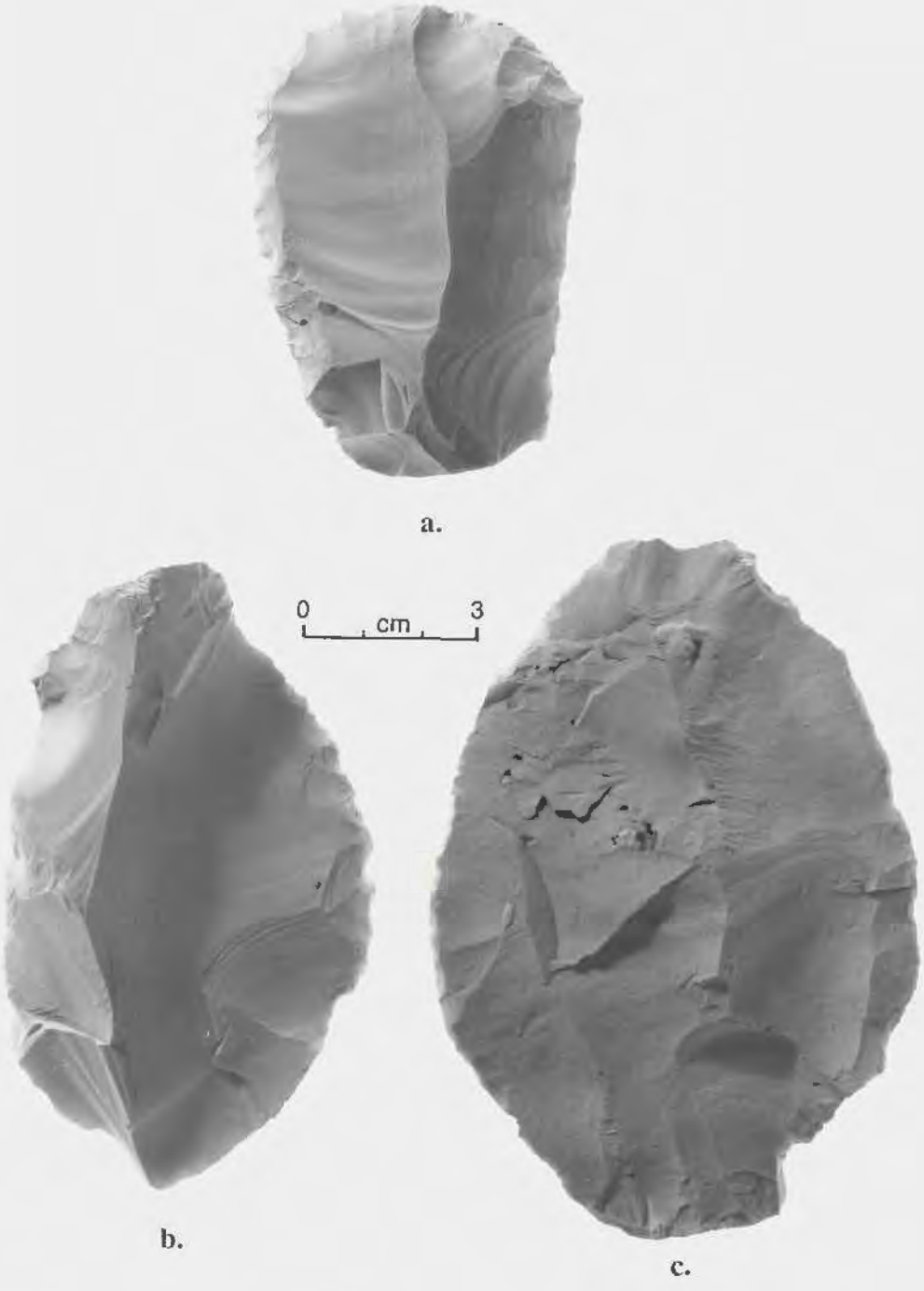


Figure 39. Selected side scrapers.

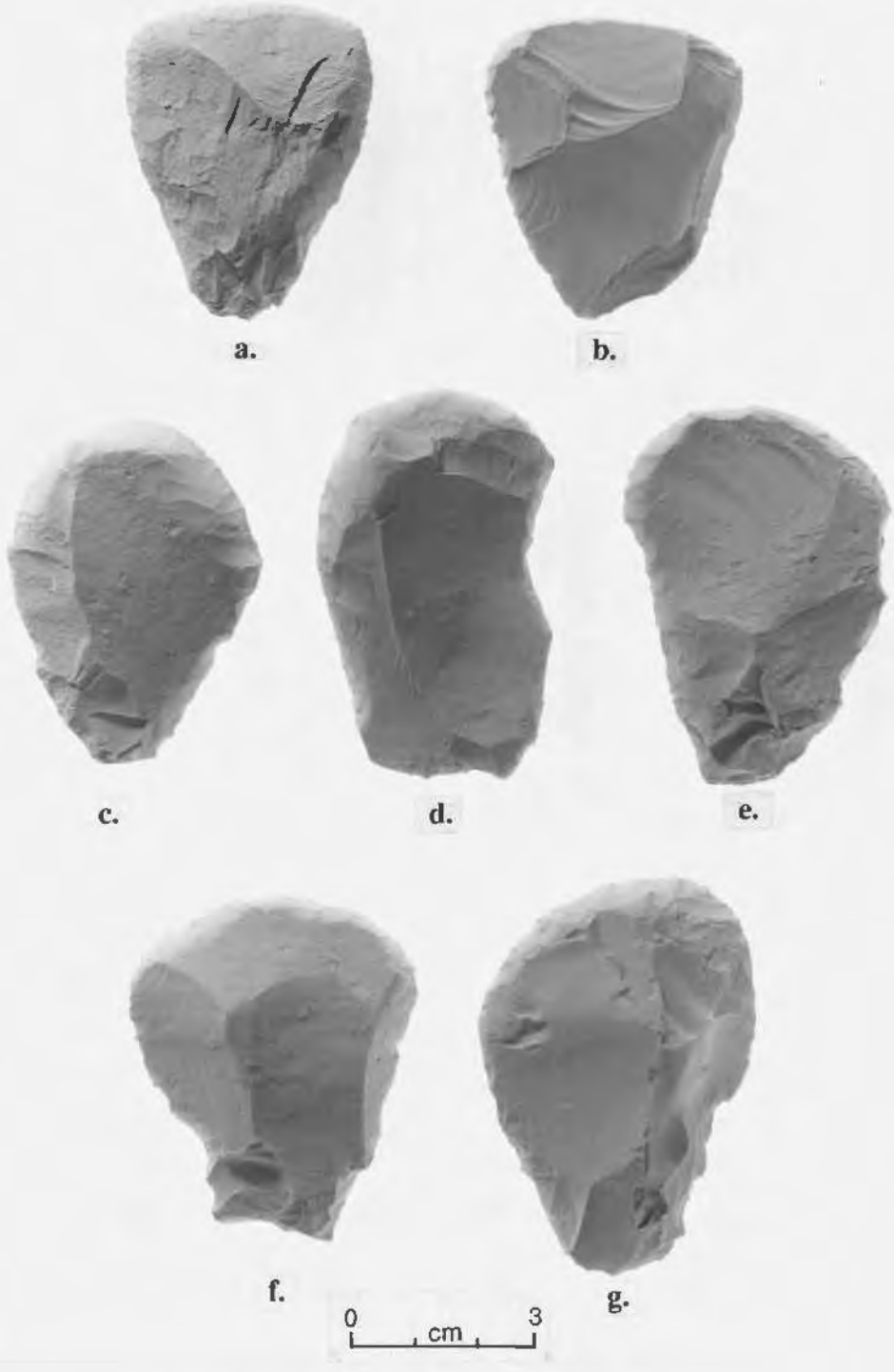


Figure 40. Selected end scrapers.

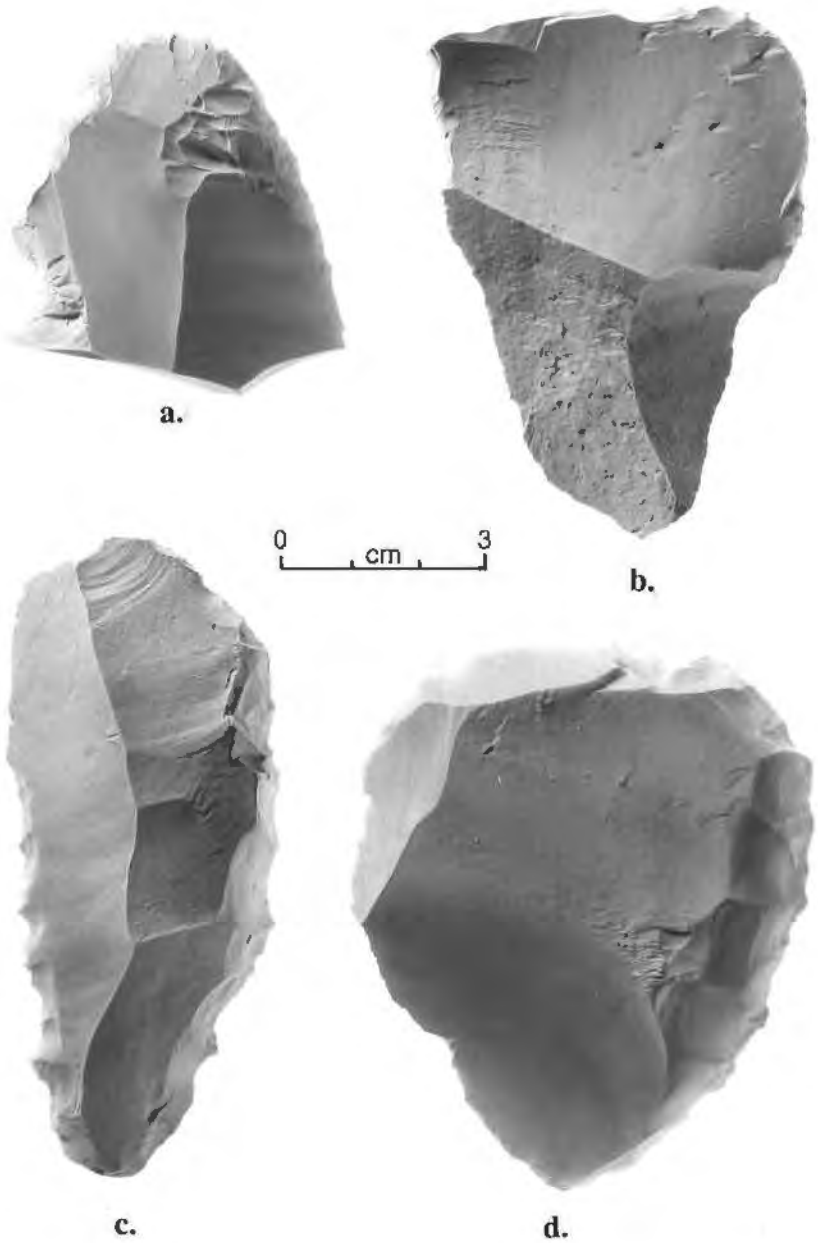


Figure 41. Selected miscellaneous scrapers.

Table 21. Flake Tool Types by Material Type.

Tool Type	Material Opalite	Obs	Bas	Chal	Jas	Opal	Other	Total	%
Side Scraper	32	1	-	1	4	1	-	39	4.51
End Scraper	75	3	1	-	6	6	6	97	11.23
Misc. Scraper/Frag	43	-	-	-	3	4	2	52	6.02
Sym. Pointed Tool (elong)	48	3	1	1	2	1	-	56	6.48
Sym. Pointed Tool (short)	16	4	-	-	1	-	1	22	2.55
Assym. Pointed Tool	24	2	-	1	-	-	1	28	3.24
Trihedral Pointed Tool	5	-	-	-	-	-	-	5	0.58
Notch/Denticulate	58	-	-	-	3	5	-	66	7.64
Bif. w/straight profile	6	-	-	-	-	-	-	6	0.69
Bif. w/slightly sinuous prof	12	2	-	-	-	-	-	14	1.62
Bif. w/coarse sinuous prof	3	1	-	-	-	-	-	4	0.46
Flake w/cont. retouch (one edge)	89	4	1	3	11	1	-	109	12.62
Flake w/cont. retouch (multiple edges)	29	-	-	-	1	-	-	30	3.47
Flake w/localized retouch	92	4	-	-	8	1	1	106	12.27
Crudely retouched flake/chunk	12	-	-	-	-	2	-	14	1.62
Flake w/var. retouch pattern (multiple edges)	46	5	-	6	3	-	1	61	7.06
Microdenticulate	6	1	-	-	-	-	-	7	0.81
Discoidal tool	6	-	1	-	-	-	3	10	1.16
Pressure flaked tool fragment	20	3	-	3	2	-	-	28	3.24
Fragmentary Indeterminate	80	6	-	-	5	2	-	93	10.76
Chopping Tool/Hammer	9	-	3	-	-	-	-	12	1.39
Other	4	-	1	-	-	-	-	5	0.58
Total	715	39	8	15	49	23	15	864	
%	82.75	4.51	0.92	1.74	5.67	2.66	1.74		

Key: Obs = Obsidian Chal = Chalcedony
Bas = Basalt Jas = Jasper

Table 22. Material Diversity by Tool Type.

Flake Tool Type	"White"	Total	%
Side Scraper	27	39	69.23
End Scraper	66	97	68.04
Misc. Scraper/Fragment	36	52	69.23
Sym. Pointed Tool (elongated)	42	56	75.00
Sym. Pointed Tool (short)	9	22	40.91
Assym. Pointed Tool	24	28	85.71
Trihedral Pointed Tool	4	5	80.00
Notch/Denticulate	50	66	75.76
Bif. w/straight profile	6	6	100.00
Bif. w/slightly sinuous profile	7	14	50.00
Bif. w/ coarse sinuous profile	2	4	50.00
Flake w/ cont. retouch (one edge)	86	109	78.90
Flake w/ cont. retouch (mult. edges)	24	30	80.00
Flake w/localized retouch	75	106	70.75
Crudely retouched flake/chunk	8	14	57.14
Flake w/ var. ret. pat. (mult. edges)	39	61	63.93
Microdenticulate	5	7	71.43
Discoidal tool	8	10	80.00
Pressure flaked tool fragment	13	28	46.43
Fragmentary Indeterminate	67	93	72.04
Flaked/Battered Tools	8	12	66.67
Other	3	5	60.00
Total	609	864	70.49

Scrapers (69%) are made on biface thinning flakes more often than other tool types (54% for all flake tools; cf. Table 23), and are less often broken. This probably owes to their morphology (which includes a high edge angle; cf. Table 24) as well to their use pattern. Scrapers generally are manufactured by direct percussion; most especially, side-scrapers exhibit exclusively unifacial-direct retouch (retouch initiated from the ventral surface), and several exhibit more than one working edge (Table 25).

Table 23. Flake Tools Sorted by Blank Type.

Tool Types	Biface Frags.	BTF	BTF %	Other/ Ind. Flake	Ang. Frag. Chunk	Indet.	Total	%
Side Scraper	-	26	67.0	11	1	1	39	4.51
End Scraper	2	67	69.0	24	2	2	97	11.23
Misc. Scraper	-	27	52.0	17	4	4	52	6.02
Sym. Pointed Tool (elong)	11	19	34.0	22	-	4	56	6.48
Sym. Pointed Tool (short)	3	12	55.0	7	-	-	22	2.54
Assym. Pointed Tool	-	18	64.0	10	-	-	28	3.24
Trihedral Pointed Tool	-	-	-	3	2	-	5	0.57
Notch/Denticulate	1	35	53.0	22	7	1	66	7.63
Biface w/straight profile	1	4	67.0	1	-	-	6	0.69
Biface w/slightly sinuous profile	4	4	29.0	6	-	-	14	1.62
Biface w/coarse sinuous profile	1	2	50.0	-	-	1	4	0.46
Flake w/cont. retouch (one edge)	1	58	53.0	39	5	6	109	12.61
Flake w/cont. retouch (mult. edges)	-	25	83.0	4	-	1	30	3.47
Flake w/localized retouch	-	79	75.0	22	1	4	106	12.27
Crudely retouched flake/chunk	-	5	36.0	6	1	2	14	1.62
Flake w/variable ret. pattern (mult. edges)	-	44	72.0	16	-	1	61	7.06
Microdenticulate	-	5	71.0	2	-	-	7	0.81
Discoidal Tool	2	-	-	5	2	1	10	1.16
Pressure flaked tool fragment	3	6	21.0	16	1	2	28	3.24
Fragmentary Indeterminate	-	29	31.0	44	1	19	93	10.76
Chopping Tool/Hammer	-	3	25.0	6	3	-	12	1.39
Other	-	1	20.0	2	1	1	5	0.58
Total	29	469	54.0	285	31	50	864	
%	3.36	54.28	0.54	32.99	3.59	5.79		

Table 24. Edge Angles of Flake Tools.

Flake Tool Type	Acute n	Medium n	Obtuse n	Total	%
Side Scraper	11	17	11	39	4.51
End Scraper	10	36	51	97	11.23
Misc. Scraper	7	20	25	52	6.02
Sym. Pointed Tool (elong)	13	31	12	56	6.48
Sym. Pointed Tool (short)	9	11	2	22	2.55
Asymmetrical Pointed Tool	7	13	8	28	3.24
Trihedral Pointed Tool	0	0	5	5	0.58
Notch/Denticulate	13	29	24	66	7.64
Bif. w/straight profile	2	4	0	6	0.69
Bif. w/slightly sinuous profile	3	11	0	14	1.62
Bif. w/coarse sinuous profile	0	4	0	4	0.46
Flake w/cont. ret. (one edge)	42	49	18	109	12.62
Flake w/cont. retouch (mult. edges)	14	13	3	30	3.47
Flake w/localized retouch	52	36	18	106	12.27
Crudely ret. flake/chunk	0	8	6	14	1.62
Flake w/var. ret. pat. (mult. edges)	27	24	10	61	7.06
Microdenticulate	7	0	0	7	0.81
Discoidal tool	0	6	4	10	1.16
Pressure flaked tool fragment	8	17	3	28	3.24
Fragmentary Indeterminate	39	39	15	93	10.76
Chopping Tool/Hammer	0	3	9	12	1.39
Other	2	1	2	5	0.58
Total	266	372	226	864	
%	30.79	43.06	26.16		

Table 25. Proportion of Flake Tools Exhibiting Pressure Flaking.

Flake Tool Type	Pressure Flaked	Total	%
Side Scraper	1	39	2.56
End Scraper	5	97	5.15
Misc. Scraper/Frag	1	52	1.92
Sym.Pointed Tool (elongated)	26	56	46.43
Sym.Pointed Tool (short)	11	22	50.00
Assym.Pointed Tool	6	28	21.43
Trihedral Pointed Tool	0	5	0.00
Notch/Denticulate	1	66	1.52
Bif. w/straight profile	0	6	0.00
Bif. w/slightly sinuous profile	3	14	21.43
Bif. w/ coarse sinuous profile	0	4	0.00
Flake w/ cont. retouch one edge	5	109	4.59
Flake w/ cont. ret. (mult. edges)	1	30	3.33
Flake w/localized retouch	6	106	5.66
Crudely retouched flake/chunk	0	14	0.00
Flake w/ var. ret. patt.(mult. edges)	1	61	1.64
Microdenticulate	0	7	0.00
Discoidal tool	1	10	10.00
Pressure flaked tool fragment	28	28	100.00
Fragmentary Indeterminate	11	93	11.83
Chopping Tool/Hammer	0	12	0.00
Other	0	5	0.00
Total	107	864	12.38

Heat-treated scrapers are less frequent (16.5%) than all heat-treated flake tools (21.4%). Like most other tool classes, when heat-treated, scrapers are made on heat-treated flakes (Table 26). Of seven pressure flaked scrapers, only three were heat-treated.

Table 26. Thermal Alteration of Flake Tool Types.

Flake Tool Type	Blank H/T Core	H/T Blank	H/T During Reduction	Post. Dep. H/T	Poss. Dep. H/T	Not H/T	H/T-Stage Indet.	Total	H/T Total	H/T %
Side scraper	1	3	-	-	1	34	-	39	4	10.3
End scraper	4	9	-	2	1	78	3	97	16	16.5
Misc. scraper	-	8	-	1	3	37	3	52	11	21.2
Sym. pointed tool (elong)	5	5	-	3	1	36	6	56	16	28.6
Sym. pointed tool (short)	-	10	2	1	-	9	-	22	12	54.5
Assym. pointed tool	3	5	-	-	1	19	-	28	8	28.6
Trihedral pointed tool	-	2	-	-	-	3	-	5	2	40.0
Notched/denticulate	2	3	-	-	2	58	1	66	6	9.1
Bif. w/straight profile	2	2	-	-	-	2	-	6	4	66.7
Bif. w/slightly sinuous prof.	-	3	2	1	-	8	-	14	5	35.7
Bif. w/coarse sinuous prof.	-	-	1	-	-	3	-	4	1	25.0
Flake w/cont. ret. (one edge)	9	9	-	1	2	86	2	109	20	18.3
Flake w/cont. ret. (mult. edges)	-	7	-	-	-	22	1	30	8	26.7
Flake w/localized retouch	8	14	-	-	1	82	1	106	23	21.7
Crudely retouched flake/chunk	-	-	-	-	-	14	-	14	-	0
Flake w/var. ret. pat. (mult. edges)	3	7	-	1	-	48	2	61	12	19.7
Microdenticulate	1	-	-	-	-	6	-	7	1	14.3
Discoidal tool	1	-	-	-	-	8	1	10	2	20.0
Pressure flaked tool fragment	1	7	-	1	3	15	1	28	9	32.1
Fragment-indeterminate	5	19	-	3	-	65	1	93	25	26.9
Chopping tool/hammer	-	-	-	-	-	12	-	12	-	0
Other	-	-	-	-	-	5	-	5	-	0
Total	45	113	5	14	15	650	22	864	185	21.4

Most end-scrapers tend to have convex edges, while other types have almost equal proportions of straight and irregular edges (Table 27). Few scrapers (6 examples) have convergent working edges; straight profiles dominate in all types.

Table 27. Edge Shapes of Flake Tools.

Flake Tool Type	Convex n	Concave n	Straight n	Irregular n	Multiple n	Convergent n	Total	%
Side Scraper	13	2	12	11	1	-	39	4.51
End Scraper	64	2	11	9	6	5	97	11.23
Misc. Scraper	19	1	12	13	3	4	52	6.02
Symmetrical Pointed Tool (elong)	-	-	15	8	1	32	56	6.48
Symmetrical Pointed Tool (short)	1	-	6	8	-	7	22	2.55
Asymmetrical Pointed Tool	-	-	4	11	1	12	28	3.24
Trihedral Pointed Tool	-	-	1	2	1	1	5	0.58
Notch/Denticulate	1	44	3	17	-	1	66	7.64
Biface w/straight profile	1	-	3	2	-	-	6	0.69
Biface w/slightly sinuous profile	8	-	-	6	-	-	14	1.62
Biface w/coarse sinuous profile	1	-	-	3	-	-	4	0.46
Flake w/cont. retouch (one edge)	17	6	60	26	-	-	109	12.62
Flake w/cont. retouch (mult. edges)	5	-	6	15	2	2	30	3.47
Flake w/localized retouch	16	11	42	32	5	-	106	12.27
Crudely retouched flake/chunk	2	-	2	10	-	-	14	1.62
Flake w/variable ret. pattern (mult. edges)	12	4	23	18	3	1	61	7.06
Microdenticulate	2	-	3	2	-	-	7	0.81
Discoidal tool	2	-	-	4	-	4	10	1.16
Pressure flaked tool fragment	6	-	15	3	3	1	28	3.24
Fragmentary Indeterminate	19	5	54	14	-	1	93	10.76
Chopping Tool/Hammer	3	-	1	8	-	-	12	1.39
Other	1	-	1	2	1	-	5	0.58
Total	193	75	274	224	27	71	864	
%	22.34	8.68	31.71	25.93	3.13	8.22		

One hundred eighty-four pieces were examined for use wear traces. Fragments were included in the sample because at least a portion of the worked/used edge usually is retained on scrapers. Sixty-seven percent of the specimens had been utilized (Table 28); between 10% and 20% of end-scrapers and side-scrapers exhibit macroscopically visible rounding produced by intensive use on the working edge. As evidenced by greater incidence of macroscopically visible rounding and gloss, end-scrapers probably often were hafted (allowing more pressure to be applied in use; cf. Broadbent and Knutsson 1975), and consequently had a longer use life than other scraper types.

Striations, possible indicators of long use-life, are produced when a small flake is detached from a working edge and is dragged across its surface during use, or when an abrasive foreign particle intrudes between the tool and the worked material (Del Bene 1979; Fedje 1979). Striations are most frequent when hard material is worked, when the tool is used for long periods of time, or when an abrasive is present. Twenty-five percent of side-scrapers, 16.5% of end-scrapers, and 10% of miscellaneous scrapers exhibit striations.

Striations also reflect motion of use. Those observed on scraper edges most often exhibit perpendicular and angled orientations, indicating a scraping or planing motion (Hayden 1979b). Parallel striations indicating motions other than scraping, such as grooving or cutting, are present but rare. Most variation in motion of use is seen on end-scrapers, perhaps a function of the large sample size. Few motions other than scraping were identified (Table 29), although one tool exhibits wear from chopping, three reflect both scraping and cutting motions, and one specimen apparently was used for grooving, scraping, and cutting. The hardness of worked

material ranges from soft/medium to medium/hard (Table 30). Side-scrapers and miscellaneous scrapers were used on harder materials than were end-scrapers.

Table 28. Determination of Flake Tool Use by Type.

Flake Tool Types	Unexam.	Used	Indet.	Unused	Total
Side Scraper	4	26	8	1	39
End Scraper	0	71	25	1	97
Misc. Scraper	0	26	26	0	52
Symmetrical Pointed Tool (elong)	0	39	17	0	56
Symmetrical Pointed Tool (short)	0	12	9	1	22
Asymmetrical Pointed Tool	0	18	10	0	28
Trihedral Pointed Tool	5	0	0	0	5
Notch/Denticulate	0	33	27	6	66
Biface w/straight profile	0	5	1	0	6
Bifacial w/slightly sinuous profile	3	7	4	0	14
Bifacial w/coarse sinuous profile	3	1	0	0	4
Flakes w/cont. retouch (one edge)	39	36	31	3	109
Flakes w/cont. retouch (mult. edges)	8	16	6	0	30
Flakes w/localized retouch	48	29	29	0	106
Crudely retouched flake/chunks	14	0	0	0	14
Flake w/variable ret. pattern (mult. edges)	23	22	16	0	61
Microdenticulate	0	5	2	0	7
Discoidal Tools	10	0	0	0	10
Pressure flaked tool fragments	25	1	2	0	28
Fragmentary Indeterminate	87	3	3	0	93
Flaked/Battered Tools	12	0	0	0	12
Other	5	0	0	0	5
Total	286	350	216	12	864

Table 29. Motion of Use of Flake Tool Types.

	MULTIPLE USES									
Flake Tool Type	Scrape/ Cut n	Scrape/ Chop n	Scrape/ Perf. n	Cut/ Groove n	Drill/ Perf. n	Perf./ Bore n	Drill/ Groove n	Bore/ Drill n	Total	%
End Scraper	5	-	-	-	-	-	-	-	5	21.74
Misc. Scraper	2	-	-	-	-	-	-	-	2	8.70
Symmetrical Pointed Tool (elong)	-	-	1	-	2	3	1	1	8	34.78
Asymmetrical Pointed Tool	-	-	1	-	1	1	-	-	3	13.04
Trihedral Pointed Tool	-	-	-	-	-	-	-	-	-	0.00
Notch/Denticulate	-	1	-	-	-	-	-	-	1	4.35
Biface w/coarse sinuous profile	-	1	-	-	-	-	-	-	1	4.35
Flake w/cont. retouch (one edge)	1	-	-	-	-	-	-	-	1	4.35
Flake w/cont. retouch (mult. edges)	1	-	-	-	-	-	-	-	1	4.35
Flake w/variable ret. pattern (mult. edges)	-	-	-	1	-	-	-	-	1	4.35
Total	9	2	2	1	3	4	1	1	23	
%	39.13	8.70	8.70	4.35	13.04	17.39	4.35	4.35		

Table 29, continued.

Flake Tool Type	SINGLE USES Scrape n	Cut n	Groove n	Perf. n	Bore n	Drill n	Chop n	Total	%
Side Scraper	27	-	-	-	-	-	-	27	9.06
End Scraper	60	-	-	-	-	-	1	61	20.47
Misc. Scraper	21	-	-	-	-	-	-	21	7.05
Symmetrical Pointed Tool (elong)	2	-	3	9	2	5	-	21	7.05
Symmetrical Pointed Tool (short)	-	1	3	4	1	-	-	9	3.02
Asymmetrical Pointed Tool	4	-	1	6	-	-	-	11	3.69
Notch/Denticulate	25	5	-	-	-	-	-	30	10.07
Biface w/straight profile	-	5	-	-	-	-	-	5	1.68
Biface w/slightly sinuous profile	1	5	-	-	-	-	-	6	2.01
Flake w/cont. retouch (one edge)	15	19	-	-	-	-	1	35	11.74
Flake w/cont. retouch (mult. edges)	5	9	-	-	-	-	-	14	5.03
Flake w/localized retouch	13	16	-	-	-	-	-	29	9.73
Flake w/variable ret. pattern (mult. edges)	7	12	-	-	-	-	-	19	6.38
Microdenticulate	3	2	-	-	-	-	-	5	1.68
Pressure flaked tool fragment	-	1	-	-	-	-	-	1	0.34
Fragmentary Indeterminate	1	1	-	-	-	-	-	2	0.67
Total	184	76	7	19	3	5	2	296	
%	61.74	25.50	2.35	6.38	1.01	1.68	0.67		

Table 30. Flake Tools - Hardness of Worked Materials.

Flake Tool Type	N/A n	Unused n	Soft n	Soft/ Medium n	Medium n	Medium/ Hard n	Hard n	Ind n	Total	%
Side Scraper	-	1	-	3	9	11	-	15	39	4.51
End Scraper	-	1	1	23	14	13	-	45	97	11.23
Misc. Scraper	-	-	1	3	4	10	-	34	52	6.02
Symmetrical Pointed Tool (elong)	-	-	1	10	10	8	-	27	56	6.48
Symmetrical Pointed Tool (short)	-	1	-	3	6	1	-	11	22	2.55
Asymmetrical Pointed Tool	1	-	1	5	3	1	-	17	28	3.24
Trihedral Pointed Tool	5	-	-	-	-	-	-	-	5	0.58
Notch/Denticulate	-	6	-	1	8	9	3	39	66	7.64
Biface w/straight profile	-	-	-	1	1	3	-	1	6	0.69
Biface w/slightly sinuous profile	3	-	-	1	1	4	-	5	14	1.62
Biface w/coarse sinuous profile	3	-	-	-	1	-	-	-	4	0.46
Flake w/cont. retouch (one edge)	39	3	1	4	11	12	4	35	109	12.62
Flake w/cont. retouch (mult. edges)	8	-	-	-	7	6	2	7	30	3.47
Flake w/localized retouch	48	-	1	7	13	5	1	31	106	12.27
Crudely retouched flake/chunk	14	-	-	-	-	-	-	-	14	1.62
Flake w/var ret pat (mult. edges)	22	1	-	2	8	8	-	20	61	7.06
Microdenticulate	-	-	-	4	1	-	-	2	7	0.81
Discoidal tool	10	-	-	-	-	-	-	-	10	1.16
Pressure flaked tool fragment	25	-	-	-	-	-	-	3	28	3.24
Fragmentary Indeterminate	88	-	-	-	2	-	-	3	93	10.76
Chopping Tool/Hammer	12	-	-	-	-	-	-	-	12	1.39
Other	5	-	-	-	-	-	-	-	5	0.58
Total	283	13	6	67	99	91	10	295	864	
%	32.75	1.50	0.69	7.75	11.46	10.53	1.16	34.14		

Five side-scrapers exhibit traces of red staining (ochre?), while other scraper classes each contain only one specimen with such traces (Table 31). This staining may be post-depositional or may reflect the addition of an abrasive during use.

Table 31. Flake Tools with Red Staining.

Flake Tool Type	No. with staining	Total
Side Scraper	5	39
End Scraper	1	97
Misc. Scraper	1	52
Symmetrical Pointed Tool (elong)	1	56
Biface w/slightly sinuous profile	1	14
Flake w/cont. retouch (one edge)	1	109
Flake w/cont. retouch (mult. edges)	1	30
Flake w/localized retouch	1	106
Flake w/variable ret. pat. (mult. edges)	1	61
Total	13	

Tosawihi scrapers, while diverse in form, appear to have been used for similar functions, i.e., scraping medium-hard materials. While other materials also may have been scraped, fresh and dry hides are the materials most likely to have been processed. Antler and bone are too hard to have produced the observed traces, but scraping soft wood may have co-occurred with hide working. Minimal microscopic edge damage (other than rounding) limits the activity to light-duty tasks.

Pointed Tools

Pointed tools include symmetrical tools (55 with long bits and 22 with short bits), as well as 28 asymmetrical ones and 5 trihedrals. All are elongate; with the exception of trihedrals, they are relatively small, show little size variance, and were made on thin (average 7.2mm) blanks (Figures 42, 43; Table 20). The possibility that symmetrical short-bit tools were reworked and more highly curated than other pointed tools is suggested by bit size and the greater proportion of obsidian (exotic to the project area) material from which these tools are manufactured.

Somewhat fewer symmetrical-elongate tools are made on biface thinning flakes (Table 23), but surfaces tend to be obscured by pressure flaking and a large number of blank types remain indeterminate. Pressure flaking is more frequent than average for this group, as is the incidence of heat-treatment (Tables 25, 26). These two variables are not perfectly correlated but, unlike some other artifact classes, about half the pressure flaked tools are heat-treated. Most retouch is continuous and invasive, and frequently is bifacial.

More than half the pieces are complete or broken only at the tip. Symmetrical pointed pieces often are less complete, perhaps due to functions that resulted in more frequent breakage (Unger-Hamilton et al. 1987). The proportion of heat-treated pieces ranges from 28.5 to 54.5% (20% is average for the entire Tosawihi assemblage; cf. Table 25). Most specimens were heat-treated as flakes rather than as cores.

Seven pieces, most of them symmetrical with short bits, show macroscopic gloss, suggesting that some pieces in this sub-class were used more heavily than those in other classes. All pointed tools, with the exception of trihedrals, were examined for microscopic use wear traces. Trihedral pieces were excluded primarily because they are difficult to position under the microscope. Frequency of observed use wear ranges from 54% to 70% (Table 28), similar to that of scrapers but higher than the average for all flake tools.

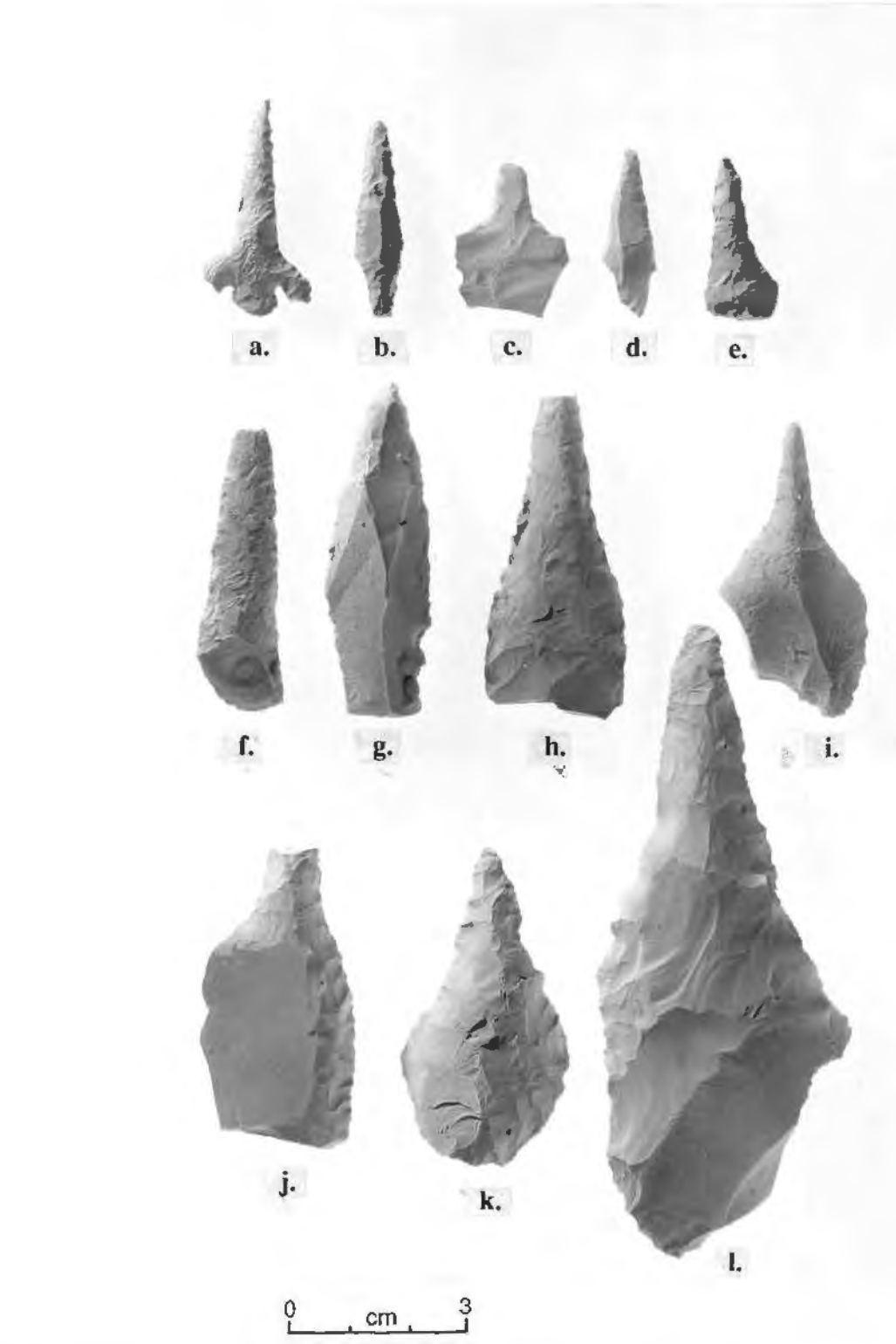


Figure 42. Selected symmetrically pointed tools.

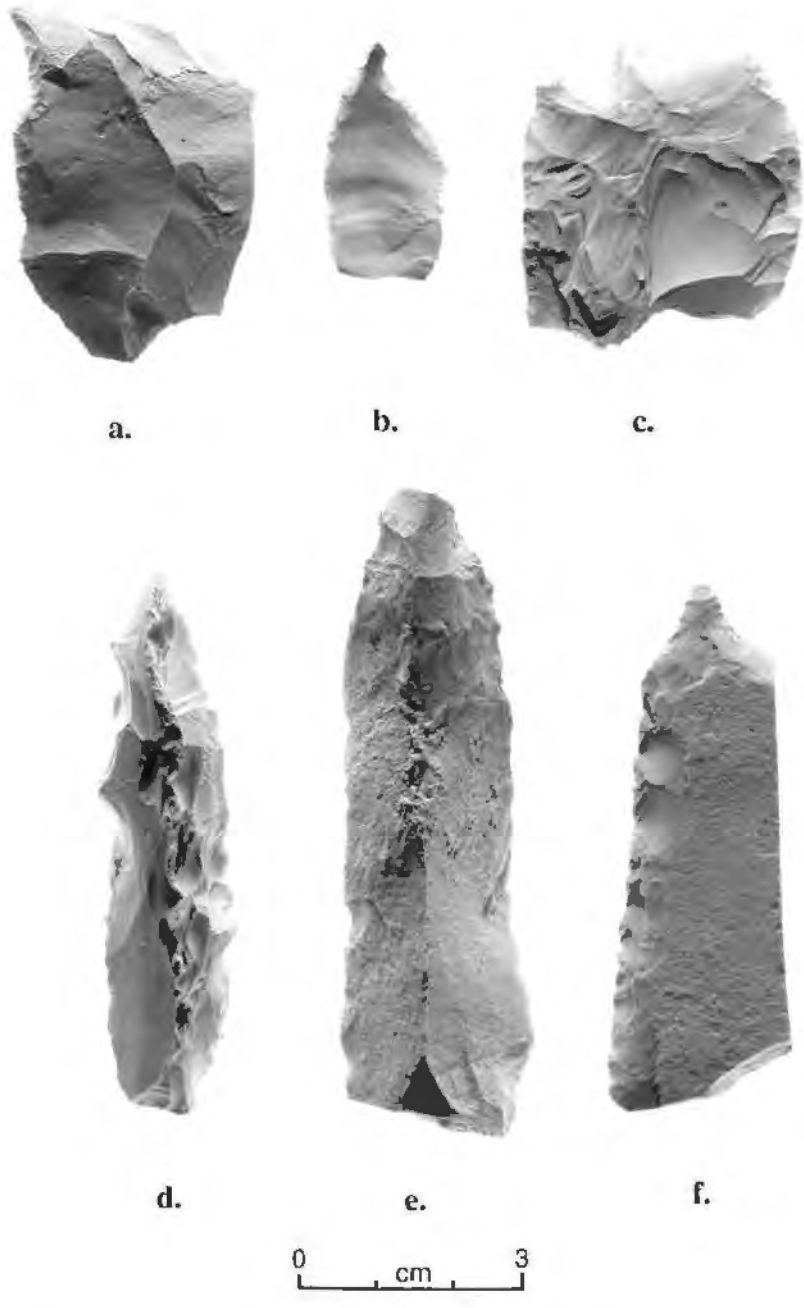


Figure 43. Selected asymmetrical and trihedral pointed tools.

Striations are more common on pointed tools than on many other types, probably owing to heavier use or use on harder materials. Perpendicular striations (indicating perforating, boring, scraping, or drilling motions) are most common, but parallel striations caused by cutting or incising also are present. A number of pointed tools have striations with more than one superimposed pattern, indicating multiple motions of use. Symmetrically pointed pieces, the largest group, exhibit the widest range of use motions (Table 29). Most specimens were used for perforating. A few pieces also exhibit drilling-wear (concentric patterns of striations and a symmetrically rounded tip), and others, wear from grooving or incising. Symmetrically pointed tools with short bits show wear chiefly from perforating and grooving and asymmetrically pointed tools, chiefly from scraping and perforating. Most inferred multiple motions include perforating. Perforating and grooving tools were used primarily on soft or soft/medium materials, and scraping, boring, and drilling tools on medium/hard materials (Table 30).

In contrast to scrapers, pointed tools exhibit less variation in size and form, but greater variation in apparent function. Perforating is common to all three sub-classes. Materials worked with perforating and grooving tools would include hide, wood, plants, and other materials of a yielding nature; scraping and drilling tools may have been used on materials such as wood, antler, or soft stone.

Notches/Denticulates

Sixty-six flake tools are classified as notches or denticulates. This tool type can be mimicked by trampling, so we were particularly conservative in classifying angular pieces as notches or denticulates, especially when recovered from quarry locations; even so, fully one third of the specimens in this class are from localities in the Tosawihi Quarry.

Of 66 tools, we consider 25 to be complete, that is, made on unbroken blanks. The pieces are quite variable in size (Table 20, Figure 44); the length of complete specimens ranges from 34.4 mm to 107.0 mm and the mean length is 68.4 mm, comparable to other flake tool classes.

Ninety percent of notches and denticulates are non-specific opalite, while 10% are jasper and opal (Table 21); none is basalt or obsidian. More than half the blanks for notches clearly are biface thinning flakes, most made on either expanding or irregular flakes (Table 23). The fragment types show no clear pattern; few (38%) are on complete flakes, but this tool type can be made effectively from flake fragments.

Ten percent of the tools have been thermally altered (Table 25); only one obviously was pressure flaked (Table 26). More than half the pieces exhibit localized retouch only in the area of the notch(es), but many are notched on edges with retouch along the entire margin. Most (80%) retouch is unifacial, and most is direct (initiated from the ventral surface and lying on the dorsal), although some is inverse (initiated from the dorsal surface). The retouch on most, but not all, specimens is quite invasive. Few (10%) pieces were used on more than one edge. Both medium and obtuse edge angles are about twice as frequent as acute ones (cf. Table 24).

All notches and denticulates were examined for use wear traces. About half the sample was considered indeterminate because polish produced by post-depositional surface modification has altered or covered use traces. Six pieces are unused, 25 were used for scraping/shaving, five for cutting, and one piece was used for scraping and chopping (Tables 28, 29). The invasiveness and distribution of polish produced by use is quite variable, but few examples exhibit highly developed polish. This, together with light or medium microscopic rounding of used edges, indicates moderate use intensity and little use on hard materials. Only four examples exhibit striations, all of them perpendicular to the edge (consistent with a scraping/shaving motion).

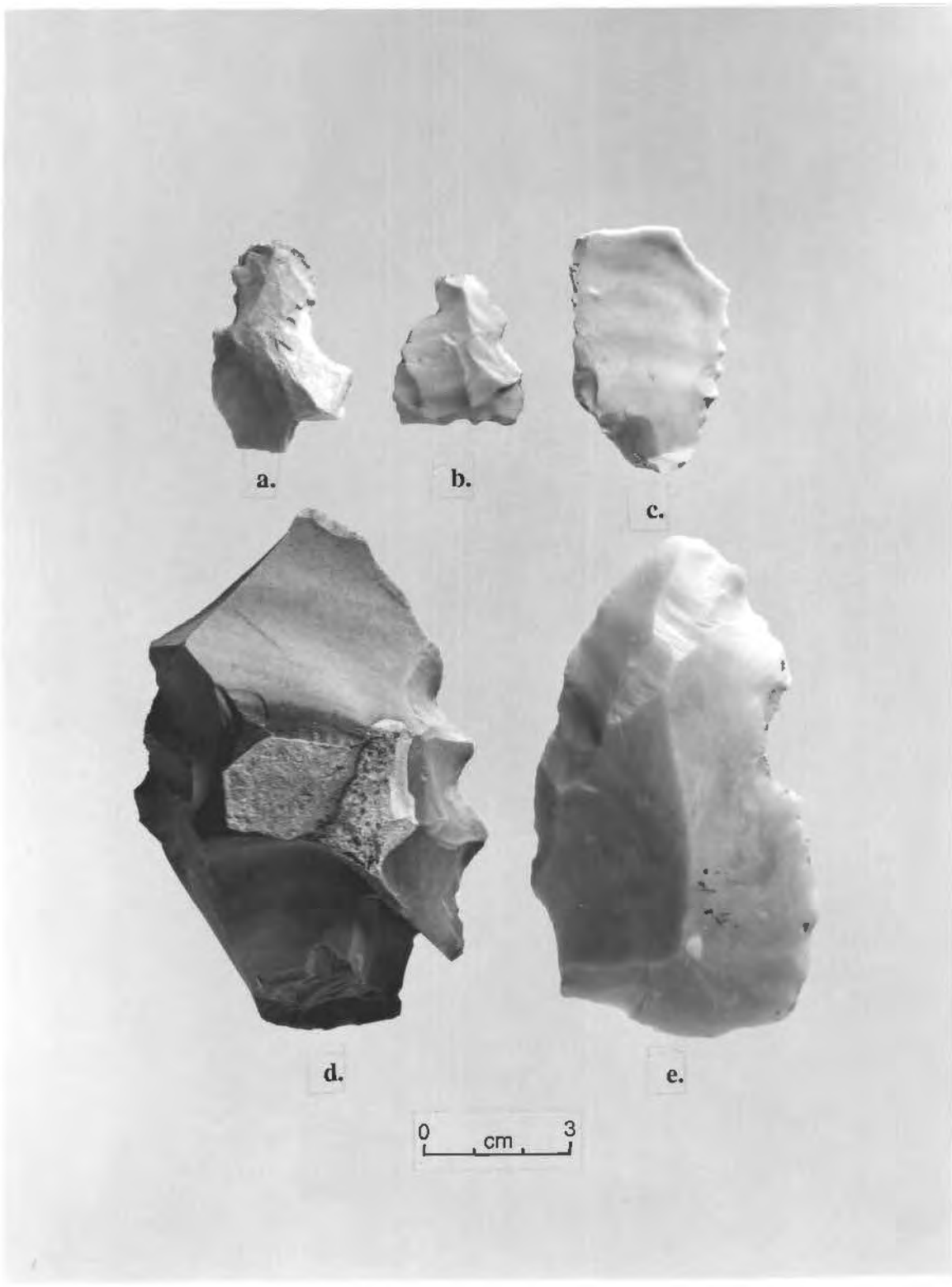


Figure 44. Selected notched and denticulate tools.

Most specimens were used on medium to medium/hard material at moderate intensity of use (Table 30). Thus, most were used for scraping medium to medium/hard contact materials. Hard plant material such as arrow cane, wood, or soaked antler could have been worked in the production or sharpening of tools such as arrows, atlatls, or digging and quarrying tools. The hardness of worked material could not be determined for 39 pieces.

Bifacial Flake Tools

This class includes bifacial tools with a straight profile (i.e., the shape of the edge in cross-section), those with a slightly sinuous profile, and those with a coarsely sinuous profile. Bifacial flake tools are distinguished from bifaces (although a few are made on bifaces) in that the former have regularized or straightened edges, and the flake scars on working edges often do not extend far onto interior surfaces (Figure 45). The class is represented by 24 specimens.

Six specimens with straight profiles have a mean length of 46.1 mm, slightly smaller than the other subtypes (Table 20). Fourteen specimens have slightly sinuous profiles and four, coarsely sinuous ones. The mean lengths of complete examples of these two types are 54.3 mm and 80.7 mm, respectively. The size variance among all types is smaller than for other tool classes, perhaps reflecting small sample sizes.

Three of these tools are obsidian and the rest are non-specific opalite (Table 21). Half the specimens are made on biface thinning flakes (Table 23), and several are made on biface fragments. One-half are heat-treated, a proportion higher than the average for all flake tools. Pressure flaking is not associated with heat-treatment (Table 25) or with tools of obsidian (Table 26).

Blank shapes for bifacial flake tools often are indeterminate because the pieces are highly reduced. No uniform fragment type is represented, but the shape of the worked edge is usually convex or irregular (Table 27). Edge angles are primarily medium but some are acute (Table 24). Flake, step, and snap fractures are found on the edges. There is very little macroscopic rounding.

Pieces were selected for use wear examination on the basis of completeness of working edge and straightness of profile; we assumed that traces on more complete pieces should be interpreted more easily and that tools with straighter edges are more likely to be broken in use than in manufacture. All specimens with straight profiles were examined, as were 11 with slightly sinuous edges and one with a coarsely sinuous edge. A wide range in the degree of polish indicates that tools in this class were used for various lengths of time on materials of various hardnesses. Thirteen pieces were used (Table 28); use of five could not be determined, and six pieces were not examined. One piece was used for scraping, ten for cutting, and one for chopping/whittling (Table 29). Most pieces were used relatively intensively for cutting medium/hard material (Table 30). In our experiments, such tools have proven useful in skinning and butchering large mammals; too, they can be resharpened easily. Wear traces observed on the worked edges of our archaeological examples are compatible with such use.

Miscellaneous Retouched Tools

Miscellaneous retouched tools (Figure 46) were defined by the presence of patterned retouch along one or more edges. These pieces, commonly referred to as "utilized flakes" or "expedient tools," often have more acute edges and straighter profiles than other tool types and may have served specific functions. We collected 306 of them, comprising more than a third of our entire flake tool assemblage.

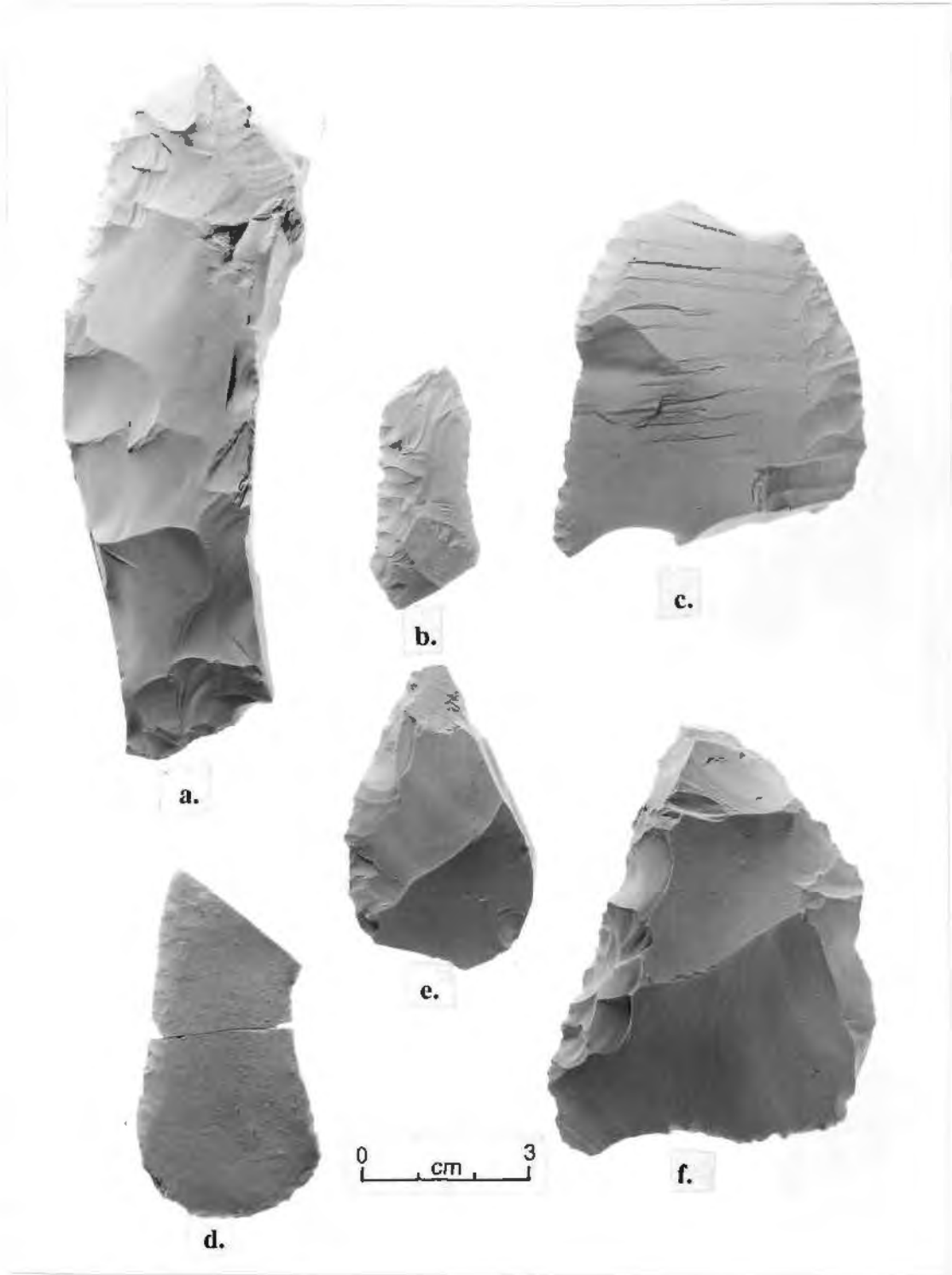


Figure 45. Selected bifacial flake tools.

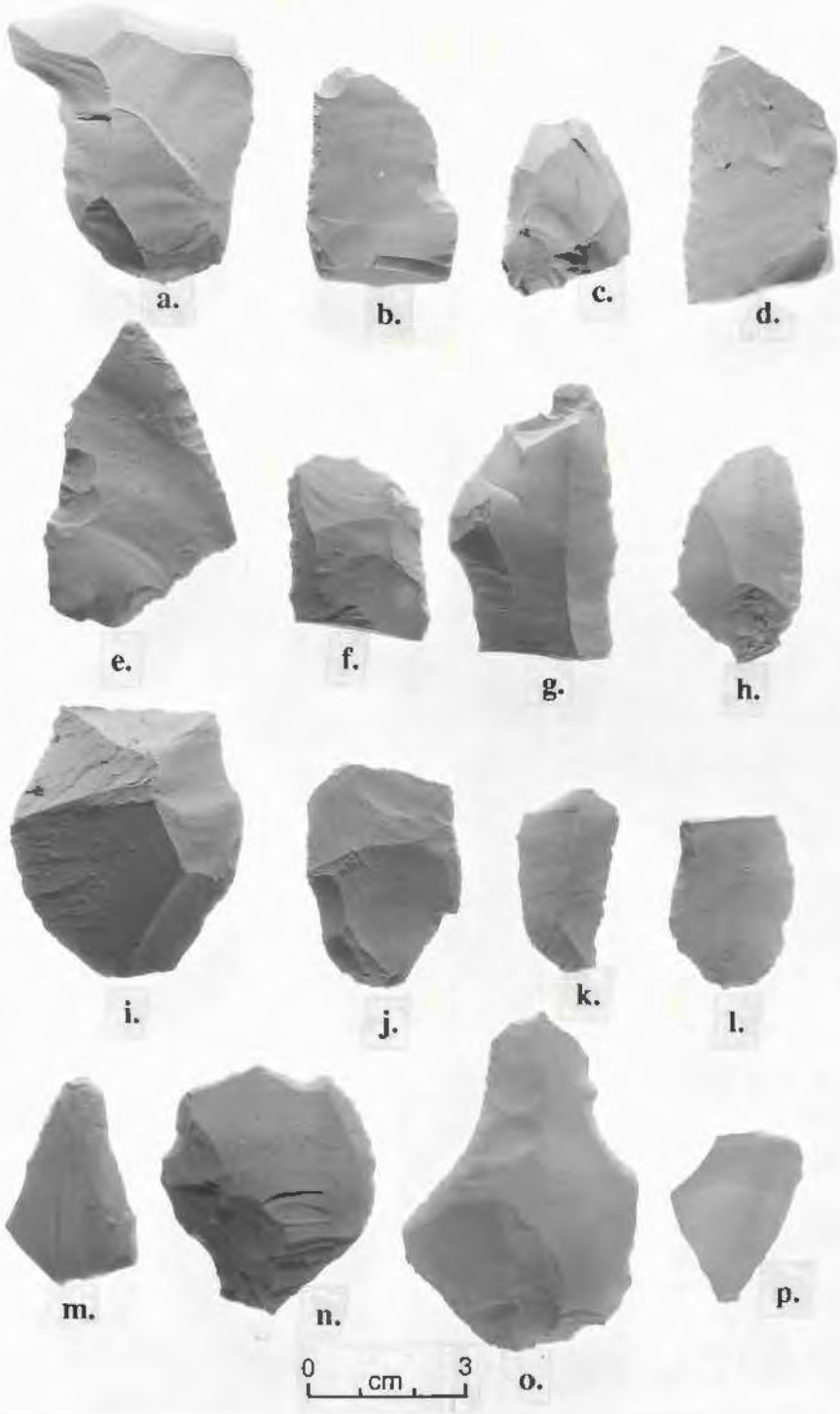


Figure 46. Selected examples of miscellaneous retouched tools.

Miscellaneous retouched tools include four morphological types defined by the number of retouched edges and the nature of retouch: flakes with continuous retouch on one edge (n=109), flakes with continuous retouch on multiple edges (n=30), flakes with localized retouch (n=106), and flakes with variable retouch on multiple edges (n=61); variance within each morphological group is high. The length of complete pieces ranges from 48.1 to 68.1 mm, the average being 48.7 mm (Table 20). Specimens tend to be somewhat more elongate than some other flake tool types.

Jasper and chalcedony were used in slightly higher proportions than among flake tools. Of the subtypes presently considered, the two categories with single retouched edges contain slightly more jasper; the proportion of non-white opalite is similar to that for all flake tools (Tables 21, 22). Specimens with continuous retouch on multiple edges have less material diversity, while those with variable retouch on multiple edges exhibit greater material diversity (obsidian is twice as frequent as the average, and chalcedony slightly more frequent than average). These may represent more highly curated tools.

A larger proportion of miscellaneous retouched tools is made on biface thinning flakes than most flake tools (Table 23). Those with continuous retouch on a single edge have the lowest proportion (53%) made on such flakes; those with continuous retouch on multiple edges have the highest (83%). About 47% of the total are made on expanding flakes, but this varies greatly from sub-type to sub-type; 37% of specimens with localized retouch and 80% of those with variable retouch on multiple edges exhibit the trait. Only pieces with continuous retouch on a single edge show it frequently (33%; cf. Table 23).

The proportion of heat-treated specimens is similar to that of all flake tools, and varies only slightly among sub-types. More than twice as many pieces were heat-treated as blanks than were made on flakes removed from heat-treated cores (Table 25).

Retouch is variable and unpatterned, containing high proportions of both invasive and non-invasive scars. Most invasive scars are found in the groups with continuous retouch on multiple edges and with localized retouch. Variable retouch on multiple edges occurs least. Pieces with continuous retouch on a single edge have the greatest frequency of straight edges, and pieces with localized retouch the least, suggesting that straighter edges may have been chosen for tasks requiring a long cutting edge (Table 27). Almost all pieces in every category have straight profiles, perhaps a factor in tool blank selection.

The edge angles of most pieces (84%) are acute or medium. They are less acute on tools with continuous retouch on a single edge; pieces with continuous retouch on multiple edges and with localized retouch have more acute edges, while those with variable retouch on multiple edges exhibit both acute and medium edge angles. A few pieces have light macroscopic rounding. Three exhibit visible gloss, and four, red staining (Table 31).

One hundred eighty-eight pieces were examined for use wear traces; most complete specimens were included. Of the total, 54.8% clearly were used; evidence of use wear could not be identified on the remainder (Table 28). Almost all use wear is referable to cutting and scraping. Cutting was somewhat more important in all categories, especially for tools with more than one used edge (Table 29). Cutting soft materials often leaves no visible trace, although straight, acute edges are ideal for cutting soft materials such as meat or soft plants (Keeley 1980; Symens 1986). In general, material worked with miscellaneous retouched tools was medium to hard. Tools with one continuous retouched edge appear to have been used on variable material hardness while those with localized retouch were used on soft materials (Table 30). Cutting tools seem to have been used on diverse materials while most scraping tools were used on medium/hard materials. A few pieces exhibit multiple use traces; these tools seem to be used more heavily than those with only one indicated motion.

Crudely Retouched Flake/Chunk

This tool class contains only 14 examples. They are modified intentionally, but the retouch is relatively coarse and less patterned than on other tools. These pieces are somewhat larger and much heavier than most other flake tools, and they vary in size (Table 20). There is little material diversity in this group; 12 specimens are opalite and two are opal. Only 57% are white, indicating greater material diversity (when measured by color) than other tool types (Tables 21, 22), suggesting these tools derive from multiple lithic sources.

Six specimens are made on complete flakes, of which five are biface thinning flakes (Table 23). In general, these blanks are much more robust than those of other types. Blanks are primarily irregular or expanding flakes with unifacial-direct or combination retouch. Half the pieces show use on multiple edges, with great variation in the extent of retouch; most (78.6%) exhibit invasive retouch, perhaps the result of deliberate production of a strong edge. Seventy-one percent have irregular edges exhibiting various types of edge profile. Almost all have medium or obtuse edge angles. No rounding or gloss was observed (Table 24), and no specimens were thermally altered.

Discoids

Pieces in this category have generally circular shapes and flat cross-sections. Some resemble circular bifaces, some discoidal hammerstones, and some are merely curious objects. Their distinctive shape occurs in no other tool type, and their variation in size, material, and modification makes it unlikely that they served similar functions (Figure 47). Highly variable in size (length 45.0-143.5 mm), these tools exhibit a mean length (102.6 mm) greater than other classes of flake tools (Table 20). Raw material is highly variable as well, and includes one tool of basalt, one of quartzite, one of schist, one of "bedded ash," and six of opalite (Table 21).

Although some discoids are made on flakes, all are too robust to be biface thinning flakes. Quartzite and basalt specimens are made from rounded cobbles, those of schist and bedded ash from tabular pieces, and three of the opalite specimens on flakes detached from cobbles. All are retouched (often bifacially) around the edges, some more extensively than others. Only two appear to be made on heat-treated pieces. None shows clear evidence of pressure flaking.

Five (including the largest pieces) are battered and three are rounded, both presumably by use. At least three of these pieces may have been used as hammerstones or for other heavy-duty tasks, but unlike other percussion tools, they have been flaked extensively to form the discoidal shape. Two are opalite and one is quartzite. The basalt specimen also may be a chopper or a hammer, but it exhibits much less edge damage and has some rounding of the retouched edges. It may have been used for heavy duty cutting rather than percussion, possibly in the dismemberment of large game or the production of wood or antler quarrying tools. These pieces are too large to examine microscopically.

Specimens of schist and bedded ash are more unusual. The schist piece is made from a thin sheet with parallel faces, of a material not local to the immediate quarry area. Three-quarters of its circumference is retouched, with two convex and two straight edges. It could have been used either for cutting or scraping, but it exhibits no macroscopic gloss. It was not used on very hard material, as it is of soft, brittle stone. The specimen of bedded ash has several, apparently natural, holes on interior surfaces. The material is soft and striations are visible to the naked eye on one interior surface. Whether they are products of manufacture, use, post-depositional alteration, or excavation and processing procedures is not clear. The striations run perpendicular to the edge in a localized area on one-half of one face. Despite their macroscopic

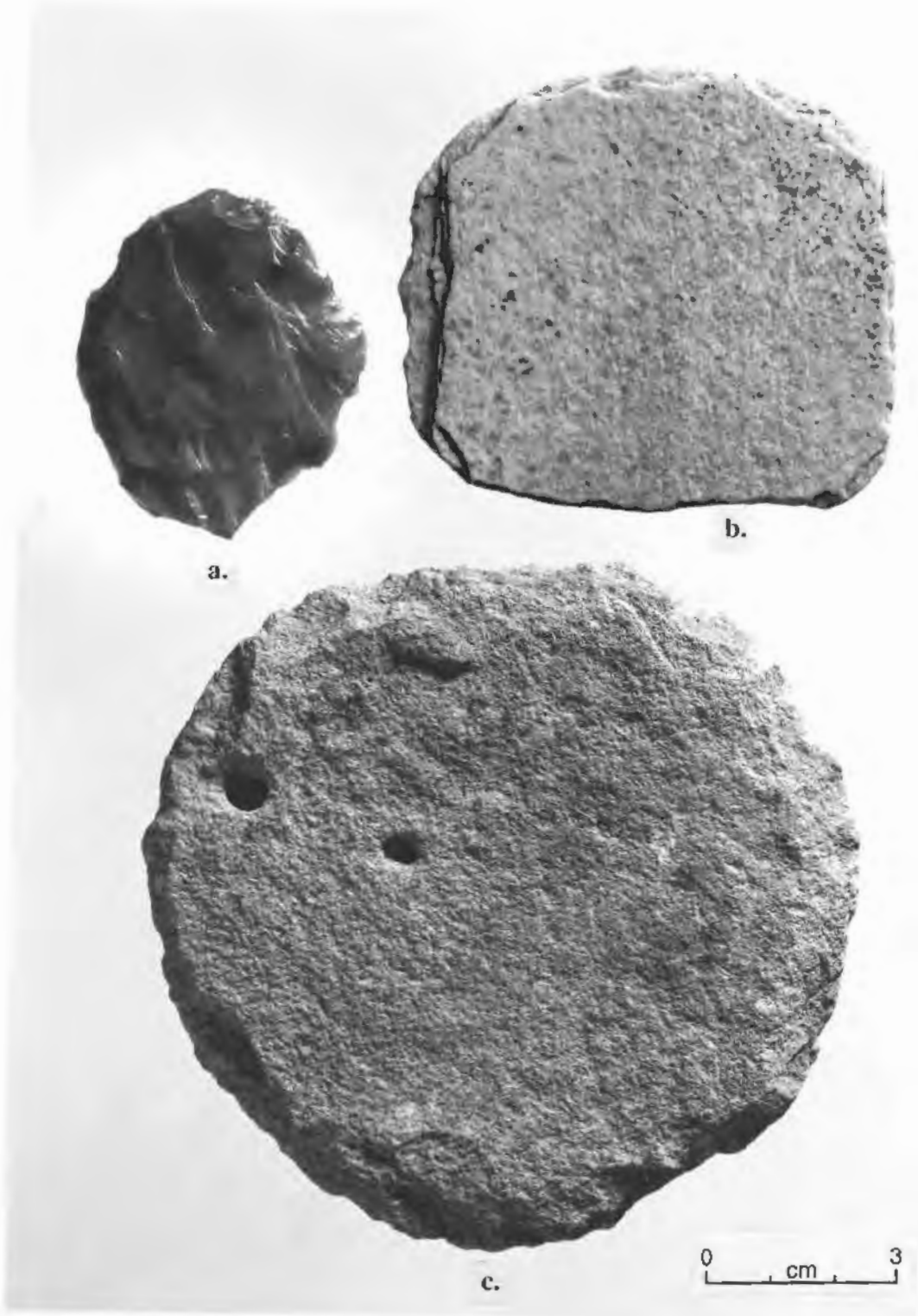


Figure 47. Selected discoidal tools.

visibility, they cannot be seen even at the lowest (50x) magnification available to us because of the coarseness of the material. These tools could have been used for scraping soft to medium materials such as hide, or for processing (shredding, grinding, scraping) soft or fibrous plant materials. Other tools of this class are flaked more extensively, have medium edge angles, and could have been employed in cutting, chopping (of soft/medium materials), or scraping.

Microdenticulates

This small tool group contains only seven specimens. Given small sample size and minimal retouch, we are not certain that these pieces have been retouched deliberately. Nevertheless, they are very similar in form to clearly documented European Mesolithic and Neolithic examples (Jensen 1988; Levi-Sala 1984-86; Barton 1981). Similar artifacts also have been reported from California (E.L. Davis 1978b), where they have been described as "flakes with micro-serrations" and "steak knives."

These tools are rather small compared to some other tool types (34-50 mm in length; cf. Table 20), and their size variance is low (Figure 48). Most are made on biface thinning flakes (Table 23), and only one is thermally altered (Table 21). There is little diversity in raw material; six are opalite and one is obsidian. Several are made on parallel-sided, blade-like flakes, but expanding and contracting flakes also are present. The precise and even retouch probably was produced by pressure.

Five specimens have retouch on more than one edge, but they are denticulated only on one edge. On three pieces, denticulation extends continuously along a single edge while on others it usually is more localized. Edge shape varies, but the profile of all edges is straight (Table 27). All pieces have acutely angled edges, none showing macroscopic rounding and only one piece showing a slight macroscopic gloss.

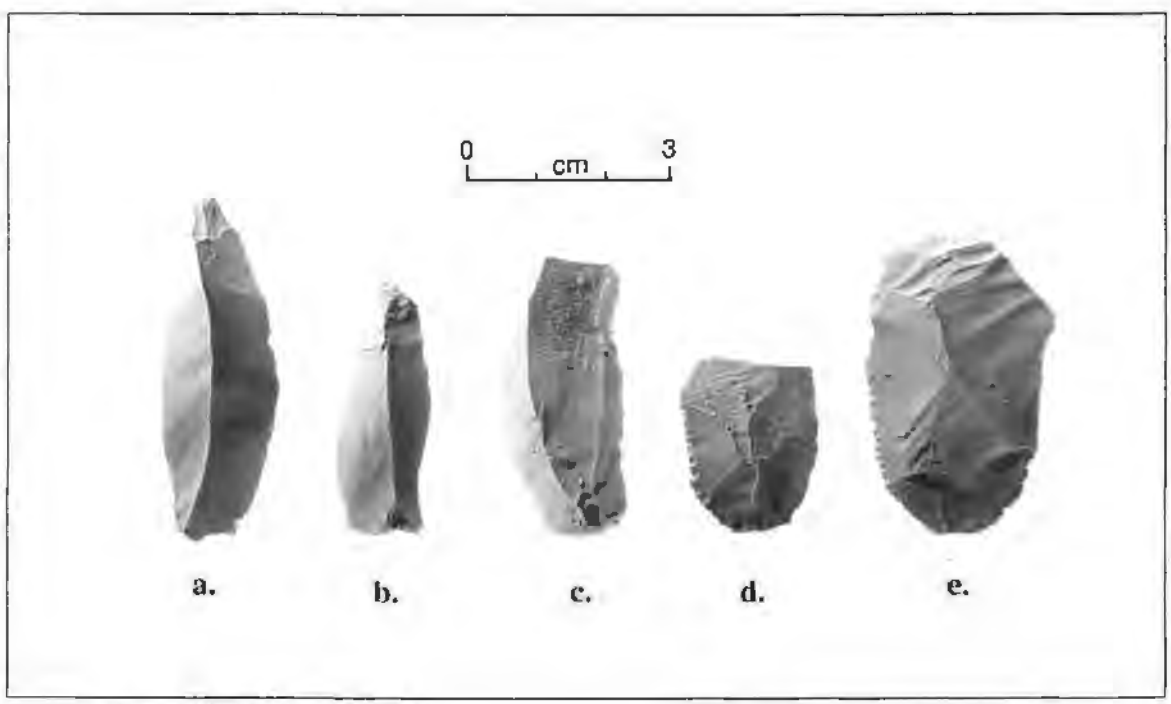


Figure 48. Microdenticulates.

Use wear examination was made of all specimens; five exhibit clear traces of use (Table 28). Three apparently were used for cutting soft/medium materials and two for scraping soft/medium and medium materials (Table 30). Similar tools occur in the European Mesolithic, where their use has been interpreted to entail both parallel and transverse motions for cutting or scraping plants or plant fibers (Levi-Sala 1984-86; Jensen 1988). A similar range of uses is possible here, but materials worked might also include wood.

Pressure Flaked Tool Fragments

Twenty-eight small pieces (mean length = 30.3 mm) consist of pressure flaked tool fragments whose intended form is unclear. Materials are diverse; three pieces are obsidian, three are chalcedony, and two are jasper. Among the remaining pieces, all opalite, a wide range of color, similar to that observed among points and preforms, is present. Nine pieces were heat-treated.

Use wear studies were not performed on these tools; they are assumed to have been broken in manufacture and in use. Most of the pressure flaked pieces in the Tosawihi assemblage are projectile points or preforms; many of the present specimens (at least seventeen of them) *could* be point or preform fragments.

Flaked/Battered Tools

These heavy-duty tools differ from the hammers and choppers described in Chapter 11 because their primary modification was by flaking rather than by battering (Figure 49). The 12 specimens of the class exhibit variable size (mean length = 111.8 mm). Nine are opalite and three are basalt (Table 21). Few (25%) are made on biface thinning flakes; most are on other flakes or chunks and only five are complete. None is heat-treated.

Flaking is primarily bifacial, producing medium to obtuse edge angles (Table 24). The edges include straight, slightly sinuous, and coarsely sinuous examples. Two basalt pieces and one opalite piece are similar in manufacture to Tosawihi bifaces exhibiting distinctive edge preparations and thinning techniques in which multiple flakes are removed contiguously from a single face using a flat, wide platform (cf. Chapter 6). These pieces were not completed as bifaces, however; they exhibit edges battered as a result of use, not of platform preparation. One large basalt piece retains tuff dust in its battered edges, and was likely used as a quarrying tool. The other basalt specimen has a long, straight edge with edge damage suggesting scraping or light chopping.

Two opalite pieces also were flaked bifacially but are domed, suggesting a scraper in form (except for the bifacial retouch); both, however, also have heavily battered edges. Another opalite piece is flaked on its entire circumference and exhibits little battering. Its function is unclear but, based on size, it may have been used as a hammerstone for removing flake blanks. Yet another opalite tool resembles a split hammerstone subsequently flaked and used for chopping or adzing. Two others are flakes with strong but somewhat pointed edges suggesting use as choppers.

Other Flake Tools

Five pieces are distinctive, but they do not fit in any other category; they vary in form and size. Three are complete; none is heat-treated; one is made on a biface thinning flake. One is basalt and the others are non-specific opalite.

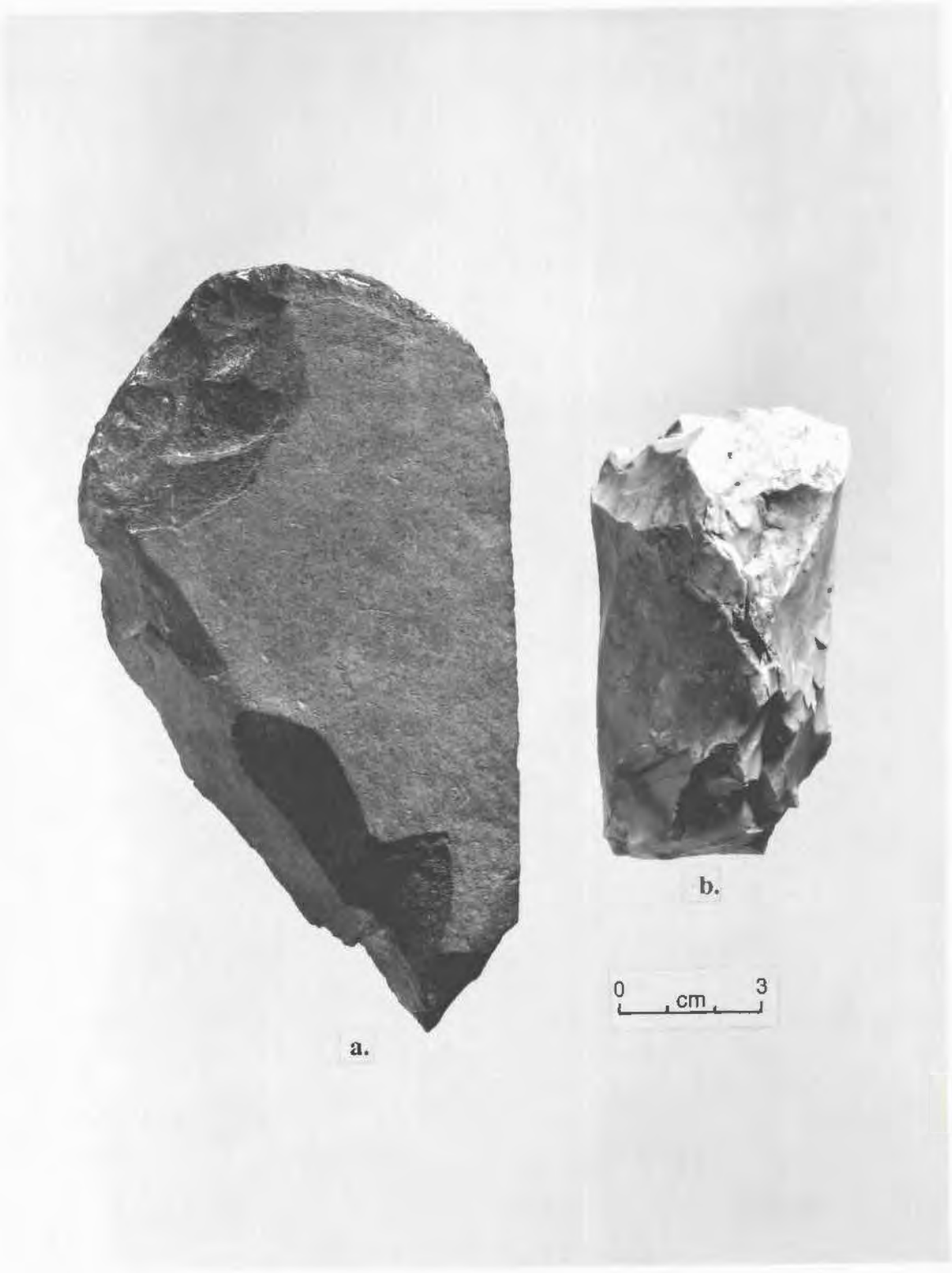


Figure 49. Selected flaked/battered tools.

One piece resembles the distal end of a backed bladelet. Another resembles a small unifacial biface, thick and narrow with several hinge fractures on its dorsal surface. Differing significantly from other Tosawihi bifaces, it was classified separately. Another piece is an opalite flake with a rounded protuberance flanked by two notches; a larger, similar piece is of basalt. Both are unifacially flaked and their probable function is ambiguous. One piece with a heavily worn (but not deliberately retouched) edge also has battering on the opposite end.

Flake Tool Fragments

This class consists only of retouched flake fragments, not pressure flaked, the original form of which cannot be determined. Ninety-three pieces form the group; they are generally small, with a mean length of 25.7 mm. Eighty-six percent of them are opalite, and a few are obsidian, jasper, and opal. Seventy-two percent are white, and 26% are heat-treated. About a third of them are made on biface thinning flakes.

Debitage

A sample of unretouched flakes was examined to determine how often such pieces were used as tools without creating patterned edge damage. This was intended to test our conservative assignment of flakes as flake tools. A sample of 76 pieces was selected largely on the basis of morphology, particularly the presence of long straight edges useful for tasks such as cutting, scraping, or whittling which can be accomplished with unretouched edges. We drew the sample from proveniences which seemed, from the presence of other tools and debitage, to be those hosting the widest variety of activities. We can suggest that, in most cases, the proportion of used debitage at any unexamined locus probably is not higher than in the sample.

The sample consists of 51 opalite, 20 obsidian, 1 basalt, 1 chalcedony, 1 jasper, and 2 opal pieces. The mean size of 50 complete pieces is smaller than scrapers and notches but larger than miscellaneous retouched tools. The proportion made on biface thinning flakes (49%) is similar to the average for all flake tools (54%). Blank shapes are variable; expanding and irregular shapes each account for approximately 33% of the sample, and blade-like flakes, 20%. Only 10 pieces (8 of them complete) were thermally altered. Edge shapes also are quite variable; most (91%) have straight profiles and acutely angled edges (60%).

Fifteen specimens clearly were used (Table 32). Edge shape, profile, and angle do not differ significantly between used and unused specimens. Approximately one-half of the used pieces have acutely angled edges; four probably were used for scraping and ten for cutting materials of various hardness. Cutting tools were used less often on hard materials; one specimen was used for scraping and cutting medium/hard materials. Additional to unequivocally used specimens, 21 clearly were not used, while the use of 40 could not be determined.

Table 32. Functional Analysis of Debitage Sample.

Hardness of Material Worked	Scraping n	Cutting n	Multiple n	Total
Soft		1		1
Soft/Medium	1	1		2
Medium	1	4		5
Medium/Hard	1	1	1	3
Indeterminate	1	3		4
Total	4	10	1	15

Summary and Discussion

Manufacturing

Material Preference

The choice of raw material for the production of particular tool types in an area where raw material is abundant is influenced by curation as well as by manufacturing and functional considerations. Tools made of exotic materials should be more highly curated, more intensively used, and of more formal design. The proportions of material types used in production of flake tools are listed in Table 21. Obsidian and basalt were used rarely, but they clearly were preferred for the production of some tool types.

Obsidian was used most often to produce pressure flaked tools. It also occasionally yielded miscellaneous retouched tools used in cutting, for which it is particularly well suited. The presence of several heavily used tools of obsidian and other exotic materials indicates that some flake tools probably were brought to Tosawihi in finished form.

Basalt is very rare in the flake tool assemblage, and its use is restricted almost exclusively to heavy duty tools (i.e., flaked/battered tools and discoids). It was used occasionally for other tools, one of which is a robust, symmetrically pointed piece made on a blank, originally perhaps a large projectile point. Relatively fine-grained basalt is common in some parts of the project area but it does not produce edges as sharp as opalite does and its flaking is more difficult to control. Thus, it is less suitable for many Tosawihi tool types.

Chalcedony, which of local lithic materials is easiest to pressure flake without heat-treating, was used primarily for pressure flaked tools. Jasper was used for a wide range of tool types without apparent preference by type, while opal was used primarily for scrapers.

Symmetrically pointed tools with short bits, bifacial flake tools, and pressure flaked tool fragments, were made of non-white material more often than were other types (Table 22). Within these types, some of the color variation is due to the presence of higher proportions of obsidian, but it also reflects the presence of curated tools made of opalite from diverse quarry locations.

Blank Production

A question central to understanding Tosawihi technology concerns whether or not flake tool blanks were struck from bifaces (either produced with specific intent or scavenged from debitage) or from flake cores. Most flake tools *could* have been detached from flake cores (cf. Table 77), but because flake cores are relatively rare and because approximately 50% of the flake tools were made on biface thinning flakes (Table 23), we assume the flake core/flake tool trajectory to have been of minor importance.

Consequent questions involve the stage in the biface trajectory at which flake tool blanks are produced, and whether this varies from type to type. Most flake tools are oriented on the detachment axis of the blank, so their lengths are functions of the widths of the bifaces from which they were detached; flake lengths, thus, can be used to index the widths (and probably the stage) of the original bifaces. Using the mean lengths of complete examples of each flake tool type and the mean widths of bifaces by stage, t-tests were run for the 14 tool types most frequently made on biface thinning flakes (Tables 33, 34).

All three types of scrapers are longer than could have been removed from average Stage 2, 3, or 4 bifaces. Symmetrically elongate and asymmetrically pointed tools probably were removed from Stage 2 or 3 bifaces, while symmetrically pointed tools with short bits, as well as microdenticulates, could have been removed from bifaces of any stage. Trihedrally pointed tools are too large to have been removed from Stage 2, 3, or 4. Notched and denticulate tools most likely were removed from Stage 2 or 3 bifaces, while miscellaneous retouched tools could have been removed only from Stage 2 bifaces.

Table 33. Comparison of Mean Sizes of Complete Flake Tools and Bifaces.

Flake Tool Type	Total n	LENGTH (cm) Mean	Range	S.D.
Side Scraper	22	69.8	28.1 - 117.3	24.5
End Scraper	67	58.6	20.8 - 110.4	21.1
Misc. Scraper	24	67.2	21.3 - 120.2	27.2
Symmetrical Pointed Tool (elong)	13	43.5	24.2 - 69.3	13.5
Symmetrical Pointed Tool (short)	6	41.4	31.9 - 63.3	11.4
Asymmetrical Pointed Tool	15	43.4	25.0 - 67.5	13.0
Trihedral Pointed Tool	5	85.6	71.1 - 104.2	14.2
Notch/Denticulate	25	68.4	34.4 - 107.4	21.1
Biface w/straight profile	0	-	-	-
Biface w/slightly sinuous profile	6	54.3	34.6 - 75.3	15.5
Biface w/coarse sinuous profile	2	80.7	744.6 - 86.8	8.6
Flake w/cont. retouch (one edge)	36	48.1	20.8 - 131.3	19.9
Flake w/cont. retouch (multiple edges)	14	68.1	34.0 - 112.9	24.1
Flake w/localized retouch	50	58.8	30.0 - 125.1	22.3
Crudely retouched flake/chunk	6	70.1	23.1 - 100.4	31.2
Flake w/variable retouch pattern (mult. edges)	26	56.7	32.5 - 122.3	22.4
Microdenticulate	4	41	34.4 - 50.3	6.7
Discoidal tool	8	102.6	45.0 - 1143.5	33.4
Pressure Flaked Tool Fragment	1	-	29.4 - 29.4	-
Fragmentary Indeterminate	2	40.6	15.2 - 66.0	35.9
Chopping Tool/Hammer	5	116.2	58.3 - 180.0	49.5
Other	3	81.8	61.1 - 100.0	49.5
Biface Stage			WIDTH	
Stage 1	24	72.7	54.0 - 87.1	9.3
Stage 2	191	69.2	28.9 - 116.2	16.5
Stage 3	380	62.4	21.4 - 118.5	17.9
Stage 4	6	59.6	35.2 - 84.4	21.6

Table 34. T-test Results Comparing Mean Flake Tool Lengths and Estimated Mean Biface Sizes.

Flake Tools Made on Biface Thinning Flakes	BIFACE MEASURE Stage 2	Stage 3	Stage 4
Side scraper	+	+	+
End scraper	+	+	+
Misc. scraper	+	+	+
Sym. pointed (elong)	-	0	+
Sym. pointed (short bit)	-	0	0
Assym. pointed tool	+	0	+
Trihedral pointed	+	+	+
Notched/denticulate	+	+	+
Misc. Retouch			
Cont. retouch-single edge	0	0	+
Localized	0	+	+
Variable ret.-mult. edges	0	0	0
Microdenticulate	0	0	0

Given P = .05:
+ = Flake tool (average size) significantly larger than biface measure
- = Flake tool (average size) significantly smaller than biface measure
0 = Flake tool and biface measure equal

These observations suggest that most flake tools were detached from early stage, "raw" (i.e., not heat-treated) bifaces. Most bifaces probably were exported from the quarries around middle Stage 3, and at least half probably were heat-treated. Therefore, it seems likely that most reduction (much of the biface debitage was detached from Stage 3 bifaces) is unrelated to flake tool manufacture. If bifaces removed from the quarries served as cores for the production of flake tool blanks, the resulting tools necessarily would be smaller than most of those recovered at Tosawihi.

Thermal Alteration

Heat-treatment is an important step in the manufacturing sequence for many Tosawihi artifact types. In the biface, projectile point, and preform classes it appears to precede thinning and pressure flaking. Among flake tools heat-treatment is less frequent (22%), and has little interpretable patterning (Table 25). Some flake tool types were heat-treated more frequently than others, including those with the greatest degree of pressure flaking (pointed tools and fragments; Table 35). There is not, however, perfect correspondence between pressure flaking and heat-treatment.

Table 35. Frequency of Heat-Treatment on Flake Tools.

Stage of Heat-Treatment	Tools w/Pressure Flaking n	%	All Flake Tools n	%
Blank From H/T Core	7	7.29	45	5.21
H/T as a Blank	22	22.92	113	13.08
H/T during Reduction	3	3.13	5	0.58
H/T Stage Indet.	8	8.33	22	2.55
Post-Dep. H/T	2	2.08	14	1.62
Possible H/T	4	4.17	15	1.74
Not H/T	50	52.08	650	75.23
Total	96		864	

Heat-treated flake tools more often were heat-treated as flakes than they were detached from heat-treated cores. However, 16% of them were made on flakes struck from heat-treated cores (usually bifaces), a proportion considerably greater than in other tool categories. Thus, the selection of blanks for tools drew from a mixture of variously heat-treated and non heat-treated flakes resulting from biface manufacture. This pattern suggests expediency in flake tool production.

Retouch

Most Tosawihi flake tools are not heavily modified; scrapers and pointed tools are the most formalized. Percussion techniques dominate; only about 10% of the tools exhibit clear evidence of pressure flaking (Table 26). Unretouched but utilized flakes were not examined systematically in this analysis since their macroscopic identification is equivocal (Young and Bamforth 1990). Obsidian tools are pressure flaked more often than tools of other materials, but the resulting forms do not appear to differ from those made of local materials. Obsidian debitage is distributed widely over the project area, indicating that at least some obsidian flake tools were manufactured at Tosawihi.

Hafting

Microscopic hafting traces caused by friction between tool and haft have been reported (Buller 1988; Plisson 1987; Anderson-Gerfaud and Helmer 1987; Winiarsk-Kabacinska 1988), but such identifications have been criticized strongly (Unger-Hamilton et al. 1987). Even proponents of the distinctiveness of microwear polishes note that the incidence of such traces is rare (Keeley 1982). The present analysis has not attempted such observations. No other direct evidence for the hafting of flake tools was found in the Tosawihi assemblage, that is, no breakage or use wear traces produced by use in a haft were noted, nor were any hafts recovered. Too, no residue of mastic adhering to the hafting elements was identified.

There is however, some indirect evidence for tool hafting. The symmetrically rounded tip with concentric striations occurring on drilling tools (Calley and Grace 1988; Keeley 1983) could have been produced only by incorporation in a mechanical drill (such as a bow drill or pump drill); therefore, they must have been hafted. Many scrapers, especially end-scrapers, probably were hafted as well. This is suggested by analogy with numerous ethnographic and archaeological examples of similar tools (Cauvin, Deraprahmian, and Helmer 1987; Julien, Vaughan, and Lavallée 1987; Asch 1981; Tohey 1981; Burch 1984); many are small, formally shaped, and probably resharpened (Semenov 1964; Keeley 1982) and would be much more efficient and easier to use when hafted (Broadbent and Knutsson 1975). Other tool forms also may have been hafted, but we have no evidence of it.

Standardization of Production

The question of standardization and specialization of lithic production has been approached in various ways (Torrence 1986; Sackett 1982; Miller 1987; Gibson 1982) and, though generally associated with complex economies, the existence of lithic specialists has been documented among hunter-gatherer groups (McBryde 1978). The apparently intense volume of production and the discovery of a number of biface caches, as well as the quality of products observed at Tosawihi, prompt examination of this question (cf. Chapter 6 for discussion of the issue as it applies to biface production).

Evidence for lithic specialists may be expressed variously in the archaeological record. Three principal indicators are 1) spatial segregation of production stages suggesting production by different individuals, 2) scales of production indicating manufacture for trade, and 3) standardization of products, including evidence of high degree of skill and low error rate as well as consistency of form. This information also bears on questions of contemporaneity, cultural similarity, and ethnicity which may cloud interpretation of the archaeological record.

Since there are few regionally distinctive tool types present at Tosawihi, our particular flake tool classes cannot inform the issue directly. Examination of evidence for the standardization of manufacturing techniques, however, may be more useful. As noted above, almost all Tosawihi flake tools are produced on early stage biface thinning flakes, retouch is produced primarily by percussion, and patterns of heat-treatment are extremely consistent. So, although flake tool manufacture was somewhat expedient (i.e., blanks were scavenged from biface production), it was also rather uniform. The pattern suggests that most Tosawihi knappers generally approached flake tool manufacture similarly.

Use

Flake tools at Tosawihi are diverse in function as well as in use intensity. Predictably, given the local abundance of toolstone, more than twice as many miscellaneous retouched tools,

often with more than one suitable working edge, exhibit use on only one edge. Some tool types were used for a single purpose (e.g., all scraper types were used almost exclusively for scraping), some were used for a few (e.g., miscellaneous retouched tools were used for both cutting and scraping), and others for several (e.g., pointed tools were used for scraping, grooving, perforating, boring, and drilling). As discussed above, 20% of a sample of debitage selected from contexts exhibiting great diversity in tool manufacture exhibit evidence of use, suggesting that unretouched flakes were used as tools fairly frequently, primarily for cutting and occasionally for scraping materials of varying hardness.

The following discussions examine function in terms of macroscopic characteristics, in the hope that these may help compare the Tosawihi assemblage to other published collections.

Tool Design and Function

Tool selection and design are related to function (Jones and White 1988), as well as to raw material availability, mechanical properties of available toolstone, and cultural preferences (Close 1979; Sackett 1982). Generally, the highly formalized flake tools at Tosawihi (primarily end-scrapers and symmetrically pointed tools) are very similar in form to those found across the Great Basin, and their form probably was dictated largely by function. Less formalized flake tools appear to have been selected for the suitability of their edges (e.g., straightness of profile, acuteness of angle) for performing specific tasks.

At Tosawihi, tools with convex and concave working edges were used primarily for scraping but also for cutting; straight working edges served equally for scraping and cutting as well as for other functions (Table 36). Tools with irregular working edges and those with more than one used edge were used primarily for scraping and diverse functions (including cutting), while convergent edges (such as those on pointed tools) were used chiefly for scraping and perforating.

Table 36. Edge Shape and Motion of Use of Flake Tools.

Motion of Use	Convex n	Concave n	Straight n	Irregular n	Convergent n	Multiple n	Total	%
Scraping	67	20	33	43	11	10	184	57.32
Cutting	17	5	31	18	2	3	76	23.68
Grooving	-	-	3	1	3	-	7	2.18
Perforating	-	-	4	3	12	-	19	5.92
Boring	-	-	1	1	1	-	3	0.93
Drilling	-	-	2	1	2	-	5	1.56
Chopping	-	-	-	2	-	-	2	0.62
Multiple								0.00
Scraping and Cutting	4	-	2	-	1	2	9	2.80
Scraping and Chopping	-	1	-	1	-	-	2	0.62
Scraping and Perforating	-	-	1	1	-	-	2	0.62
Scraping and Boring	-	-	-	-	1	-	1	0.31
Cutting and Grooving	-	-	-	1	-	-	1	0.31
Drilling and Perforating	-	-	-	-	3	-	3	0.93
Perforating and Boring	-	-	2	-	3	-	5	1.56
Drilling and Grooving	-	-	-	-	1	-	1	0.31
Boring and Drilling	-	-	-	-	1	-	1	0.31
Total	88	26	79	72	41	15	321	
%	27.41	8.10	24.61	22.43	12.77	4.67		

Straight edge profiles, produced by unifacial retouch, dominate all functional categories and may have formed criteria for blank selection; sinuous edges, produced by bifacial retouch,

were used most often for cutting, perforating, and drilling. Tools with different degrees of edge angle also were used differentially. Acute edges were used about equally for scraping and cutting, as well as for perforating, grooving, boring, drilling, and other functions (Table 37). Medium angled edges were used for scraping and, to a lesser degree, for cutting. Obtuse edges were used primarily for scraping, but also for perforating and drilling.

Table 37. Edge Angle and Motion of Use of Flake Tools.

Motion of Use	Acute n	Medium n	Obtuse n	Total
Single Motion				
Scraping	42	67	75	184
Cutting	37	34	5	76
Grooving	2	5	0	7
Perforating	9	5	5	19
Boring	1	2	0	3
Drilling	1	3	1	5
Chopping	1	1	0	2
Multiple motion				
Scraping/cutting	3	4	2	9
Scraping/chopping	0	2	0	2
Boring/perf.	2	1	2	5
Scraping/perf.	1	1	0	2
Perf./cutting/grooving	1	0	0	1
Cutting/grooving	0	1	0	1
Drilling/perf.	0	2	1	3
Grooving/scraping/cutting	0	1	0	1
Scraping/grooving	0	0	1	1
Scraping/boring	0	1	0	1
Drilling/grooving	0	1	0	1
Drilling/boring	0	1	0	1
Indeterminate	62	115	68	245
Unused	5	5	3	13
Unexamined	99	120	63	282
Total	266	372	226	864

Other macroscopic indications of use include the presence of gloss and edge rounding. Intensive use of opalite in certain circumstances creates a macroscopically visible gloss. We produced such gloss experimentally on three scrapers while scraping one deer hide, both in fresh and dry states, for 5 to 10 hours. Macroscopically visible gloss was observed on 13 Tosawihi flake tools, primarily scrapers and miscellaneous retouched tools (Tables 38, 39). Five were used for scraping, two for cutting, and one for multiple tasks.

Table 38. Presence of Gloss on Flake Tool Types.

Flake Tool Type	Presence of Gloss n	Total	%
Side Scraper	2	39	5.13
End Scraper	4	97	4.12
Notch/Denticulate	1	66	1.52
Biface w/straight profile	1	6	16.67
Flake w/cont. retouch (one edge)	1	109	0.92
Flake w/cont. retouch (mult. edges)	1	30	3.33
Flake w/variable ret. pattern (mult. edges)	1	61	1.64
Microdenticulate	1	7	14.29
Fragmentary Indeterminate	1	93	1.08
Total	13	508	2.56

Table 39. Presence of Microscopic Gloss Relative to Motion of Use on Flake Tools.

Motion	Presence of Gloss n
Unexamined	2
Scraping	5
Cutting	2
Grooving scraping/cutting	1
Indeterminate motion	3
Total	13

Nine specimens with gloss also exhibit macroscopic rounding, another indication of intensive use (Table 40). Rounding, recorded as light, moderate, or heavy, was observed more often than macroscopic gloss. Our own experiments demonstrate that rounding can be produced by both scraping and cutting. At Tosawihi, macroscopic edge rounding is found on a wider range of tool types than is gloss; they include scrapers, pointed tools, bifacial tools, and miscellaneous retouched tools. Most rounding is light, less is moderate, and on a small number of tools it is heavy. Thus, few Tosawihi flake tools evidence very intensive use.

Table 40. Edge Rounding on Flake Tool Types.

Flake Tool Type	Light n	Medium n	Heavy n	Absent n	Total	%
Side Scraper	7	1	-	31	39	4.51
End Scraper	7	4	1	85	97	11.23
Misc. Scraper	2	-	-	50	52	6.02
Symmetrical Pointed Tool (elong)	1	-	-	55	56	6.48
Symmetrical Pointed Tool (short)	4	-	-	18	22	2.55
Asymmetrical Pointed Tool	1	-	-	27	28	3.24
Trihedral Pointed Tool	-	-	-	5	5	0.58
Notch/Denticulate	3	-	-	63	66	7.64
Biface w/straight profile	2	-	-	4	6	0.69
Biface w/slightly sinuous profile	2	-	-	12	14	1.62
Biface w/coarse sinuous profile	-	-	-	4	4	0.46
Flake w/cont. retouch (one edge)	7	2	1	99	109	12.62
Flake w/cont. retouch (mult. edges)	1	-	-	29	30	3.47
Flake w/localized retouch	7	-	-	99	106	12.27
Crudely retouched flake/chunk	-	-	-	14	14	1.62
Flake w/variable ret. pattern (mult. edges)	9	-	-	52	61	7.06
Microdenticulate	-	-	-	7	7	0.81
Discoidal tool	-	1	1	8	10	1.16
Pressure flaked tool fragment	-	-	-	28	28	3.24
Fragmentary Indeterminate	2	-	-	91	93	10.76
Chopping Tool/Hammer	-	1	-	11	12	1.39
Other	1	-	-	4	5	0.58
Total	56	9	3	796	864	
%	6.48	1.04	0.35	92.13		

We also examined macroscopic red staining on flake tools, but it remains unclear if and how it relates to use. Such staining has been noted elsewhere in the Great Basin; at James Creek Shelter it is associated with scraping (Elston and Budy 1990), while at Gatecliff Shelter, various tools were stained with what was identified as red ochre (Thomas 1983b). Of the flake tools at Gatecliff, however, only a scraper plane and a perforator were stained. At Kramer Cave in Western Nevada, red ochre was found on the hafts of flaked obsidian objects used as pendants (Hughes and Bennyhoff 1986). At several sites in Idaho, red ochre staining has been noted on stone tools recovered from burials (Pavesic 1985).

Red ochre has been associated with hide-working in the Old World Paleolithic (Rosenfeld 1971; Leroi-Gourhan and Brézillon 1972; Audoin and Plisson 1982), but its purpose is debated; insecticidal, preservative, and aesthetic reasons all have been cited (Keeley 1980). An additional explanation for the occurrence of red ochre on the non-working surfaces of stone tools involves its possible use as a hafting temper (Buller 1988; Beyries 1983). At Tosawihi, red staining was noted primarily on the working edges of scrapers (54% of red stained pieces) and miscellaneous retouched tools (31% of red stained pieces; cf. Table 31, Figure 50). Six of seven stained scrapers were used for scraping, whereas only one of four miscellaneous retouched pieces definitely was used for cutting (Table 41). Unidentified stained retouched flakes are of indeterminate function, as is the single example of a stained pointed tool.

Table 41. Frequency of Red Staining by Motion of Use on Flake Tools.

	Presence of Staining
Motion	n
Unexamined	1
Scraping	6
Cutting	1
Indeterminate function	5
Total	13

Edge Maintenance

Only scrapers exhibit unequivocal evidence of edge maintenance; approximately one-third of them have short, stepped terminations around the working edge. This type of fracture can be produced by hafted scrapers, but it also can be caused by original retouching tool or by heavy use on rather hard materials (Broadbent and Knutsson 1975).

Curation and Expediency

Curated tools are transported from their location of manufacture with the expectation of future use, while *expedient* tools are produced, used, and discarded at the same locus. The possibility that some obsidian tools were brought to Tosawihi in finished form has been noted above; obsidian wears down quite quickly, however, so it is difficult to identify which tools may have been most highly curated. The issue is less ambiguous for opalite tools. Based on a number of macroscopic and microscopic variables reflecting intensity of use (including edge rounding and macroscopic gloss, number of used edges, and degree of polish development), analyzed tools were

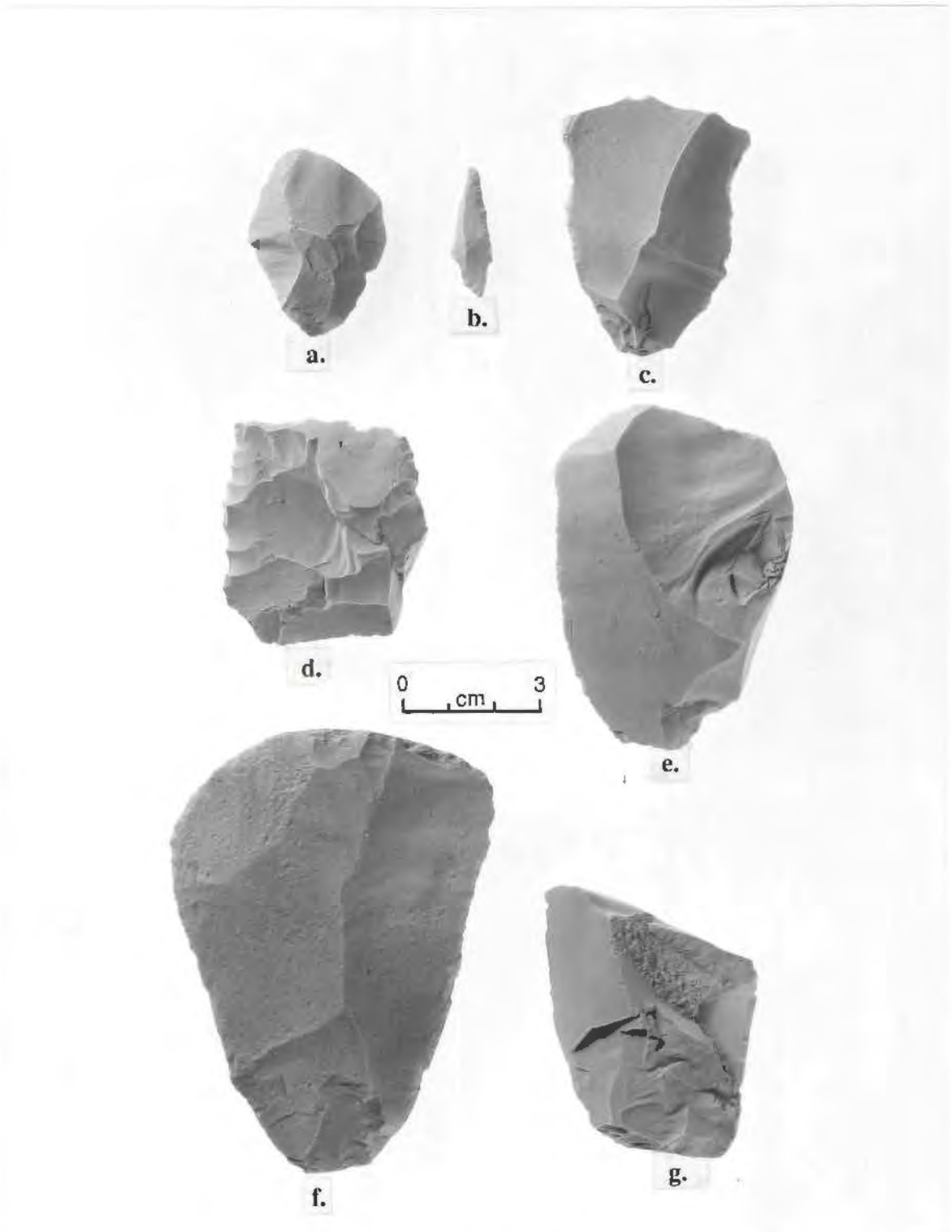


Figure 50. Tools with red staining. a,c. miscellaneous retouched tools; b. symmetrically pointed tool; d. bifacial tool; e,f,g. scrapers.

sorted into classes of light, moderate, or heavy use. The number of tools in each class was weighted, summed, and divided by the total, producing an index. An intensity-of-use-index was assigned each tool type (Table 42) and each site (Table 43); the higher the index, the more intensive the flake tool use at that site or of that tool type. This index measures only relative, not absolute, intensity. Types and sites exhibiting greatest intensity of use are those which contain the most highly curated tools and/or those used to work harder materials.

Table 42 reveals that microdenticulates and bifacial tools with straight and slightly sinuous edges exhibit greatest intensity of use, while retouched flakes with localized retouch, notches, and denticulates exhibit least. Most other tools fall between; scrapers, pointed tools, and most miscellaneous retouched types differ only subtly.

Table 42. Intensity of Use by Flake Tool Type.

Flake Tool Type	Weighted Score	n	Intensity Index
Side scraper	95	28	3.4
End scraper	240	69	3.5
Misc. scraper/fragment	94	25	3.8
Sym. pointed tool (elong.)	135	37	3.6
Sym. pointed tool (short)	37	11	3.7
Assym. pointed tool	60	17	3.5
Notched/denticulate	130	39	3.3
Bifacial w/straight profile	20	5	4.0
Bif. w/slightly sinuous profile	24	6	4.0
Flake w/cont. retouch/single edge	123	36	3.4
Flake w/cont. retouch mult. edge	55	15	3.6
Flake w/localized retouch	58	24	2.1
Flake w/var. ret. patt. (mult. edges)	70	19	3.7
Microdenticulate	20	5	4.0

Excluding sites with small samples of flake tools, quarries (such as Localities 19 and 20) score lower than more residential places (such as Locality 27). Taken together, tools at quarries exhibit a similar or slightly lower level of use intensity than at larger sites in the East, levels which are slightly lower than that of the largest sites in the West and North (Table 43). This suggests that certain tool-using activities of longer duration were undertaken more often at non-quarry sites removed from the quarry proper.

There is some evidence for the expedient *manufacture* of flake tools. Blanks frequently were selected from debitage produced in early stage biface manufacture rather than from flake cores. Selection of blanks, however, was not random; certain characteristics were favored and pieces exhibiting, for example, straight edges and straight profiles were chosen for making flake tools. There seems to be little correlation between tool type or function and heat-treatment, and only a weak correlation between heat-treatment and pressure flaking. On the other hand, we find little evidence reflecting the expedient use of most tools; rather, most tools in most tool classes exhibit moderate use intensity. With the exception of miscellaneous retouched tools with localized retouch, the intensity of use on most miscellaneous retouched tools is roughly equivalent to that on scrapers and pointed tools, despite a small number of scrapers and pointed tools that display a far greater use intensity than most. Unretouched pieces from the debitage sample exhibit a lower intensity of use, but this merely may reflect their suitability for short-term rather than "expedient" use.

Table 43. Intensity of Flake Tool Use by Site.

Subarea	Site/Locality	Weighted Score	n	Intensity Index
Quarry	26Ek3032/L19	43	13	3.3
	L20	10	3	3.3
	L21	0	0	0
	L22	0	0	0
	L23	35	10	3.5
	L25	17	5	3.4
	L26	0	0	0
	L27	47	13	3.6
	L98	0	0	0
East	230	0	0	0
	123	4	1	4
	26Ek3170	54	16	3.4
	26Ek3171	12	4	3
	26Ek3173	8	2	4
	26Ek3179	2	1	2
	26Ek3184	100	28	3.6
	26Ek3185	34	10	3.4
	26Ek3190	15	5	3
	26Ek3191	0	0	0
	26Ek3192	117	34	3.4
	26Ek3193	0	0	0
	26Ek3195	8	2	4
	26Ek3196	6	2	3
	26Ek3197	0	0	0
	26Ek3198	21	7	3
	26Ek3200	4	1	4
	26Ek3204	37	10	3.7
West	26Ek3084	4	1	4
	26Ek3086	8	2	4
	26Ek3088	4	1	4
	26Ek3090	4	1	4
	26Ek3092	172	49	3.5
	26Ek3093	6	2	3
	26Ek3095	88	26	3.4
	26Ek3101	4	1	4
	26Ek3102	0	0	0
	26Ek3106	4	1	4
	26Ek3114	4	1	4
	26Ek3115	12	3	4
	26Ek3116	22	6	3.7
	26Ek3149	8	2	4
	26Ek3160	121	33	3.7
	26Ek3165	12	3	4
	26Ek3208	0	0	0
	26Ek3271	78	20	3.9
North	26Ek3234	23	6	3.8
	26Ek3238	4	1	4
	26Ek3239	0	0	0
	26Ek3251	37	10	3.7

Distribution

The distribution of flake tools in the project area is essentially a reflection of discard practices, variously induced. Tools broken in manufacture, use, and resharpening, as well as those used expediently, probably were discarded in their area of final use in most cases. On the other hand, heavily curated tools and hafted tools may have been discarded in areas where they were repaired rather than where they were used. Only a small proportion of pieces from each tool type appear to have been broken in manufacture. Since only a minority of tools were hafted or heavily curated, most pieces in the assemblage probably were discarded near their area of final use. If we assume that most tools were discarded near where they were used, the co-occurrence of types at particular sites, the diversity of assemblages, and their contextual distribution may inform us of site-specific activities.

Co-occurrence of Types within Site Assemblages

When correlation coefficients are calculated for morphological types and functional types on a site by site basis, the general patterns of each (Table 44) suggest the following:

- Scrapers correlate strongly with the incidence of miscellaneous retouched tools. They are used for both cutting and scraping so we examined correlations between motions of use (functional types). Were cutting and scraping *not* highly correlated, we would have inferred an association between scrapers and only those miscellaneous retouched tools used for scraping (but not for cutting). However, when these actually are calculated, scraping and cutting are the only strongly correlated motions of use.

- Notched and denticulate tools, most often used for scraping, often are found at quarries, and are not statistically associated (Pearson's correlation coefficient) with other tool types. They may reflect maintenance of quarry-related tools such as antler wedges, digging sticks and such.

- Pointed tools are associated with unidentifiable pressure flaked tool fragments, suggesting that at least some of the latter may be pointed tool fragments broken in manufacture or use.

- Symmetrically pointed tools, used for a variety of functions, are found with end-scrapers and with asymmetrically pointed tools, but not with side-scrapers or miscellaneous scrapers.

- Scraper types correlate weakly with each other and miscellaneous retouched tool types correlate strongly with each other, while pointed tool types are less internally correlated than either group. Either the morphological distinctions between scrapers and miscellaneous retouched tools do not reflect functional differences, or each type was used in specialized but related tasks.

Table 44. Flake Tool Diversity by Site.

Subarea	Site/Locality	High	Moderate	Low	No. of Classes	No. of Tools
Quarry	Loc. 19		x		11	6
	Loc. 20			x	5	6
	Loc. 21			x	2	2
	Loc. 22			x	1	1
	Loc. 23			x	10	26
	Loc. 25	x			10	13
	Loc. 26			x	1	1
	Loc. 27	x			14	35
	Loc. 98			x	1	1
East	123 (DSC)		x		2	2
	230 (DSC)			x	1	1
	311 (DSC)		x		2	2
	26Ek3093		x		3	3
	26Ek3170	x			14	46
	26Ek3171	x			10	16
	26Ek3173		x		4	4
	26Ek3179		x		3	3
	26Ek3181			x	3	5
	26Ek3184		x		14	76
	26Ek3185			x	8	13
	26Ek3190	x			9	17
	26Ek3191			x	4	5
	26Ek3192		x		15	69
	26Ek3193			x	1	1
	26Ek3195			x	3	4
	26Ek3196			x	2	3
	26Ek3197			x	1	1
	26Ek3198			x	8	13
	26Ek3200			x	1	1
	26Ek3201			x	1	1
	26Ek3204	x			12	21
West	26Ek3084			x	2	3
	26Ek3086		x		2	2
	26Ek3088			x	1	1
	26Ek3090			x	1	1
	26Ek3092	x			20	147
	26Ek3095		x		13	59
	26Ek3101		x		3	3
	26Ek3102			x	1	1
	26Ek3106			x	2	3
	26Ek3114		x		2	2
	26Ek3115			x	3	4
	26Ek3116			x	6	8
	26Ek3149			x	3	4
	26Ek3160	x			18	83
	26Ek3165			x	6	10
	26Ek3208		x		3	3
	26Ek3271	x			16	44
North	26Ek3237	x			13	28
	26Ek3238			x	1	1
	26Ek3239		x		4	4
	26Ek3251			x	10	38

Assemblage Diversity

Assemblage diversity often has been shown to be a function of sample size (Jones, Beck, and Grayson 1989); that is, large assemblages almost always display larger numbers of artifact classes than small ones. For the sites at Tosawihi from which flake tools were recovered, the number of tool classes was plotted against the logged number of specimens and a regression line fit to the distribution; lines delimiting a confidence interval of 0.95 were plotted as well (Figure 51). Sites falling above the regression line have a high tool diversity relative to sample size; those below the line have less diversity, or exhibit more specialized activity. Table 44 classifies sites according to high, moderate, and low diversity. It appears that large residential sites were loci of diverse but perhaps not very intensive activities, while smaller sites (including many reduction stations) witnessed a narrow range of perhaps more intensive activities (Table 45).

The flake tool assemblage from a site (26Ek3251) in the Northern Corridor does not fit the pattern described above. It is a large site, with relatively large numbers of flake tools (38), points (45), and preforms (63). Its low flake tool diversity suggests that it may reflect an intensive but limited range of activities, thus differing from most other large sites in the project area.

Table 45. Sites Arrayed in Order of Decreasing Number of Flake Tool Classes.

Site	No. of Tool Classes Present	Site	No. of Tool Classes Present
26Ek3092	20	26Ek3093	3
26Ek3160	18	26Ek3101	3
26Ek3271	16	26Ek3115	3
26Ek3192	15	26Ek3149	3
26Ek3184	14	26Ek3179	3
26Ek3170	14	26Ek3181	3
26Ek3032 L27	14	26Ek3195	3
26Ek3095	13	26Ek3208	3
26Ek3237	13	123 (DSC)	2
26Ek3204	12	311 (DSC)	2
26Ek3032 L19	11	26Ek3032 L21	2
26Ek3032 L23	10	26Ek3086	2
26Ek3032 L25	10	26Ek3106	2
26Ek3171	10	26Ek3114	2
26Ek3251	10	26Ek3196	2
26Ek3190	9	26Ek3084	2
26Ek3198	8	230 (DSC)	1
26Ek3185	8	26Ek3032 L22	1
26Ek3165	6	26Ek3032 L26	1
26Ek3116	6	26Ek3032 L98	1
26Ek3032 L20	5	26Ek3088	1
26Ek3173	4	26Ek3090	1
26Ek3191	4	26Ek3102	1
26Ek3239	4	26Ek3193	1
		26Ek3197	1
		26Ek3200	1
		26Ek3201	1
		26Ek3238	1

Contextual Distribution of Flake Tools

Various contextual distributions (i.e., surface vs. sub-surface, feature vs. non feature, residential vs. non-residential) of major tool groups were compared; the data are presented in Tables 46-48. Adjusted standardized residuals (Everitt 1977) were calculated, and statistically statistically significant associations noted on the tables. Since surface materials were collected

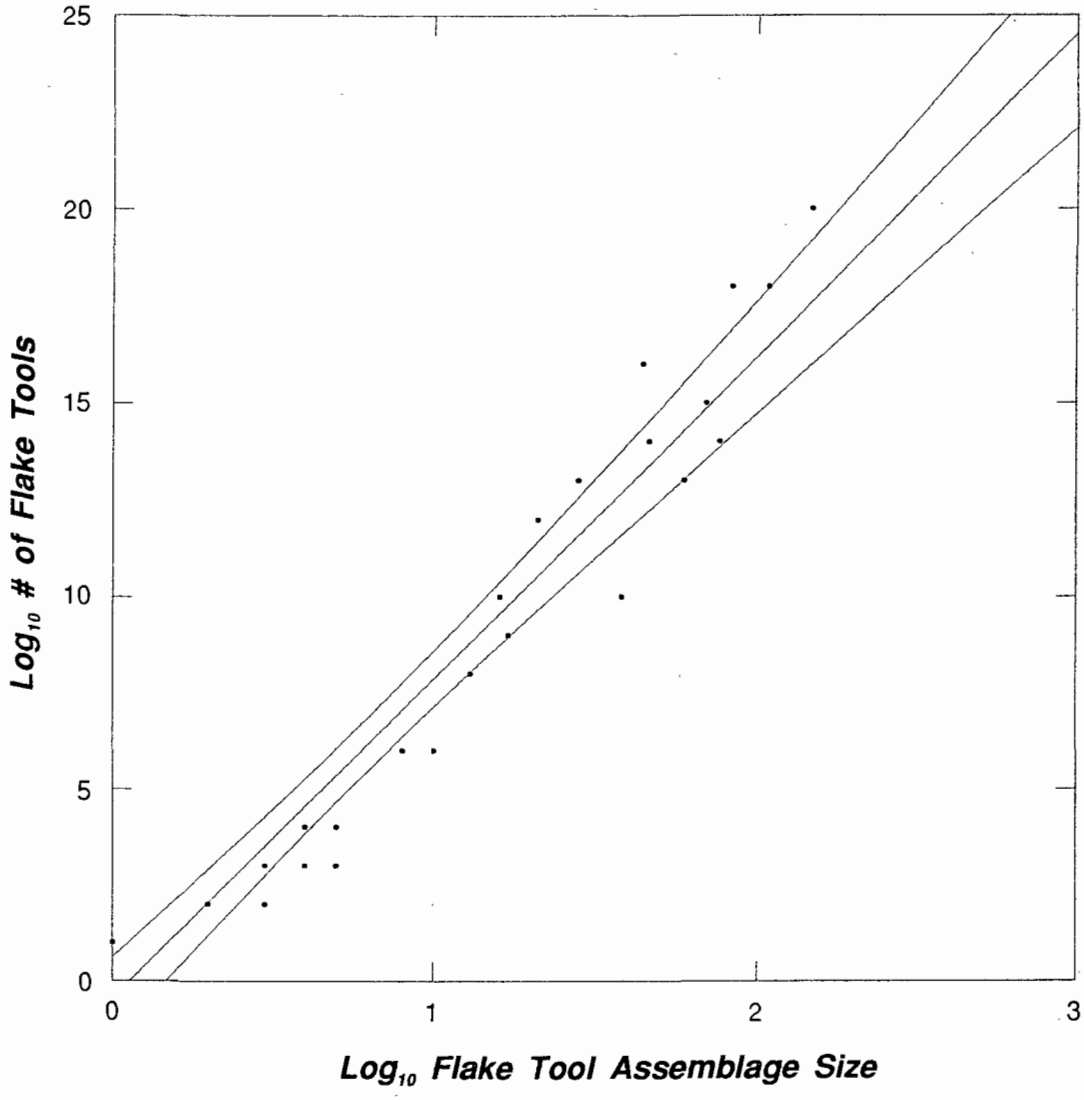


Figure 51. Flake tool assemblage diversity (logged).

from every site, and since formal tools and larger, more complete ones were recognized more easily and collected more often, surface samples contain high proportions of formed tools; subsurface samples contain a lower proportion of fragmentary tools.

Table 46. Incidence of Surface vs. Subsurface Flake Tools by Subarea.

	NORTH		EAST		WEST		QUARRY		TOTAL	
	n	%	n	%	n	%	n	%	n	%
SURFACE FLAKE TOOLS										
Scrapers	10	0.43	21	0.40	19	0.23	6	0.43	56	0.32*
Pointed	7	0.30	6	0.11	24	0.29	3	0.21	40	0.23*
Misc. Retouch	2	0.09	18	0.35	23	0.28	4	0.29	47	0.27*
Notch	1	0.04	4	0.08	5	0.06	1	0.07	11	0.06*
Fragment	2	0.09	1	0.02	8	0.10	0	0	11	0.06
Press	1	0.04	2	0.04	4	0.05	0	0	7	0.04
Total	23		52		83		14		172	
SUBSURFACE FLAKE TOOLS										
Scrapers	2	0.04	65	0.28	47	0.18	18	0.22	132	0.21*
Pointed	10	0.22	23	0.10	28	0.11	9	0.11	70	0.11*
Misc. Retouch	13	0.29	97	0.41	126	0.48	23	0.29	259	0.42*
Notch	2	0.04	15	0.07	18	0.07	20	0.25	55	0.09*
Fragment	15	0.33	27	0.12	32	0.12	8	0.10	82	0.13
Press	3	0.07	5	0.02	11	0.04	2	0.02	21	0.03
Total	45		232		262		80		619	

*Indicates types with statistically significant differences.

Table 47. Incidence of Feature vs. Non-feature Flake Tools by Subarea.

	NORTH		EAST		WEST		QUARRY		TOTAL	
	n	%	n	%	n	%	n	%	n	%
FEATURE FLAKE TOOLS										
Scrapers	3	0.08	69	0.29	33	0.20	15	0.23	120	0.24
Pointed	8	0.22	22	0.09	22	0.13	7	0.11	59	0.12*
Misc. Retouch	8	0.22	101	0.43	73	0.43	20	0.31	202	0.40
Notch	1	0.03	17	0.07	15	0.08	16	0.25	49	0.09
Fragment	14	0.39	24	0.10	21	0.12	5	0.08	64	0.13
Press	2	0.06	4	0.02	4	0.02	2	0.03	12	0.02*
Total	36		237		168		65		506	
NON-FEATURE FLAKE TOOLS										
Scrapers	8	0.26	17	0.36	33	0.19	9	0.30	67	0.23
Pointed	9	0.29	7	0.15	30	0.17	6	0.20	52	0.18*
Misc. Retouch	7	0.22	14	0.30	76	0.43	7	0.23	104	0.36
Notch	2	0.06	2	0.04	8	0.05	5	0.17	17	0.06
Fragment	3	0.10	4	0.08	19	0.11	3	0.10	29	0.10
Press	2	0.06	3	0.06	11	0.06	0	0	16	0.06*
Total	31		47		177		30		285	

*Indicates types with statistically significant differences.

Table 48. Incidence of Flake Tools in Residential and Non-residential Contexts by Subarea.

	NORTH		EAST		WEST		QUARRY		TOTAL	
	n	%	n	%	n	%	n	%	n	%
NON-RESIDENTIAL FLAKE TOOLS										
Scrapers	1	1	67	0.31	14	0.44	15	0.23	97	0.31
Pointed	0	0	17	0.08	6	0.19	7	0.11	30	0.10*
Misc. Retouch	0	0	90	0.43	10	0.31	20	0.31	120	0.40
Notch	0	0	10	0.05	1	0.03	16	0.25	27	0.09
Fragment	0	0	21	0.10	1	0.03	5	0.08	27	0.09*
Press	0	0	6	0.03	0	0	2	0.03	8	0.02
Total	1		211		32		65		309	
RESIDENTIAL FLAKE TOOLS										
Scrapers	11	0.16	19	0.26	52	0.18	9	0.31	91	0.19
Pointed	17	0.25	12	0.16	17	0.06	5	0.17	51	0.11*
Misc. Retouch	15	0.22	25	0.34	139	0.49	7	0.24	186	0.40
Notch	3	0.04	9	0.12	22	0.08	5	0.17	39	0.08
Fragment	17	0.25	7	0.09	39	0.14	3	0.1	66	0.14*
Press	4	0.06	1	0.01	15	0.05	0	0	20	0.04
Total	67		73		284		29		453	

*Indicates types with statistically significant differences.

Late projectile points were found more often in feature than in non-feature contexts, suggesting that earlier features have become dispersed while later ones are more intact and can be defined on the ground. This is supported by differences in hydration rind thicknesses on obsidian artifacts from feature and non-feature contexts (cf. Chapter 19), but here the difference might owe equally to varying patterns of site use and point discard. Among flake tools, pointed tools (one of the smaller and most frequently pressure flaked tool groups) and pressure flaked tool fragments are associated positively with non-feature contexts.

When apparently residential and non-residential sites are compared, differences among proportions of flake tools types are evident. Assemblages from "non-residential" sites (Elston and Budy 1990) exhibit a much larger proportion of scrapers (31% as opposed to 19%); fragmentary tools and pressure flaked tool fragments are more common at "residential" sites. Differences among other tool classes in the two contexts do not differ significantly. If several of the large sites with large flake tool inventories from the Eastern Periphery, originally thought to be primarily reduction stations, are considered residential, differences in assemblages become more pronounced; scrapers still dominate at non-residential sites, but we find an increased proportion of miscellaneous retouched tools at residential sites.

In sum, the Eastern Periphery dominates the non-residential sample and the Western Periphery dominates the residential sample, but it is clear that the East hosts proportionally a greater number of scrapers than the West. It is clear as well that notches and denticulates are most common in the Quarry sub-area, and fragmentary tools (as well as a high proportion of pointed tools) prevail in the North; miscellaneous retouched tools are found everywhere. Some implications of these patterns are discussed in subsequent chapters.

Chapter 8

PROJECTILE POINTS AND PREFORMS

Kathryn Ataman and Michael P. Drews

This chapter describes the chronological, morphological, technological, and functional characteristics of the projectile points and preforms recovered from Tosawihi. For the purposes of this study, preforms are defined as flakes discarded during the process of being made into smaller projectile points. Preforms for larger points often are indistinguishable from small knives or small knife preforms; for this reason, such pieces have been included under the more general grouping of small bifaces. The differences between large preforms and small knives are discussed in more detail in Chapter 21. Distinctions between preforms and points were made on the basis of degree of finishing and certain key morphological attributes. The research questions to be addressed by projectile points and preforms involve chronology, technology, and the characterization of feature-specific activity areas. All have implications concerning the nature of prehistoric exploitation of the quarries.

Research Questions

Chronology

Projectile points have proven useful temporal indicators in the western and central Great Basin (Heizer and Baumhoff 1961; Heizer and Hester 1978; O'Connell 1967; Clewlow 1967; Thomas 1971, 1981). As such, they help constrain the age of deposits in which they are found. The relative dating they provide can be used to construct local chronologies of sites and features as well as to date associated geological strata. They also provide frameworks in which to analyze temporal variation in technology, intensity of use, subsistence, mobility, and stylistic change. The chronological discussions here are descriptive, relating to specific point types and their suggested temporal ranges. A chronological synthesis is presented in Chapter 19.

Several researchers (Flenniken 1985; Flenniken and Raymond 1986; Titmus and Woods 1986; Flenniken and Wilke 1989) question the validity of the currently accepted Great Basin projectile point sequence, suggesting that breakage and subsequent modification produce morphological variation sufficient to render many types poor temporal indicators. A relatively large projectile point assemblage (402 specimens) allowed us to examine breakage patterns and instances of reworking in the interest of addressing this issue.

C14 dating and obsidian hydration readings are relatively accurate indicators of chronological age; together with patterns of post-production modification, they allow us to assess the general validity of the typological scheme. Preforms provide less specific chronological information, but, to a degree, relative size may prove a useful chronological index.

Technology

Projectile points and preforms enter the archaeological record variously, and evidence of their manufacture, use, reworking, retooling, and discard have implications concerning the logistical organization of prehistoric groups. Several levels of technological organization may be reflected in an assemblage; too, projectile points may elucidate variations in group and technological patterns from one period to another.

We should expect projectile point manufacture to have occurred at Tosawihi. Manufacture alone requires little more than incidental or diurnal visits to the quarry, and the projectile point assemblage should be dominated by pressure flakes, broken, discarded preforms, and unfinished points broken in manufacture. If field camps or more logistically organized forays were required to exploit the toolstone resource, then coincidental activities such as hunting and processing might be expected. Use wear analysis and breakage patterns should reflect this, with high incidences of macroscopic and microscopic impact damage.

Evidence of reworking or redirection of broken artifacts may indicate another level of logistical organization. Thomas (1983b) suggests that tool maintenance, redirection, and discard probably are associated with long term, seasonal occupation. Evidence of post-production modification, resharpening, edge repair, redirection, or discard may signal more intensive, well planned exploitation.

Since only scant faunal material helps reconstruct Tosawihi subsistence activities, distinctions between manufacture and use of points may contribute to our understanding of subsistence. In addition, manufacturing and use wear data provide insights into the organization of lithic production. We wanted to know at what types of site (quarries, kill sites/butchering localities, or residential bases) projectile points were produced, reworked, or discarded.

Characterization of Specific Activity Areas

Data on the manufacture and function of projectile points and preforms can be used to characterize specific activity areas. Specimens broken during manufacture are unlikely to have been transported around the landscape and probably were discarded at or near their place of production. Likewise, points lost or irreparably broken during hunting should be discarded near capture or processing locales. Thus, unlike other classes of broken tools which may have been produced in one place, used in another, and discarded in a third, preforms, broken points, and pressure flakes can be assumed to reflect *in situ* or nearly *in situ* activities.

Analytical Methods

Typology

Typological criteria and temporal constraints employed in this analysis follow those outlined by Thomas (1981). This system assigns projectile points to temporal series on the basis of morphological observations including length, width, thickness, weight, basal width, and notch angles. In this scheme, the "series is the time-bearing unit and the type is merely a morphological modifier" (Thomas 1981:160). Chronological and morphological attributes for the Great Basin Stemmed Series, not addressed by Thomas (1981), follow Layton (1979), Clewlow (1968) and Frison (1978). Elston and Budy (1990), using radiocarbon dated deposits at James Creek Shelter, have developed a regional chronology for the Upper Humboldt Valley; phase names and chronological sequences throughout this chapter refer to their chronology.

Technological and Functional Analysis

In recent years considerable research has focused on the manufacture and use of projectile points. These studies have taken a variety of forms, most using typological schemes

as a broad research framework. For example, some studies have used functional and technological analyses to distinguish points tipping thrusting spears, atlatls, and arrows (Thomas 1978; Holmer 1986). Our analysis employs a similar typological framework, but examines manufacturing techniques, as well as evidence of use, to address technological and functional variability within the assemblage.

Technological Variability

Manufacturing stages of various projectile points types are investigated by contrasting them with a variety of other artifact classes. Attributes of projectile points and preforms such as general morphology, flake scar patterns, and heat-treatment are compared to those of small bifaces, and reduction sequences then are proposed. This allows us to consider associations between these artifact classes and the debitage associated with point manufacture.

The presence of diagnostic manufacturing debris such as notching flakes (Titmus 1985), pressure flakes, and other characteristic debitage associated with broken point fragments should indicate whether the entire manufacturing sequence is represented. If no point fragments are present, production debris *may* suggest the possible range of point types manufactured.

Manufacturing failures, such as notching failure or (as in the case of our single Clovis preform) fluting failure, can be recognized as well. The presence of failed points, especially when associated with broken preforms and pressure debitage, provide evidence for on-site point manufacture. Stages of preform manufacture have been used to examine the organization and standardization of production. Other variables used to compare points and preforms include the orientation of tips on blanks, the types of blank used, the general shape of preforms as opposed to finished points, and the incidence and stage of heat-treatment.

Functional Analysis

Numerous studies have concentrated on distinguishing manufacture-induced breakage from use-related damage (Barton and Bergman 1982; Miller 1982; Bergman and Newcomer 1983; Fischer et al. 1984; Odell and Cowan 1986; Ataman 1986). Distinctive breakage types have been established through experimental replication and use of replicated pieces as atlatl darts, points for thrusting spears, and arrowpoints. Diagnostic and non-diagnostic breakage patterns have been produced in a variety of materials on a number of different point types. Although breakage, proportions of fracture types, and amount of fragmentation vary, these characteristic fractures reflect utilization of points as projectiles.

Several fracture types were observed at Tosawihi; they are illustrated in Figure 52. Snap fractures are bending fractures, produced during manufacture, in use, or post-depositionally. Fluting fractures are narrow, elongated impact fractures running parallel to the axis of the point; they initiate either at tip or base, or at snap fractures in the center of the point. Another fluting fracture is caused by rebound in the haft as a result of impact (usually contact with bone), and is signalled by the presence of extensive step-like fractures initiating from a snap fracture. Burin-like fractures also are diagnostic of impact; they remove a flake from the edge of a point resembling the facet on an angle burin. Burin-like fractures may be initiated from the tip, the base, or a break at the center of the point.

Several researchers have suggested alternative or multiple uses for artifacts classified as projectiles points (Ahler 1971; Greiser 1977; Zeir 1978; Wheat 1979; Woods 1986), including their use as knives. In order to identify wear associated with alternate use, projectile points were examined microscopically. This finer level of examination allowed us to observe polish and

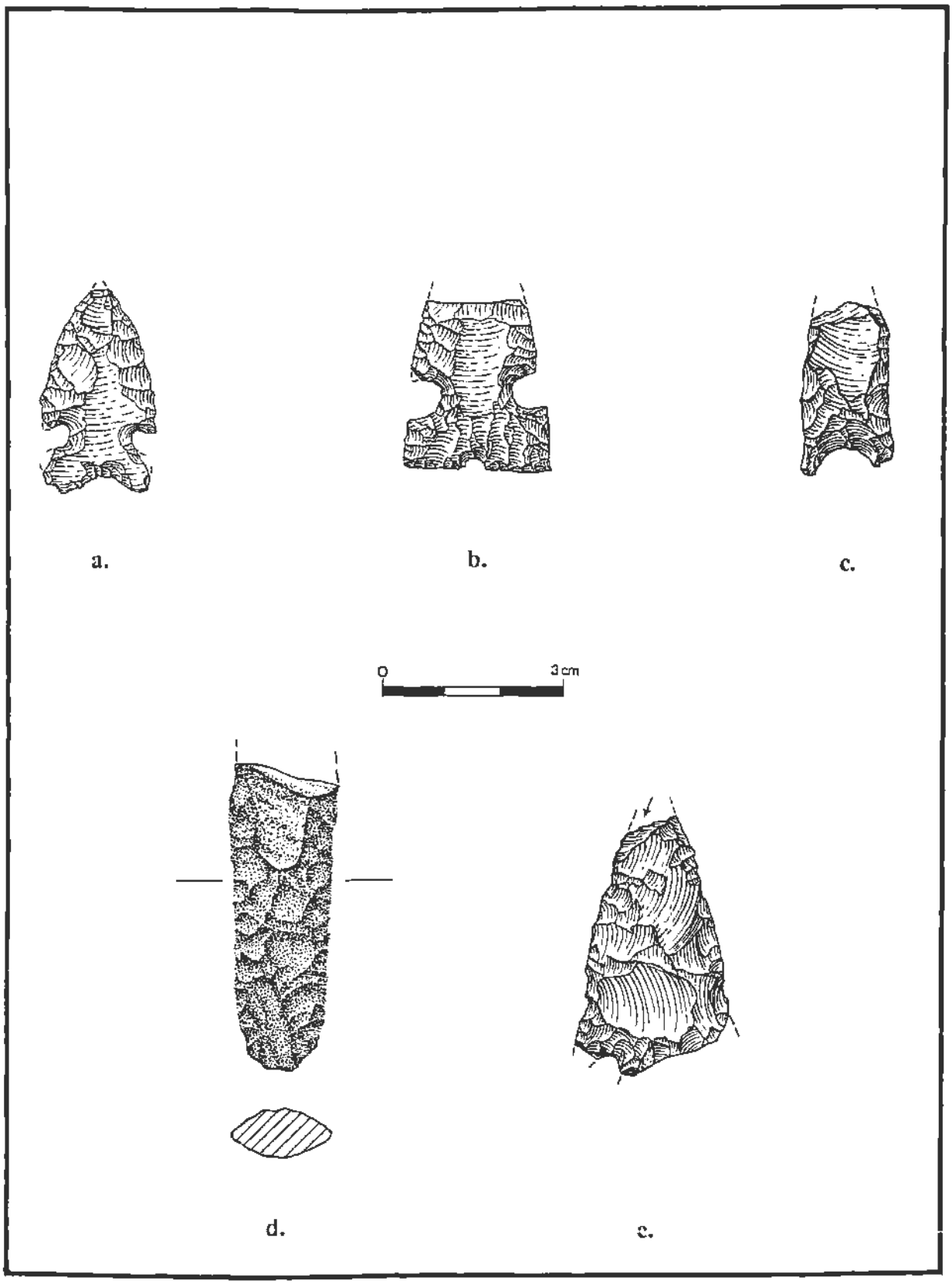


Figure 52. Fracture types on selected Tosawihi projectile points. a. fluting fracture; b. snap fracture; c,d. snap and fluting fracture; e. burin-like fracture.

striations on tool surfaces and correlate type of wear with a range of activities. The models used for identification of diagnostic features are based on experimental replication and simulated use (Nance 1971; Moss and Newcomer 1982; Fischer et al. 1984; Ataman 1986). A more detailed discussion of methods of microscopic analysis is presented in Chapter 7.

Additional to projectile points, a sample of preforms was examined for use wear traces to determine whether they might have served as finished tools. Forty-two specimens were selected, primarily complete or substantially complete pieces. Using methods similar to those described above, they were examined for the presence of macroscopic and microscopic fractures, polish, and striations indicative of use.

Data Collection Methods

Provenience, metric attributes, raw material, and thermal alteration of projectile points and preforms were recorded, and refitted pieces were logged as single specimens. Variables recorded during analysis included blank type, tip orientation, fragment type, breakage pattern, and stage of manufacture. Microscopic wear traces were recorded by the presence or absence of characteristic micro-fractures, micro-rounding, polish, and linear features or striations.

Blank types were sorted into biface thinning flakes, other blank types, or indeterminate specimens. Orientation of the point tip on the blank was attempted, but extensive pressure flaking often made this difficult. Fragment types were recorded as complete, tang or barb, stem or base, tip missing, midsection, tip, base missing, lateral fragment, barb or tang missing, or indeterminate. Breakage patterns were recorded as snap fractures, fluting fractures, burin-like fractures, haft rebounds, notch failures, other manufacturing failures, combination fractures, and indeterminate types. Stage of manufacture was recorded for preforms in a system paralleling that used for bifaces (i.e., edge preparation, primary thinning, secondary thinning, and finishing). Evidence of reworking was recognized by asymmetrical form, work on a break, non-standard form, or a localized flaking pattern not conforming to that on the rest of the point. The incidence of reworking probably is greater than indicated in our data since it is not always possible to recognize such modification on symmetrical forms.

Results

Projectile Points

The projectile point assemblage consists of 402 complete points and fragments from the Tosawihi vicinity. The assemblage exhibits a wide temporal range, providing evidence for an extremely long period of human exploitation of the quarry area. This section describes the assemblage by type, employing the typological criteria advanced by Thomas (1981), and discusses raw material preference, size, and breakage characteristics.

Clovis Preform

Our single Clovis preform consists of large basal fragment measuring 101.6 mm x 65.4 mm x 12.8 mm. It weighs 108.7 gms and approximates one-half of the intact length of the artifact (Figure 53). It was manufactured from moderate brown (5YR 4/4 Munsell Rock) to yellowish brown (10YR 5/4 Munsell Soil) local chert. Its lateral margins are percussion flaked;

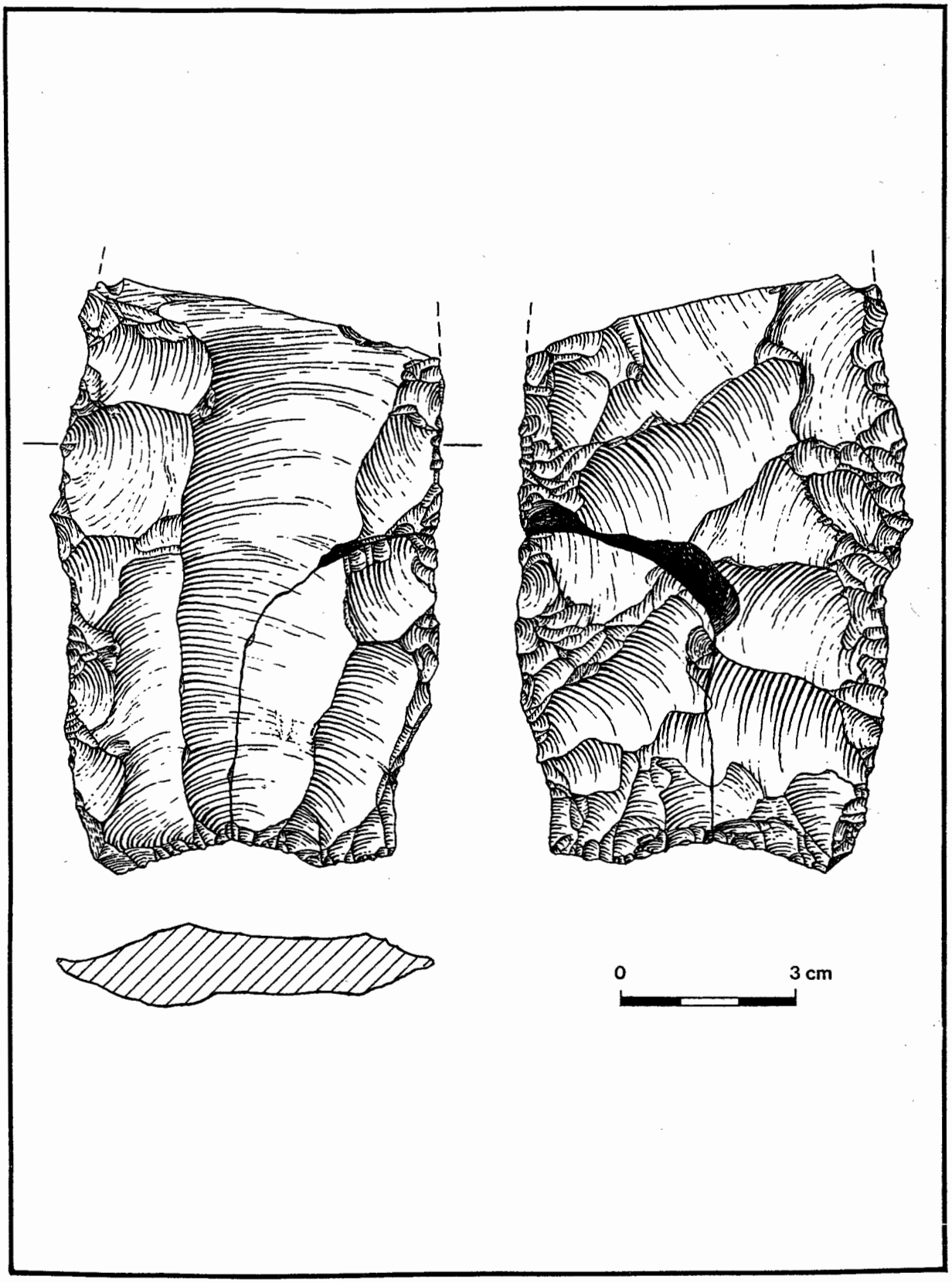


Figure 53. Clovis preform.

they exhibit very light grinding, probably related to platform preparation. The base is broadly concave. Three elongated thinning flakes were detached from the proximal end of one face. The two peripheral removals were intended to set up the preform for detachment of the central flute. The use of this sequence of flake removals, known as the "Enterline technique" (Witthoft 1952) has been noted in many Clovis industries and is often found when, as in the case of our example, successful biface thinning has resulted in a flattened rather than lenticular cross-section. The fluting attempt failed, plunging and resulting in a hinged termination. This proximal fragment, which measure 101.1 mm in length, represents 1/2 to 2/3 of the original preform. It is broken in two pieces, the fracture runs up from the center of the base, terminating in the center of a lateral edge, and could have been produced by the same blow which broke the preform.

Clovis points are widely distributed in North America, making their appearance, dispersal, and disappearance between 9500 and 9000 B.C. (Haynes 1964). Isolated Clovis and Clovis-like points are found throughout California and the Great Basin (Campbell and Campbell 1935; Shutler and Shutler 1959; Davis and Shutler 1969; Tuohy 1968, 1985). The Dietz Site, in the extreme northwestern portion of the Great Basin, has yielded the largest Clovis assemblage in the western United States (Fagan 1984). Clovis localities usually are associated with extinct low beach terraces or sluggish streams feeding pluvial lakes; ideal watering places for extinct big game species (Davis and Shutler 1969; Tuohy 1974).

The Tosawihi Clovis point was recovered from 26Ek3237 on Ivanhoe Creek. The site is stratigraphically superior to a Mazama ash layer exposed in stream cutbanks, suggesting a post-6800 B.P. date. It is uncertain whether the point represents a later manifestation of Clovis fluting technology or merely a highly curated form. Regardless, it is of local manufacture, and suggests that use of the Tosawihi opalite source may have considerable antiquity.

Great Basin Stemmed Series

Great Basin Stemmed points are long, shouldered forms, with square to contracting bases. Edge grinding along the stem and basal margins is a common and diagnostic trait. The series combines Cougar Mountain and Lake Parman variants into a contemporaneous type (Layton 1979). Usually associated with pluvial lakes in the Great Basin, they date between 8000 and 6000 B.C. (Bedwell 1973; Butler 1970; Clewlow 1968; Tuohy 1969, 1970a) and fall within the Dry Gulch Phase of the Upper Humboldt Valley sequence.

Twenty Stemmed points were recovered from Tosawihi. Eight are opalite, seven obsidian, four basalt, and one is chalcedony; only two are complete. All exhibit grinding along contracting to square basal margins. Most basal truncations occur at or below the shoulder (Figure 54). A wide range of sizes are represented by bases; basal lengths range from 65.1 to 21.1 mm (mean 35.59 mm), and widths from 32.2 to 15.9 mm (mean 16.88 mm).

Stemmed points were found throughout the Tosawihi vicinity (Table 49). Highest frequencies occur at 26Ek3170 (Eastern Periphery), 26Ek3237 and 26Ek3238 (Northern Corridor), and at Locality 23 of 26Ek3032.

Large Side-notched Points

Thomas (1981) combines several side-notched variants (Northern Side-notched, Bitterroot Side-notched, Madeline Dunes Side-notched, Elko Side-notched, and Rose Spring Side-notched; cf. Gruhn 1961; Swanson 1966; Riddell 1960; O'Connell 1975; Clewlow 1968; Heizer and Hester 1973) into a single, broadly defined series. The points are triangular in outline, with straight,

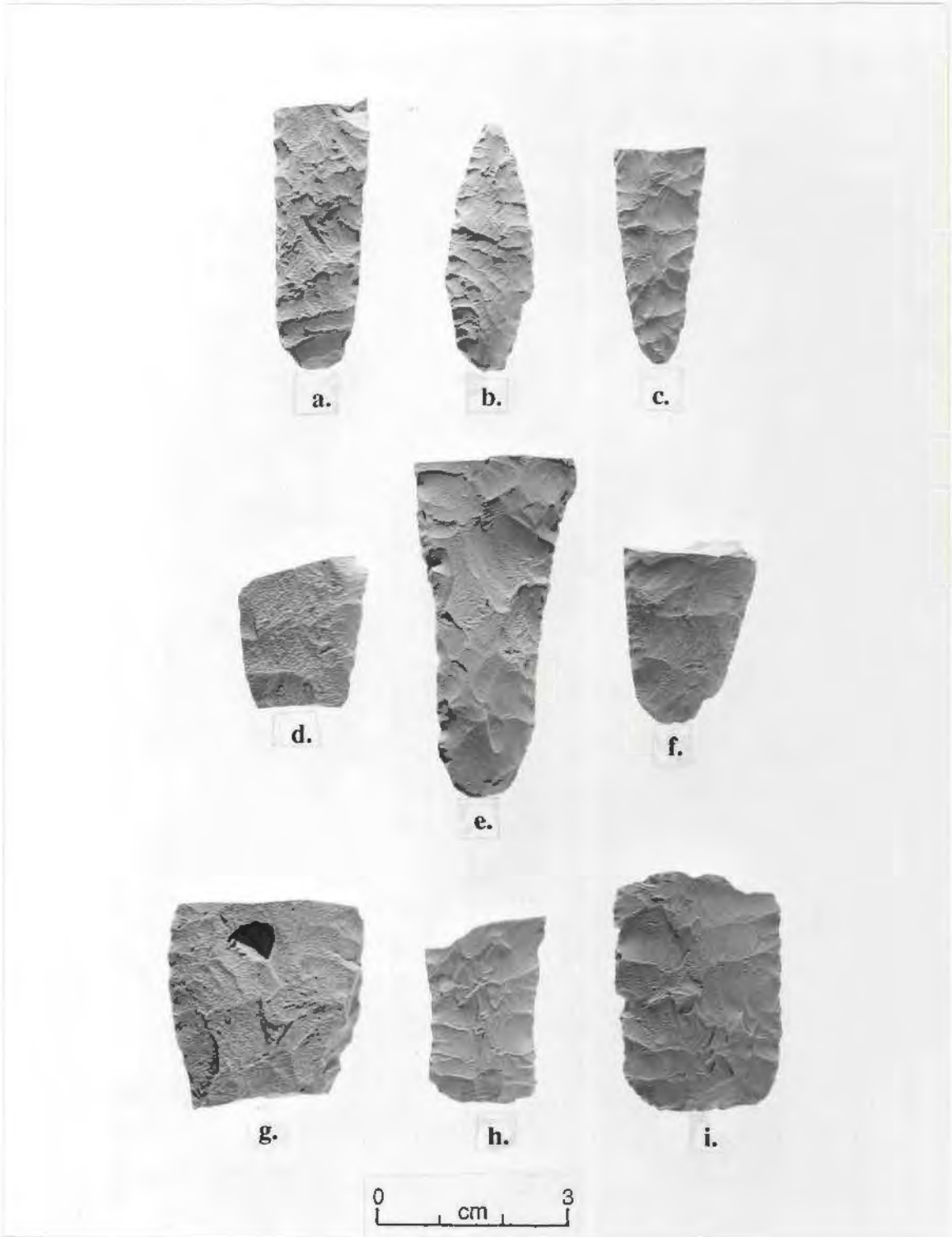


Figure 54. Great Basin Stemmed points.

concave, or notched bases (Figure 55a-c). Notches are removed from the sides rather than from corners of the blank. Temporally, the series pre-dates A.D. 1300, but extends as far back as the No Name Phase (5000 B.C.) of the Upper Humboldt Valley sequence.

Nine Large Side-notched points were identified (Table 50). Five are opalite and four are obsidian. No Large Side-notched points were recovered from localities within 26Ek3032, but they are present in the eastern, western, and northern subareas.

Table 49.
Distribution of Stemmed Points.

Site	(Locality)	Area	n
26Ek3170		Eastern Periphery	3
26Ek3192		Eastern Periphery	1
26Ek3092		Western Periphery	1
26Ek3101		Western Periphery	1
26Ek3107		Western Periphery	1
26Ek3160		Western Periphery	1
26Ek3208		Western Periphery	1
26Ek3237		Northern Corridor	2
26Ek3238		Northern Corridor	2
26Ek3032	(152)	Quarry	1
	(138)	Quarry	1
	(27)	Quarry	1
		Quarry	1
	(23)	Quarry	3
Total			20

Table 50. Distribution
of Large Side-Notched Points.

Site	Area	n
26Ek3184	Eastern Periphery	1
26Ek3204	Eastern Periphery	1
26Ek3093	Western Periphery	1
26Ek3160	Western Periphery	1
26Ek3271	Western Periphery	1
26Ek3237	Northern Corridor	3
26Ek3238	Northern Corridor	1
Total		9

Humboldt Series

The Humboldt Series was defined by a surface assemblage at the Humboldt Lakebed site (Heizer and Clewlow 1968). Humboldt points are lanceolate, of variable size, with slight to deeply concave bases (Figure 54d-h). Morphological variability and an extreme temporal range renders them relatively poor time markers in the Great Basin. Dating between 3000 B.C. and A.D. 700 (Thomas 1981), the series spans several chronological phases of the Upper Humboldt Valley sequence.

Thirteen Humboldt Series points were identified, five from two sites in the Northern Corridor, the remainder from Eastern and Western Peripheries (Table 51). Twelve points are opalite, one, basalt.

Gatecliff Series

A number of contracting stem and split stem forms are combined in the Gatecliff Series. On the basis of similar morphologies, Thomas (1981) reclassified Elko Contracting Stem (Heizer and Baumhoff 1961), and Gypsum Cave points (Harrington 1933; Fowler, Madsen, and Hattori 1973; Heizer and Berger 1970) as Gatecliff Contracting Stem variants, and Pinto Points (Clewlow 1967; Heizer and Hester 1978; Thomas 1971) as Gatecliff Split Stem. Gatecliff series

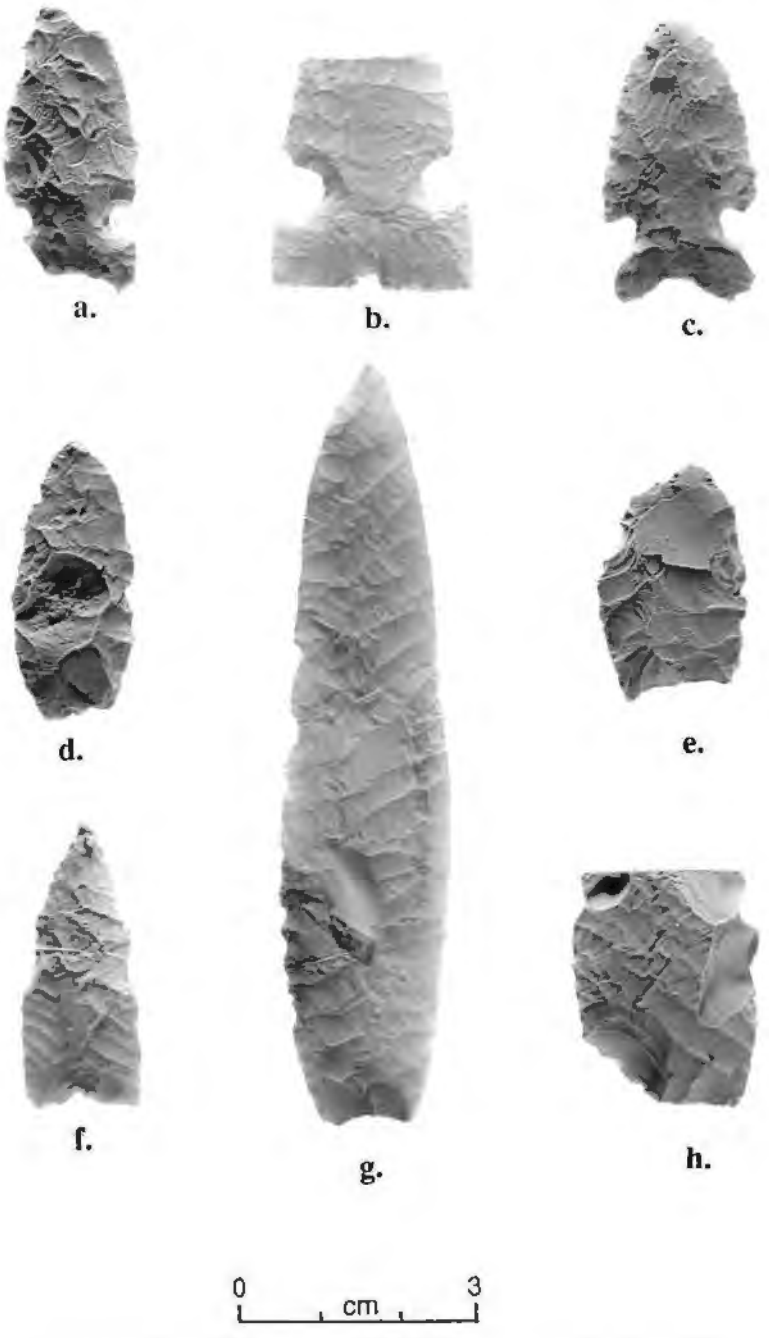


Figure 55. Large Side-notched (a-c) and Humboldt Series points (d-h).

points are relatively large triangular forms with sloping to deeply notched shoulders. Bases are parallel to contracting; split stem forms are basally notched (Figure 56a-i). Thomas (1981) dates the series between 3000 B.C. and 1300 B.C., within the latter part of the No Name Phase and most of the South Fork Phase of the Upper Humboldt Valley sequence.

Twenty Gatecliff Series points were identified. Highest frequencies occur in the Western Periphery and Northern Corridor (Table 52), with fewer numbers in the Eastern Periphery and Quarry localities. Seventeen Gatecliff points are opalite, three are obsidian. One specimen (3095-6941-1) is a contracting stem variant, the remainder are split stem.

Table 51.
Distribution of Humboldt Points.

Site	Area	n
26Ek3192	Eastern Periphery	1
26Ek3198	Eastern Periphery	2
26Ek3092	Western Periphery	2
26Ek3116	Western Periphery	1
26Ek3160	Western Periphery	1
26Ek3271	Western Periphery	1
26Ek3237	Northern Corridor	3
26Ek3251	Northern Corridor	2
Total		13

Table 52.
Distribution of Gatecliff Points.

Site	(Locality)	Area	n
26Ek3170		Eastern Periphery	1
26Ek3198		Eastern Periphery	1
26Ek3092		Western Periphery	3
26Ek3095		Western Periphery	4
26Ek3142		Western Periphery	1
26Ek3160		Western Periphery	2
26Ek3237		Northern Corridor	4
26Ek3238		Northern Corridor	1
26Ek3251		Northern Corridor	1
26Ek3032	(27)	Quarry	1
	(28)	Quarry	1
Total			20

Elko Series

The Elko Series is comprised of Elko Corner-notched and Elko Eared types (Heizer and Baumhoff 1961; Heizer, Baumhoff and Clewlow 1968; Lanning 1963). Elko points are relatively large, triangular in outline, with deep corner notches and relatively straight, expanding (Corner-notched) or deeply notched (Eared) bases (Figure 56j-r).

O'Connell (1967) demonstrated the utility of Elko points as time markers in the western Great Basin. Flenniken and Raymond (1986) warn, however that reworking of Elko points may obscure typological boundaries. The Series dates between 1300 B.C. and A.D. 700 (Thomas 1981); it occupies the latter portion of the South Fork Phase and the entirety of the James Creek Phase of the Upper Humboldt sequence.

Thirty one Elko points were identified. Nine are Elko Eared and twenty-two are Corner-notched variants. Most (n=22) are opalite, while seven are obsidian; one Corner-notched point is chalcedony and one Eared point is Basalt. Elko Series points were found in all subareas (Table 53). The highest frequencies occur in the Western Periphery, where eleven points were recovered from 26Ek3160. Relatively high frequencies also occur at 26Ek3237 in the Northern Corridor.

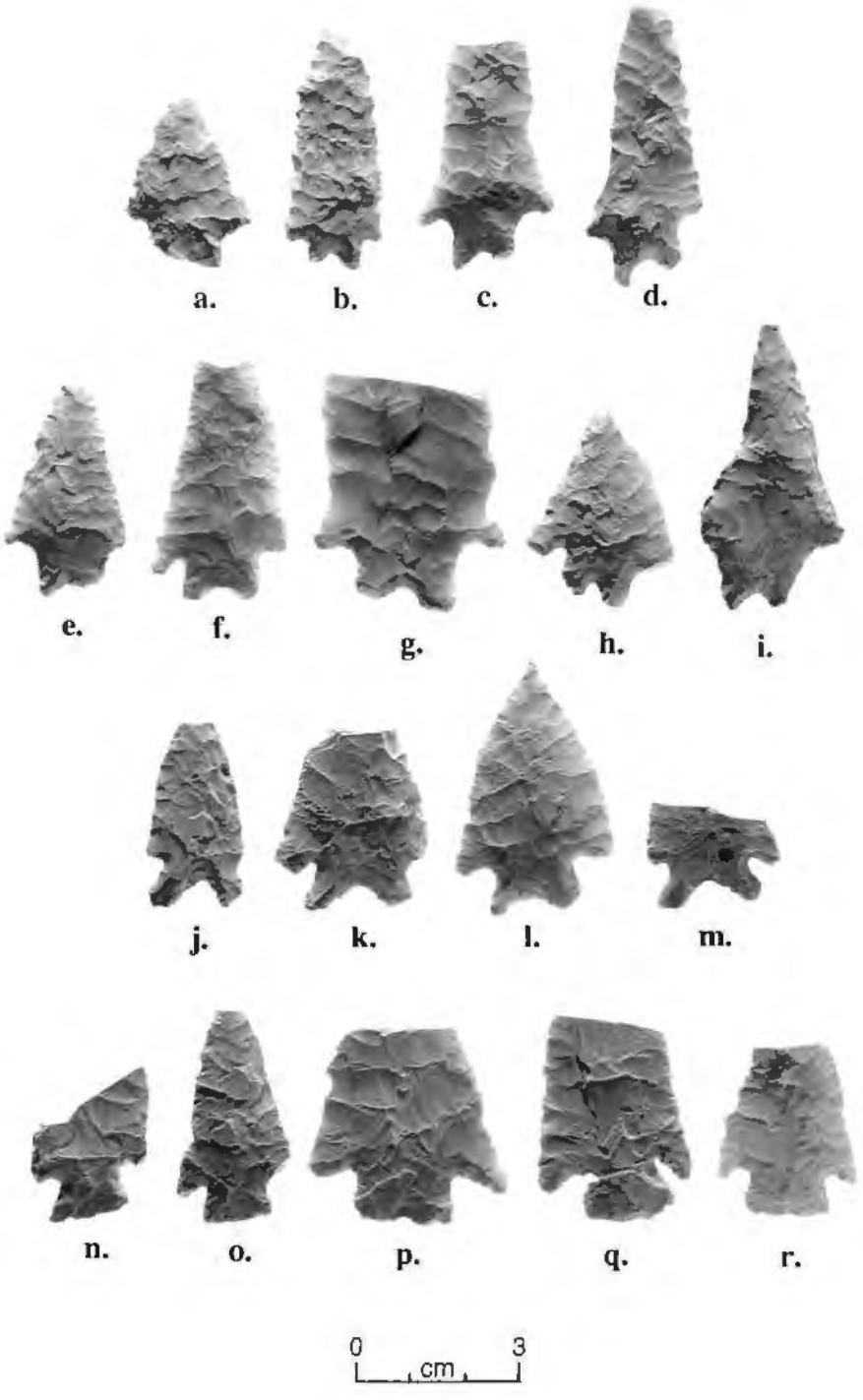


Figure 56. Gatecliff (a-i) and Elko Series points (j-r).

Rosegate Series

Rose Spring and Eastgate types have been combined into this single series (Thomas 1981). Rose Spring Corner-notched points were defined by Lanning (1963) and named for the Rose Spring Site in southern Owens Valley; Wagon Jack Shelter, near Eastgate, Nevada is the type locality for Eastgate points (Heizer and Baumhoff 1961). Both styles are relatively small and triangular with deep notches and small, expanding bases (Figure 57). Notching is generally finer, and bases are flatter and slightly more expanding among Eastgate variants.

Thomas recognizes that the two types may be regionally differentiated, but he regards them temporally indistinct. Rosegate Points are assignable to the Maggie Creek Phase of the Upper Humboldt Valley sequence; they occur within a relatively short time span, dating between A.D. 700 and A.D. 1300 (Thomas 1981).

Thirty-four Rosegate Series points were identified. Twenty-eight are opalite, five obsidian, and one chalcedony. Rosegate points were not recovered from 26Ek3032, but occur in the other three subareas (Table 54). Most were found in the Western Periphery, with relatively high frequencies at 26Ek3160 and 26Ek3271. High frequencies are present also at 26Ek3251 in the Northern Corridor.

Table 53.
Distribution of Elko Points.

Site	(Locality)	Area	n
26Ek3184		Eastern Periphery	2
26Ek3095		Western Periphery	2
26Ek3123		Western Periphery	1
26Ek3160		Western Periphery	11
26Ek3271		Western Periphery	1
26Ek3237		Northern Corridor	8
26Ek3239		Northern Corridor	1
26Ek3516		Northern Corridor	2
26Ek3032	(107)	Quarry	1
	(138)	Quarry	1
	(20)	Quarry	1
Total			31

Table 54.
Distribution of Rosegate Points.

Site	Area	n
26Ek3204	Eastern Periphery	2
26Ek3075	Western Periphery	1
26Ek3092	Western Periphery	2
26Ek3095	Western Periphery	3
26Ek3102	Western Periphery	1
26Ek3160	Western Periphery	6
26Ek3271	Western Periphery	8
26Ek3231	Northern Corridor	1
26Ek3237	Northern Corridor	3
26Ek3239	Northern Corridor	1
26Ek3251	Northern Corridor	6
Total		34

Desert Series

Three coeval types, Desert Side-notched (DSN), Cottonwood Triangular, and Cottonwood Leaf-shaped, comprise the Desert Series. Although morphologically dissimilar, all date from A.D. 1300 to the Historic Period (Thomas 1981), falling within the Eagle Rock Phase of the Upper Humboldt River Valley sequence.

Desert Side-notched points, originally defined by Baumhoff and Byrne (1959), are divided into General, Sierra, Delta, and Redding sub-types on the basis of basal treatment. They are distributed throughout southern and central California and the Great Basin. Cottonwood variants were defined originally by Riddell (1951) and Lanning (1963); they are named for the Cottonwood Site in Owens Valley, and their spatial distribution is similar to that of Desert Side-notched points.

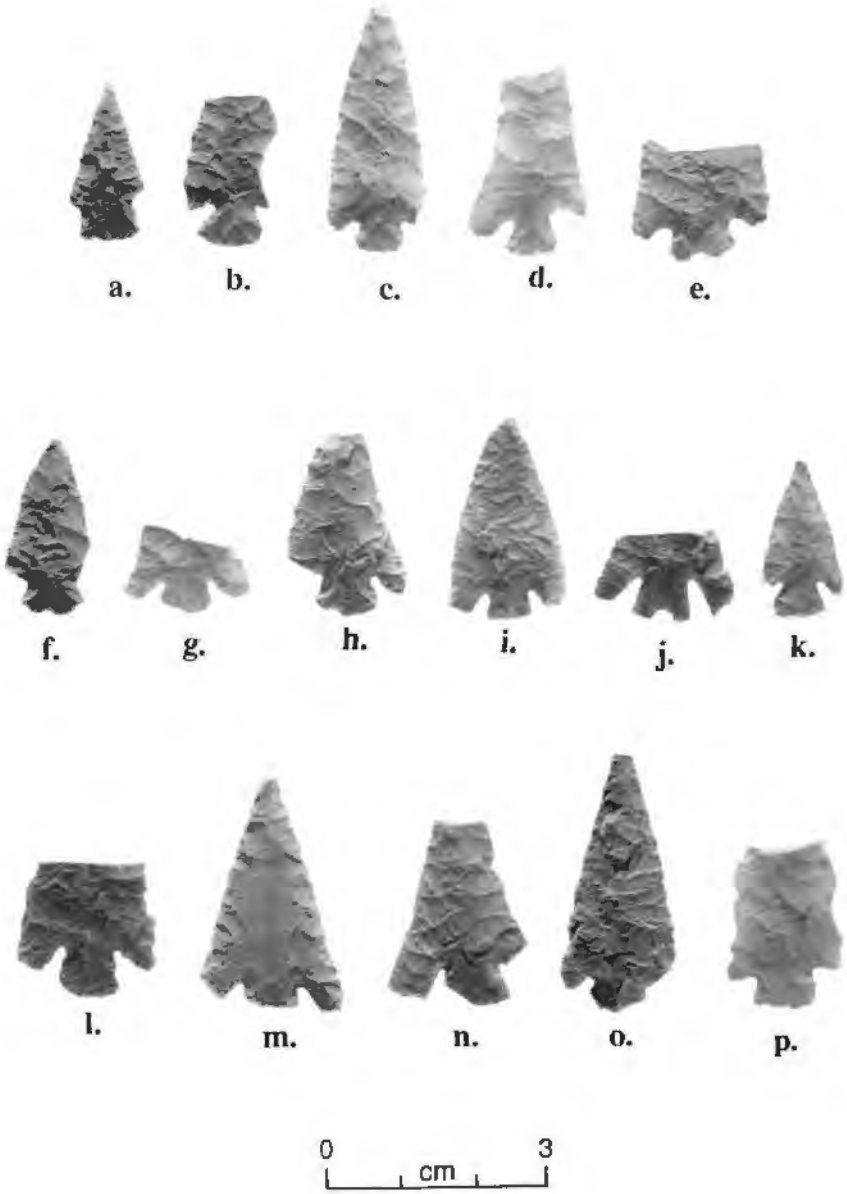


Figure 57. Rosegate Series points.

Desert Side-notched points are small, triangular in outline, with a shallow notch along the lateral margins and flat, concave, or notched bases (Figure 58a-r). Fifty-four specimens were identified; thirty-six are opalite, fifteen obsidian, and three chalcedony. DSN points are found in all subareas, with highest frequencies at 26Ek3092 in the Western Periphery (Table 55). One point (Figure 58b) is more appropriately a preform, but a notch along one margin suggests classification within the Desert Side-notched type. Five points from 26Ek3237 appear stylistically similar (Figure 58n-r); all are considerably smaller than other side-notched points, with very shallow notches located well down the lateral margins. This apparently idiosyncratic style may signal the work of a single knapper.

Cottonwood points are small (<30mm long and <4mm thick) and leaf-shaped or triangular in outline. Notching is absent. Bases of the Triangular variant are straight to slightly concave, while those of the Leaf-shaped variant are pointed to oval (Figure 58s-cc). The collection includes thirty-two Cottonwood points; four are Leaf-shaped and twenty-eight are Triangular. Cottonwood points were not found in the Quarry, the highest frequencies occurring in the Western Periphery (Table 55). Nineteen specimens are opalite, eleven are obsidian, and two are chalcedony. Only one Leaf-shaped point is opalite; the remaining three are obsidian.

Table 55. Distribution of Desert Series Points.

Site	(Locality)	Area	DSN	Cottonwood	Total
214		Eastern Periphery		1	1
26Ek3170		Eastern Periphery	3	1	4
26Ek3171		Eastern Periphery	1		1
26Ek3178		Eastern Periphery	2		2
26Ek3184		Eastern Periphery	1	1	2
26Ek3185		Eastern Periphery	3	2	5
26Ek3190		Eastern Periphery	2		2
26Ek3192		Eastern Periphery	4	1	5
26Ek3198		Eastern Periphery	4	4	8
26Ek3092		Western Periphery	8	6	14
26Ek3095		Western Periphery	4	5	9
26Ek3106		Western Periphery		1	1
26Ek3114		Western Periphery	1		1
26Ek3116		Western Periphery	2		2
26Ek3160		Western Periphery	7	8	15
26Ek3271		Western Periphery	2		2
26Ek3237		Northern Corridor	7	1	8
26Ek3251		Northern Corridor	2	1	3
26Ek3032	(4)	Quarry	1		1
Totals			54	32	86

Other Projectile Points

Twenty-eight points were modified or manufactured in such a way that their attributes do not meet type criteria proposed by Thomas (1981). Table 56 shows the probable affiliation of these remaining points. Seven would be classified as Desert Side-notched points if their proximal shoulder angles or basal width/maximum width ratios were larger. Six relatively small, thin, triangular forms are too long to be classified as Cottonwood Triangular points, and their bases are too straight for classification within the Humboldt Series. Likewise, seven concave base points evade the Humboldt Series due to their large, triangular form. Reworked margins

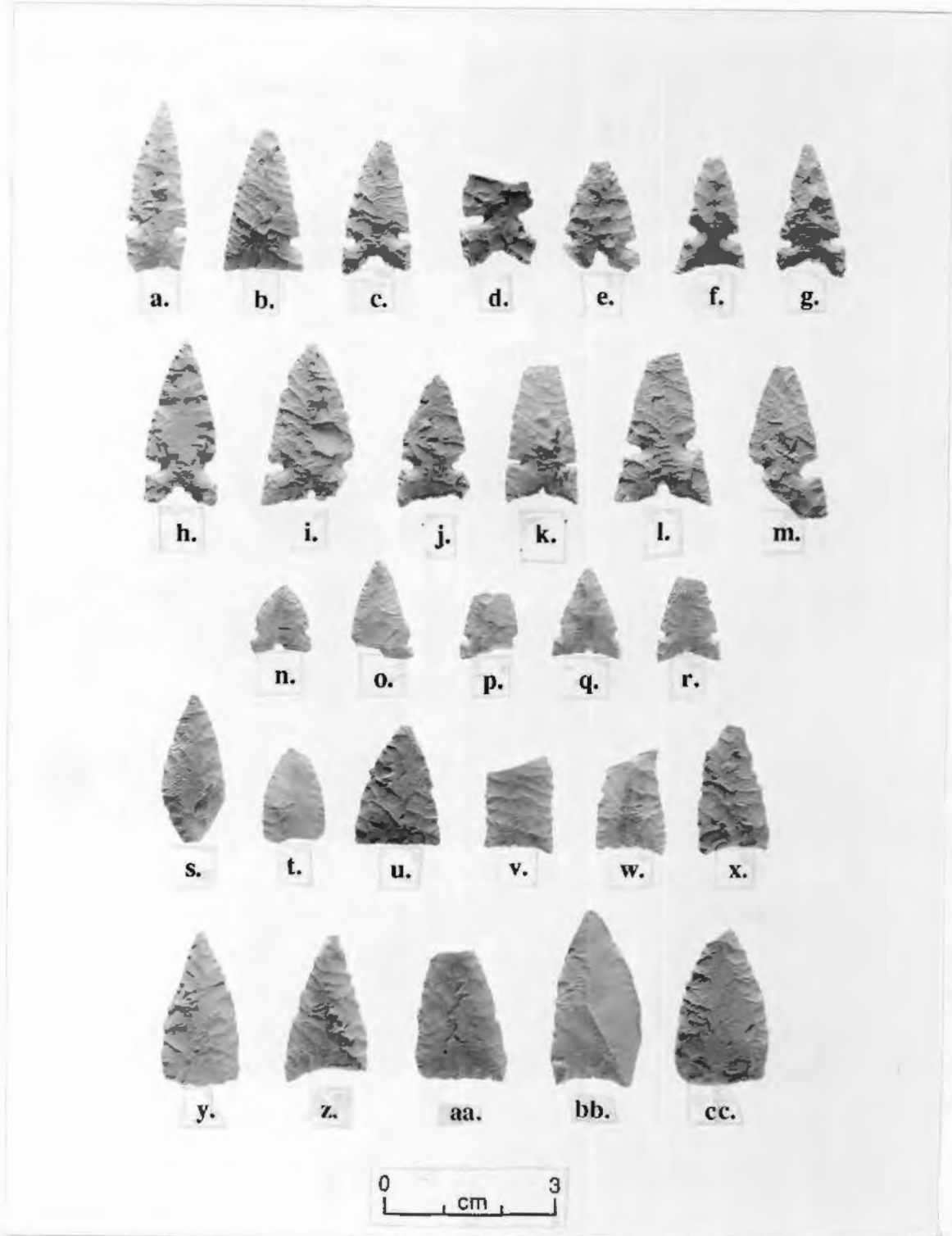


Figure 58. Desert Side-notched (a-r) and Cottonwood points (s-cc).

and excessively broad notches place four Elko points and one Rosegate point out of key, and an indeterminate proximal shoulder angle results in a similar classification for an Elko or Gatecliff point. Probable affiliations of two points could not be ascertained due to extensive reworking.

These "other" projectile points illustrate a wide range of stylistic variability within most point types. As discussed above, several researchers (Flenniken and Raymond 1986; Titmus and Woods 1986) suggest that rebasing of Pre-archaic and Archaic points may result in an apparent earlier or later type. The Tosawihi assemblage, however, while limited, indicates that rebasing of two Elko points resulted in broader proximal shoulder angles, placing the points outside Thomas's (1981) key rather than into new types.

Table 56. Probable Affiliation of Out-of-Key Projectile Points.

Site No.	(Locality)	Reference No.	Probable Type	Material	Remarks (cf. Thomas 1981)
3032	(158)	35-4	Desert Side-notch	Obsidian	Wb/Wm <.90
3032	(40)	56-3	Elko	Obsidian	Reworked, Wb < 10mm
3023	(23)	4002-21	Humboldt	Obsidian	BIR >.98
3032	(27)	6521-1	Desert Side-notch	Obsidian	PSA < 130
3092		2500-1	Cottonwood	Obsidian	reworked margin
3093		505-11	Cottonwood	Opalite	Length > 30mm
3095		510-44	Cottonwood	Opalite	Length > 30mm
3095		510-46	Rosegate	Obsidian	reworked margin
3095		510-49	Elko	Opalite	Indeterminate PSA
3095		519-12	Desert Side-notch	Obsidian	PSA < 130
3095		3011-1	Desert Side-notch	Obsidian	PSA < 130
3106		2002-1	Desert Side-notch	Basalt	PSA < 130
3148		103-1	Humboldt	Obsidian	Wb/Wm > .90
3154		109-1	?	Obsidian	Extensive rework
3160		500-2	Humboldt	Opalite	Wb/Wm > .90
3160		520-2	Humboldt	Opalite	Wb/Wm > .90
3170		4060-2	DSN/Cottonwood	Opalite	Unfinished
3171		504-7	Cottonwood	Obsidian	Length > 30mm
3177		2001-1	Elko	Opalite	Shallow notches
3177		2001-10	?	Opalite	Extensive rework
3184		4156-2	Humboldt	Obsidian	Wb/Wm> .90
3185		16-3	Humboldt	Opalite	Wb/Wm> .90
3190		1004-5	Cottonwood	Opalite	Length > 30mm
3237		1-127	Elko/Gatecliff	Opalite	PSA Indeterminate
3237		500-17	Elko	Opalite	PSA < 110
3251		1-1	Humboldt	Opalite	BIR > .98, rework
3251		3006-4	Desert Side-notch	Obsidian	PSA < 130
3251		6541-1	DSC/Cottonwood	Opalite	Extensive rework

Attributes

Raw Material

Like other flaked stone artifact classes from Tosawihi, projectile points are made primarily of opalite (Table 57). This material comprises 64.7% (n=260) of the assemblage, while 24.6% (n=99) are obsidian and the remaining 10.7% consist of chalcedony (n=24), jasper (n=7), basalt (n=5), opal (n=4), and other materials (n=3). The opalite chosen for the production of points however, is more variable than for other tool classes; it exhibits a wide range of colors, probably reflecting use of a variety of sources or outcrops. The proportion of points (especially Desert Series and Stemmed points) made from obsidian also is higher.

Table 57. Raw Materials Used for Projectile Points.

Point Type	Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other	Total
Cottonwood	15	11	-	3	2	1	-	32
DSN	32	15	-	6	-	1	-	54
Rosegate	25	5	-	2	-	1	1	34
Elko	21	7	1	2	-	-	-	31
Gatecliff	17	3	-	-	-	-	-	20
Humboldt	11	1	-	1	-	-	-	13
LSN	5	4	-	-	-	-	-	9
Stemmed	4	9	4	-	1	-	2	20
Clovis	1	-	-	-	-	-	-	1
Out of Key	14	13	-	1	-	-	-	28
Fragmentary	115	31	-	9	4	1	-	160
Total	260	99	5	24	7	4	3	402

The diversity of lithic material varies from one type to another (Figure 59). Stemmed points exhibit the greatest diversity of material, the highest incidence of obsidian, and significant proportions of opalite and basalt. Humboldt, Gatecliff, and Rosegate points exhibit little diversity; opalite dominates, basalt does not occur, and obsidian is infrequent.

Size

In the Great Basin, late points generally are smaller than earlier ones, a condition that has been linked to the transition from dart and spear to arrow. This pattern occurs at Tosawihi as well. When only complete points are considered, as arrayed in Figure 60, there appears to

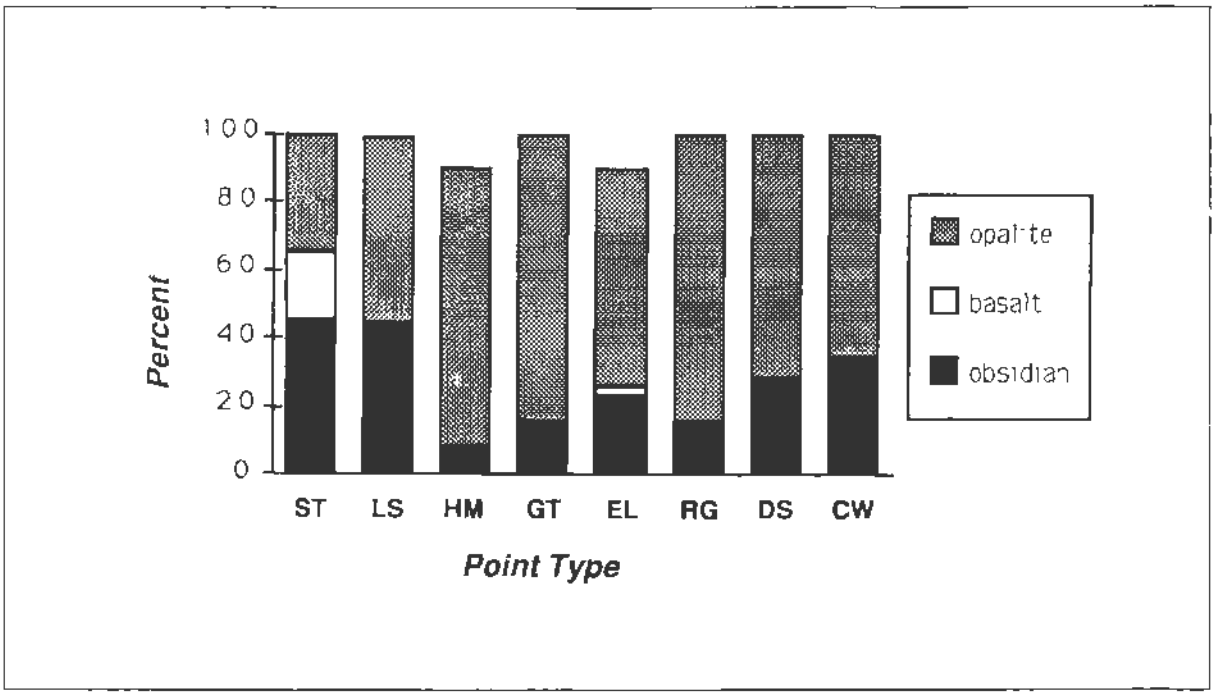


Figure 59. Frequencies of raw material by point type (opal and chert combined with opalite).

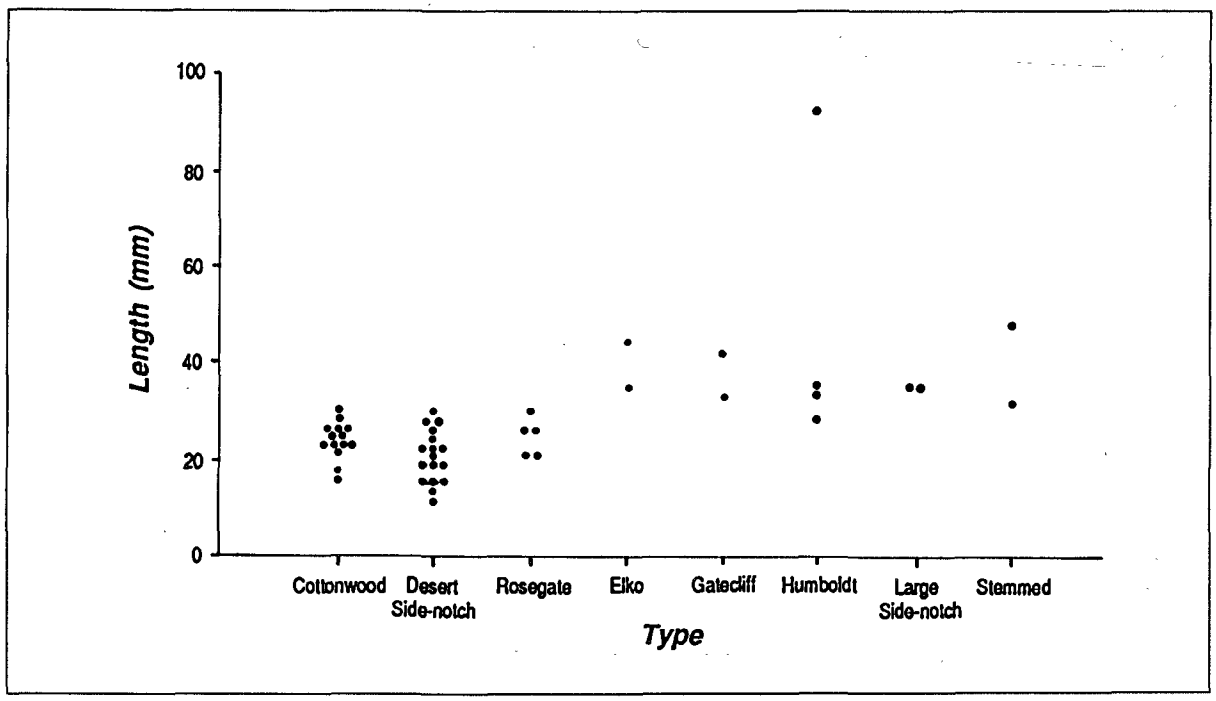


Figure 60. Lengths of complete projectile points by type.

be a break in length between Cottonwood, Desert Side-notched, and Rosegate points as opposed to earlier types, and their lengths are much more tightly clustered. This may be because earlier points, beginning larger, are more likely to have been reworked and thus to exhibit a greater size range; alternatively, their manufacture may have been less standardized. Projectile point size, in fact, may provide a means to examine production strategies. If lengths are tightly constrained, then production of a series may have been more standardized; conversely, greater size diversity may indicate more variable production strategies.

Table 58 presents mean lengths of Tosawihi projectile points, and calculates the coefficient of variability for each series. Both complete and fragmentary specimens with estimatable total lengths are included in the data set. No attempt was made to estimate lengths of Stemmed points, so measurements for that series (with the exception of two complete points) are for stems only. The table shows a gradual diminution from Gatecliff to Desert Series points, spanning the transition from atlatl to arrow. Points of the Stemmed and Humboldt exhibit the highest coefficients of variability, while Large Side-notched exhibit the least. Variability within the remaining series is relatively low, suggesting some degree of standardization within each.

Table 58. Mean Lengths and Coefficients of Variation of Projectile Point Series.

Type	Mean Length (mm)	SD	Maximum (mm)	Minimum (mm)	Coefficient of Variation
Desert	23.89	5.00	32.9	10.4	20.9
Rosegate	29.46	5.95	41.3	15.9	20.2
Elko	43.55	8.51	62.8	31.2	19.5
Gatecliff	48.31	11.22	79.5	32.1	23.2
Humboldt	46.04	18.09	94.9	21.6	39.3
Large Side-notched	38.67	5.32	49.3	31.4	13.8

Flenniken and Wilke (1989:153) suggest that Elko Corner-notched and Northern Side-notched points are archetypal forms of Thomas's (1981) Gatecliff and Humboldt Series. If that is true, the coefficient of variability within both Elko and Large Side-notched points should be high, and they should be larger than Gatecliff and Humboldt points. The data show them to be smaller, however, with a lower coefficient of variability than the Gatecliff and Humboldt Series. Given the tightly constrained, smaller size of Elko and Large Side-notched points, it seems unlikely that they could have been reworked into larger Gatecliff and Humboldt points.

Heat-Treatment

Over 85% of the opalite and chert projectile points were heat-treated during production (Table 59). Stemmed and Elko Series points exhibit the lowest frequency of heat-treatment, while frequencies for the remaining types fall near or above the mean. Since thermal alteration improves the flaking characteristics of opalite, it is not surprising that a large proportion of pressure flaked opalite points have been heat-treated.

Table 59. Heat-Treatment of Chert and Opalite Points.

Type	Heat-treated n	Heat-treated %	Possible/ Not Heat-treated n	Possible/ Not Heat-treated %	TOTAL Chert & Opalite n
Desert	56	93.3	4	6.7	60
Rosegate	26	89.7	3	10.3	29
Elko	17	73.9	6	26.1	23
Gatecliff	17	100.0	0	0.0	17
Humboldt	10	83.3	2	16.7	12
Large Side-notched	5	100.0	0	0.0	5
Stemmed	1	14.3	6	85.7	7
Clovis Preform	1	100.0	0	0.0	1
Out of Key	11	73.3	4	26.7	15
Fragmentary	110	85.3	19	14.7	129
Total	254	85.2	44	14.8	298
Preforms	157	66.8	78	33.2	

Breakage Characteristics

Projectile points enter the archaeological record variously; they are broken in manufacture, broken in use, or lost. Patterns of breakage and microscopic wear reflect *how* particular pieces were broken, whether they were used as projectiles or for other functions, and something of the circumstances of their discard or loss.

Breakage in manufacture is often difficult to recognize. Titmus and Woods (1986) have suggested that fatal breaks tend to occur on obsidian Elko points, during notching, at the end of the manufacturing process. Distinctive breaks such as lateral and snap fractures of barbs, lateral fractures at the neck, and longitudinal fractures at the notch can be identified, but manufacturing breaks occurring earlier in production often are easy to repair and may not be observable in archaeological assemblages. Lateral snap fractures at the midsection are rare during manufacture, and cannot be separated reliably from fractures caused by use or post-depositional damage. Ten pieces in the Tosawihi assemblage show clear evidence of breakage in manufacture; additional to the Clovis preform, four are Desert Series points, one a Gatecliff, one is untypeable, and three are fragmentary.

Bases may enter the archaeological record when points are broken in manufacture or during use (Titmus and Woods 1986). Flenniken and Wilke (1989) even maintain that notched points were designed to break at the notches, concluding that notches not only served as aids to hafting, but also limited the location of bending fractures so that the largest, re-usable portion of the point remained in the prey for recovery and subsequent rejuvenation. Broken tips, then, may have been transported to base camps in meat, or left among the waste portions of carcasses abandoned at kill or butchering sites. Points broken above the notches could be resharpened into shorter, blunter variants retaining the original basal morphology, while broken bases or barbs would have required basal modification prior to rehafting. A projectile point assemblage, then, should be dominated by broken bases, small broken tips, and exhausted point nubbins of various basal morphologies.

This does not seem to be the case at Tosawihi. Table 60 indicates that 14% of the points in the Tosawihi assemblage consist of bases only. Twenty seven percent lack bases or tips, but exhibit no evidence of reworking, and 32% consist only of tips and midsections. The remaining barbs, tangs, and lateral fragments may be related to breakage during use or manufacture; none exhibits evidence of reworking.

Table 60. Projectile Point Fragment Types

Type	n	%
Complete	58	14.42
Base Only	57	14.18
Base Missing	17	4.23
Tip Missing	93	23.13
Tip	72	17.91
Midsection	56	13.93
Tang/Barb	5	1.24
Tang/Barb Missing	23	5.72
Lateral Fragment	12	2.99
Indeterminate	9	2.24
Total	402	100.0

Complete points are introduced into the archaeological record through loss as misses during hunting, discard in a carcass, or loss in a residential context. Less commonly, caches may go unretrieved. Nearly 15% of the Tosawihi point assemblage *are* complete specimens. They are found in a variety of settings, but most often at residential sites. Proportions of complete specimens vary greatly from type to type; the lowest are observed in the Elko, Stemmed, and Gatecliff Series, while about one-third of the Desert Series points are complete (Table 61).

Table 61. Proportion of Complete Points by Type.

	Complete n	Total n	%
Desert	31	86	36.0
Rosegate	4	34	11.7
Elko	2	31	6.5
Gatecliff	3	20	15.0
Humboldt	4	13	30.8
Large Side-Notched	3	9	33.0
Stemmed	2	20	10.0
Out of Key	9	29	31.0

Relative size, functional variability, and reworking may account for this disparity. Large points may break in the haft more frequently than smaller ones, and bigger targets and greater propulsion may further predispose large points to breakage. Resharpening and reworking extend the use life of larger points, making discard necessary only when a piece is broken beyond repair. Conversely, maintenance of the edges of smaller points is restricted by the small margins, and resharpening may be of limited utility. Consequently, small, complete points with worn or damaged edges may be discarded rather than repaired.

Thomas (1981) maintains that bases are the most diagnostic portions of points, changing little as broken tips and margins are reworked. On the other hand, Flenniken and Wilke (1989) argue that breakage at the notches is a function of design, that rebasing *often* affects basal morphology, and that basal attributes are poor typological indicators. The Tosawihi point assemblage seems to support Thomas's argument. Table 62 identifies the location of breakage on notched points; most are broken at the tip, and few at the notches. Of course, many of the types identified in the sample may have been reworked and now are indistinguishable from unbroken points. Size variability within types and breakage characteristics argue against this, however, and we conclude that it is unlikely that many points were reworked into types with basal morphologies diagnostically different from the original.

Table 62. Location of Breakage on Points with Notches.

	Opalite		Obsidian		Total	
	n	%	n	%	n	%
Complete	22	17.1	5	18.5	27	17.3
Broken at Notches	18	14.0	6	22.2	24	15.4
Broken at Tip	41	31.8	9	33.3	50	32.1
Broken Mid-section	16	12.4	2	7.4	18	11.5
Broken at Tip and Notch	29	22.4	5	18.5	34	21.8
Indeterminate	3	2.3	0	0.0	3	1.9
Total	129	82.8	27	17.2	156	100.0

Preforms

Our preform sample consists of 260 specimens. They are characterized by retouch around the entire perimeter in early manufacturing stages and by more invasive pressure flaking in later stages (Figure 61). Some of the preforms identified here may have served as blanks for small, pointed, pressure flaked tools such as perforators or drills; we assume, however, that preforms are an intermediate stage within the projectile point trajectory. The raw materials, size, and breakage characteristics of preforms are described below.

Raw Material

Almost 83% of the preforms are opalite, 10% are obsidian, 5% percent are chalcedony, and the remainder are jasper or opal. Frequencies of non-opalitic toolstone are higher than observed among flake tools and small bifaces, and resemble more those of projectile points (Figure 62). However, the proportional use of obsidian is higher among projectile points than preforms, suggesting that some obsidian points were brought to Tosawihi in finished form. This pattern is in distinct contrast to that at James Creek Shelter (Zerga and Elston 1990), where similar proportions of obsidian points and preforms were observed.

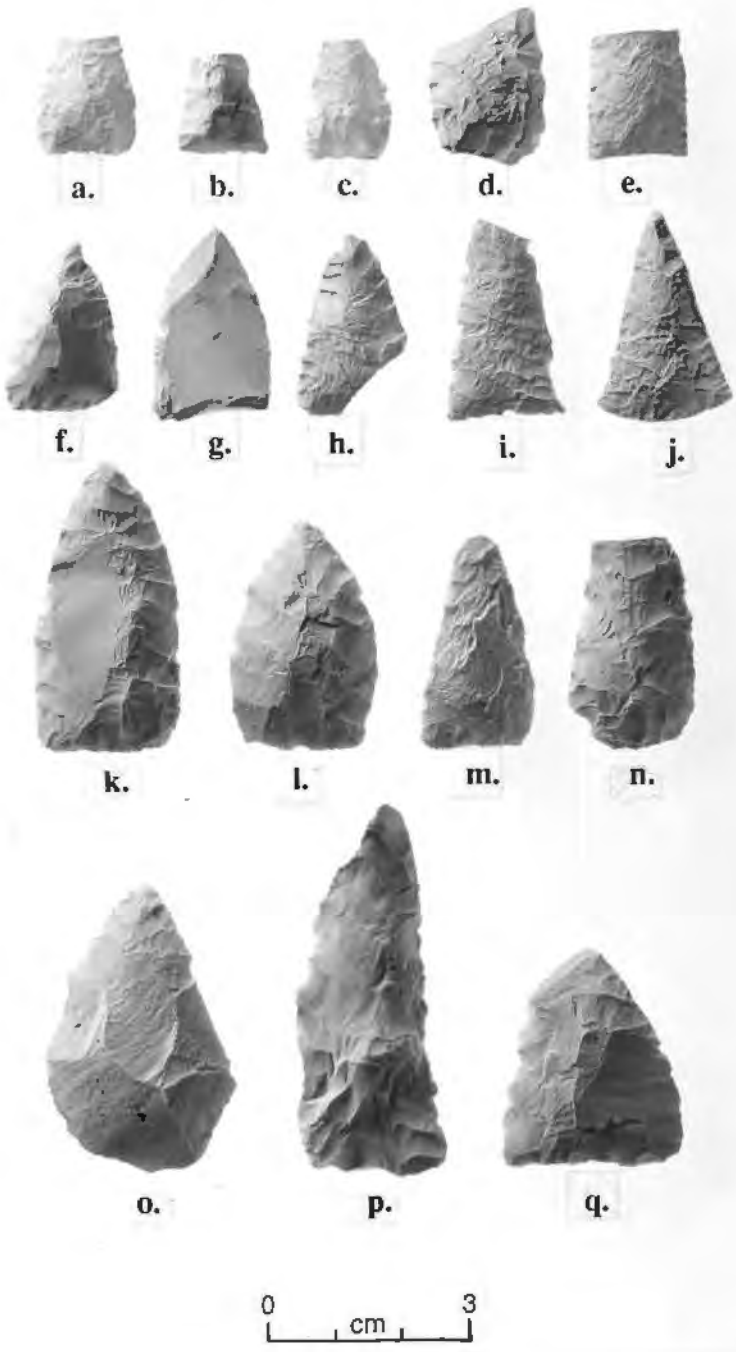


Figure 61. Selected preforms.

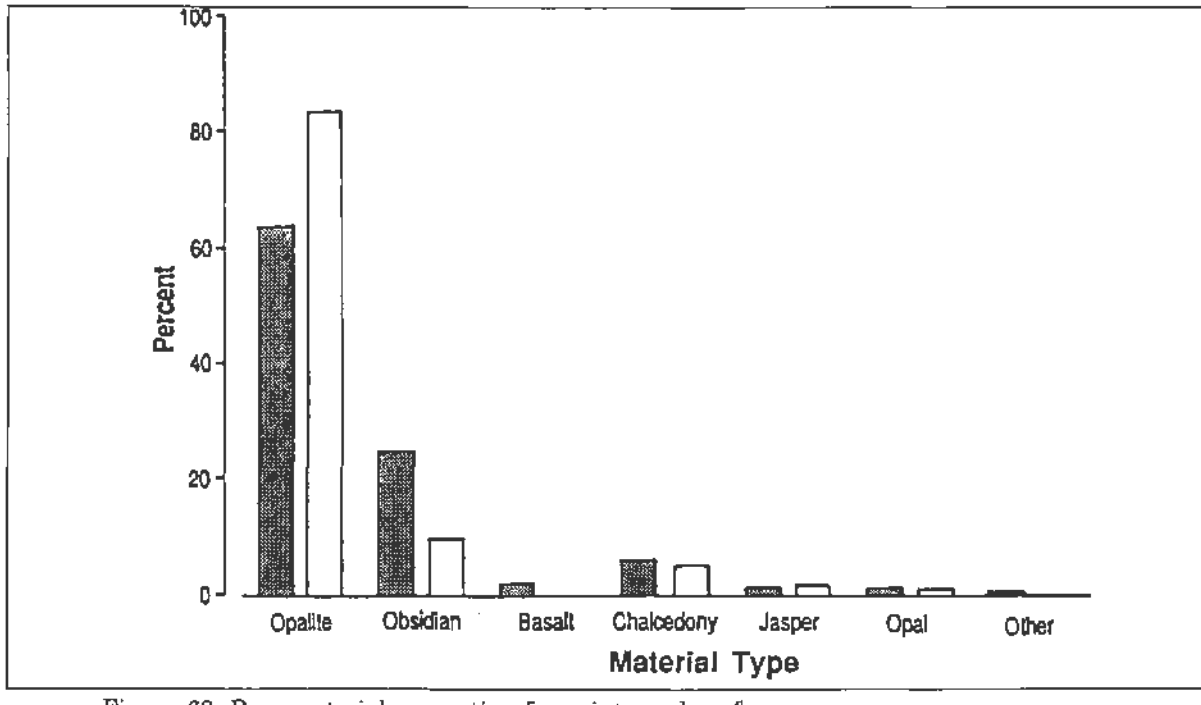


Figure 62. Raw material proportion for points and preforms.

Size

Thirty-eight preforms (14.6%) are complete; they are generally elongate to triangular. Lengths range from 13.3 to 53.3 mm, widths from 10.0 to 33.4 mm, and thicknesses from 1.7 to 7.9 mm. Since in some dimension preforms always are larger than the points produced from them, we should be able to correlate mean sizes of preforms to mean sizes of the projectile points they might have yielded. Mean dimensions for the various point types and preforms are shown in Table 63. Only Desert and Rosegate series points fall entirely within the mean size range of Tosawihi preforms. Size ranges of other, larger point types overlap with preforms when standard deviations are considered, but the means of each dimension as well as the weights of points always are higher than those of preforms.

Table 63. Mean Dimension of Points and Preforms.

Type	n	Mean Length (cm)	SD	Mean Width (cm)	SD	Mean Thickness (cm)	SD	Mean Weight (g)	SD
Desert	31	22.1	4.8	12.5	2.0	2.8	0.5	0.7	0.3
Rosegate	4	23.5	2.7	12.1	2.1	3.0	0.4	0.8	0.4
Preform	38	34.3	9.1	21.8	5.5	4.7	1.4	3.6	2.3
Elko	2	40.6	3.3	24.8	3.5	5.4	0.7	4.4	1.5
Gatecliff	3	39.4	3.8	22.7	4.0	4.4	0.6	3.6	0.8
Humboldt	4	47.9	27.3	17.4	2.6	4.3	1.5	4.5	4.2
Large Side-notched	3	36.3	3.8	18.7	2.4	3.8	0.5	3.4	1.6
Stemmed	2	39.8	7.7	16.6	0.7	5.0	0.8	3.5	1.5

To further test the correlation between small (arrow) points and preforms, Z-Scores were calculated from the mean dimensions of each point type and compared against the absolute dimensions of all complete preforms. As depicted in Figure 63, only four (10.5%) preforms are smaller than the mean of projectile point types, 5.3% (n=2) could have been made into Desert Series points, and 52.6% (n=20) could have served as preforms for points within either the Desert or Rosegate Series. The remaining 31.6% (n=12) could have been made into Desert or Rosegate Series points, but in some dimension also fit the mean of larger points.

Although a few larger, earlier point types could have been produced from our discovered preforms, we suspect that most were used to produce arrowpoints (Rosegate and Desert series) and post-date A.D. 500. Thus, preforms may be indicators of late occupation at Tosawihi.

Heat-Treatment

Like projectile points, preforms produced on heat-treated opalite blanks, or thermally altered during manufacture, would exhibit greater material compliance, better flakability, and reduced risk of breakage. One hundred eighty-four opalite preforms (78.3%) appear to have been heat-treated or manufactured on heat-treated flakes, a lower frequency (78.3%) than exhibited by projectile points. This probably is due to a higher incidence of failure and increased application of heat-treatment during preform production.

Shape and Breakage Characteristics

Outline can be determined for only 113 (43%) of the 260 preforms. Of these, 43% are oval, 35% are triangular, and about 10% each are lanceolate and elongate. Base shape, exclusive of overall shape, can be classified on 104 specimens. Among those, oval (n=55) and square bases (n=23) are most common; concave, flat, contracting, and other irregular bases account for

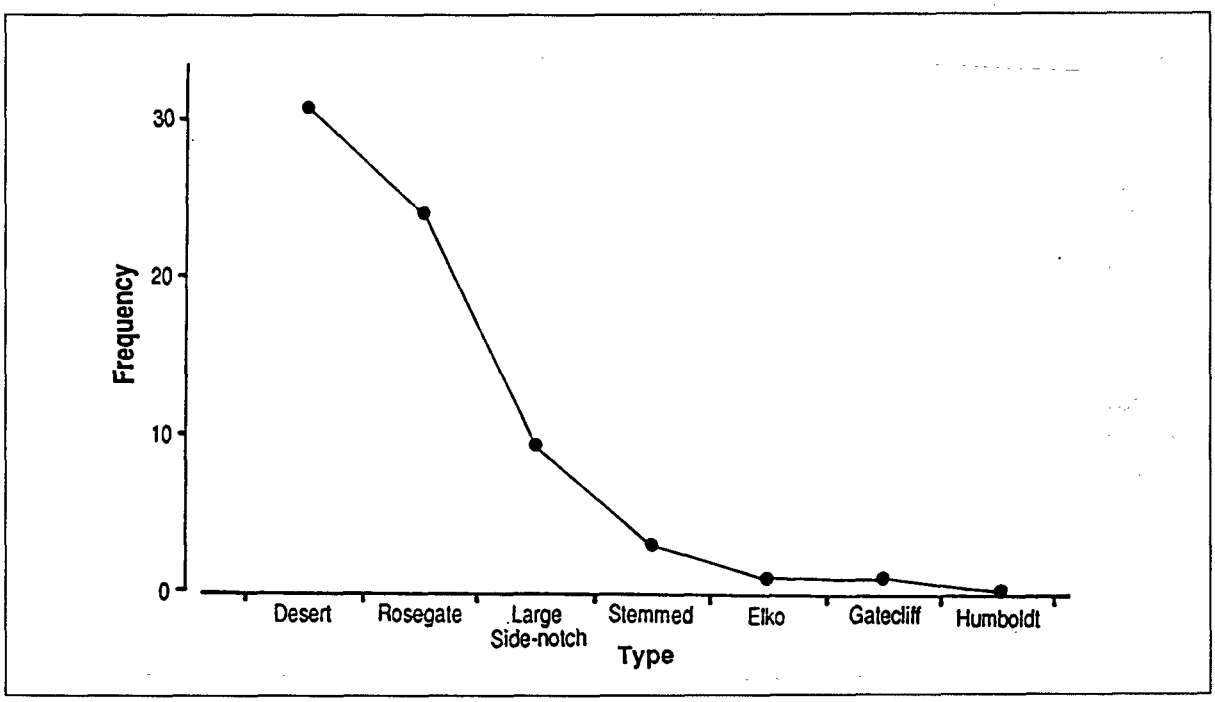


Figure 63. Preforms of sufficient dimensions to produce projectile points of different series.

relatively small proportions of the assemblage. Except for Humboldt and Stemmed points, most Great Basin point types are triangular or elongate-triangular in outline, and can be made from flat or concave based preforms.

Less than ten percent of the performs are complete, as would be expected if they did indeed represent unfinished tools. A wide range of manufacturing stages is represented, suggesting that preforms broke during all stages of reduction in roughly equal proportions.

Discussion

Chronology

The projectile point assemblage exhibits considerable typological and temporal variability (cf. Chapter 19). A Clovis point fragment suggests that utilization of the Tosawihi vicinity may have begun as early as 10,000 years ago; the range of point types present suggests that people visited the Tosawihi area without a break down to the present. Nearly all Great Basin projectile point styles are signal utilization at least to ethnographic times, but the highest frequencies are associated with later occupations.

Desert Series points dominate the total assemblage, with steadily declining frequencies of other types. A similar pattern is evident in the Eastern and Western peripheries; over one-half the points from the Eastern periphery pertain to the Desert Series. By contrast, the Northern Corridor assemblage exhibits a relatively even distribution of types. At the Quarries (26Ek3032), Stemmed points dominate and late types are rare.

With the exception of Localities 26 and 27, field work in 26Ek3032 consisted only of initial surface reconnaissance and subsequent documentation. The reversed proportions of projectile points from the Quarries might suggest more intensive use during earlier times, but field techniques and the small sample size may have resulted in a sampling bias toward the recovery of larger, more findable point types.

Materials used for projectile points also exhibit temporal diversity. The Stemmed, Large Side-notched, and Desert Series contain the highest proportions of obsidian, while lower frequencies are observed among all other types. Basalt occurs only in the Stemmed and Elko Series. The proportions suggest that during the earliest and latest phases of occupation, exotic materials were used more frequently, and that projectile points may have been manufactured elsewhere and transported into the area. This pattern is opposite that observed at James Creek Shelter, where local materials predominate during the Late Archaic (Elston and Budy 1990). The pattern may signal a temporally different logistical strategy involving increased trade and external economic influence. This is reinforced by obsidian sourcing data (cf. Chapter 5) showing that the Paradise Valley source (some 60 miles west of Tosawihi) is used almost exclusively for Rosegate, Elko, Gatecliff, Humboldt, and Large Side-notched points.

Technology

Blanks

The blank types on which projectile points and preforms are made often cannot be determined because platforms and dorsal surfaces so often are obscured by retouch; only about 10% of the preforms, for instance, unequivocally were made on biface thinning flakes. However, because so few cores occur in the industry or industries represented at Tosawihi, and because at least half the other types of flake tools are made on biface thinning flakes, it seems likely that the flakes on which preforms and projectile points are made were produced during biface reduction, whether or not the primary purpose of reduction was to produce flakes or bifacial tools.

The sizes of preforms suggest from which stage of biface they could have been detached. Flenniken and Ozbun (1988) studied bifaces from Newberry Crater, and have proposed that twice the length of a flake reflects the size of the biface from which it was detached. This assumes that most flake scars on a biface extend only to the midline. For Stage 1 and 2 Tosawihi bifaces, the 2 x length approximation is appropriate, but flake scars on Stage 3 and 4 bifaces carry across the midline, so we have estimated the size of Stage 3 and 4 bifaces by multiplying the length of complete preforms by 1.33.

Using a t-test, the length of each complete preform was compared to the computed average width of each biface stage. Table 64 shows that preform flake blanks probably were produced from Stage 3 bifaces, but could have been produced from any average size Tosawihi biface, regardless of stage. However, most bifaces were heat-treated by middle Stage 3, and many heat-treated preforms were made on flakes produced from raw bifaces. It seems likely, then, that preforms were made on flakes produced from late Stage 2 or early Stage 3 bifaces.

Table 64. Comparison of Preform Length and Estimated Biface Widths.
(ALL MEASUREMENTS IN CENTIMETERS)

	Using 2 x Length Estimate				Using 1.33 x Length Estimate	
Preform Length	Stage 1	Stage 2	Stage 3	Stage 4	Stage 3	Stage 4
13.3	+	+	+	+	+	+
16.8	+	+	+	+	+	+
23.5	+	+	+	0	+	+
24.4	+	+	+	0	+	+
24.9	+	+	+	0	+	+
25.1	+	+	+	0	+	+
28.1	+	+	+	0	+	+
28.4	+	+	+	0	+	+
28.4	+	+	+	0	+	+
28.9	+	+	+	0	+	+
29.4	+	+	+	0	+	+
29.4	+	+	+	0	+	+
30.3	+	+	+	-	+	+
30.4	+	+	+	-	+	+
30.8	+	+	+	-	+	+
30.8	+	+	+	-	+	+
31.3	+	+	+	-	+	+
31.4	+	+	+	-	+	+
31.5	+	+	0	-	+	+
33.2	+	+	0	-	+	+
33.3	+	+	0	-	+	0
34.1	+	+	0	-	+	0
35.1	+	0	0	-	+	0
35.8	+	0	0	-	+	0
36.0	+	0	0	-	+	0
39.2	0	0	0	-	+	0
40.0	0	0	0	-	+	0
41.0	0	0	-	-	+	0
41.3	-	0	-	-	+	0
41.4	-	0	-	-	+	0
41.6	-	0	-	-	+	0
41.8	-	0	-	-	+	0
42.1	-	0	-	-	+	0
43.1	-	0	-	-	+	0
49.2	-	-	-	-	0	-
50.8	-	-	-	-	0	-
52.2	-	-	-	-	0	-
53.3	-	-	-	-	0	-

+ = Preform producible from biface stage x
0 = Preform marginally producible from biface stage x
- = Preform not producible from biface stage x

Reduction

Reduction stages were assigned to preforms. Based on extent of retouch, preforms with greater proportions of retouched surface area were considered more finished. Stage 1 consists of the selection of a suitable blank; Stage 2, edge preparation; Stage 3, primary thinning; Stage 4, secondary thinning. Basal treatments and notching are applied during Stage 5. Stage 2 preforms are produced by pressure or abrasion of the edges, while Stages 3, 4, and 5 exhibit exclusively pressure retouch.

No Stage 1 preforms were identified, since preform blanks are indistinguishable from many flakes produced during biface reduction. Of the remaining stages, 28% are Stage 2, 26% Stage 3, 36% Stage 4 and 2.5% Stage 5. The remaining 7.5% could not be assigned to stages.

After initial edge preparation, the specific techniques used to produce points from flakes or preforms are quite varied. Some preforms are worked first on the dorsal and then on the ventral surface, but more often the reduction is less patterned. This contrasts with the practice at James Creek Shelter where Elko, Rosegate, and Desert Series points have a dorsal-to-ventral manufacturing sequence (Zerga and Elston 1990). Variation in these reduction strategies may be related to the cross-sections of preforms or flake blanks rather than to manufacturing traditions.

It has been assumed that Early and Mid-Archaic dart points in the Great Basin were made on small percussion flaked bifaces, while Late Archaic arrow points were made on thin flake blanks reduced directly by pressure flaking (O'Connell 1967; Lanning 1963; Zerga and Elston 1990). This scheme has been questioned by Novick (1987), who observed that Early Archaic Gatecliff and Middle-Archaic Elko points exhibit remnants of the ventral surface of the flake blank; she concludes that they were produced directly from flakes rather than from percussion flaked bifaces.

In order to discover whether there was temporal change in manufacturing techniques, remnant ventral flake scars and evidence of percussion flaking were recorded and tabulated for each point type (Table 65). In many cases, evidence of early stage reduction has been obscured by pressure flaking, making observation difficult; occasionally, however, surfaces are left unflaked or early stage percussion scars are visible.

Table 65. Proportion of Projectile Points with Ventral Detachment Scars and Visible Percussion Scars.

	Ventral Detachment Scars					Visible Percussion Scars					
	Present		Absent		TOTAL	Present		Indeterminate		Absent	
Type	n	%	n	%	n	n	%	n	%	n	%
Cottonwood	23	71.9	9	28.1	32	0	0.0	0	0.0	32	100.0
Desert Side-notched	28	51.9	26	48.2	54	0	0.0	0	0.0	54	100.0
Rosegate	13	38.2	21	61.8	34	0	0.0	2	5.9	32	94.1
Humboldt	4	30.8	9	69.2	13	0	0.0	3	23.0	10	77.0
Large Side-notched	5	55.5	4	44.4	9	0	0.0	3	33.3	6	66.7
Elko	7	22.6	24	77.4	31	4	12.9	8	25.8	19	61.3
Gatecliff	5	25.0	15	75.0	20	5	25.0	7	35.0	8	40.0
Stemmed	1	5.0	19	95.0	20	10	50.0	5	25.0	5	25.0

Table 65 shows that, unlike Early and Middle-Archaic points from Gatecliff Shelter, larger Tosawihi points were made more frequently on percussion flaked bifacial preforms while smaller ones were made on flakes requiring little thinning. Percussion scars are present or indeterminate on most larger points, and the lack of ventral detachment scars suggests that blanks were thinned fully and their margins reduced during production. Conversely, the lack of percussion scars and predominance of ventral detachment scars indicates that full reduction of the ventral surface was not always necessary to thin small blanks sufficiently.

Differences in manufacturing patterns may be related to availability of raw material or variation in material quality rather than to changes in technology. Some Early and Middle Archaic points were made on flake blanks produced without a percussion flaking stage, so the change from atlatl/dart to bow and arrow is not accompanied invariably by a complete replacement of manufacturing techniques.

Tip Orientation

Tip orientation serves as another indicator of manufacturing technique standardization. Projectile point tips may be produced on the proximal ends of point blanks, distal ends, or may be oriented transversely. Of the 51 points for which this variable could be observed (most of them Late Archaic types), 30% were made on the proximal ends of blanks and 57% on distal ends. Only 1.5% are oriented transversely. Tip orientation could be determined on 93 preforms. Of these, over 40% were made on proximal blank ends, slightly less than 40% on distal ends, and 20% are oriented transversely. Our results suggest that the orientation of tips on flake blanks is quite variable. The ventral surface of many specimens has been obscured by excessive pressure flaking, however, so observations were not always possible. Tip observations may, in fact, be limited to points with only partially reduced ventral surfaces, and blanks selected for those points may have had significantly different morphologies from fully reduced points and preforms.

Heat-treatment

A relatively high proportion of projectile points (93.3%) and preforms (78.3%) are heat-treated. Table 66 identifies the stage at which thermal alteration may have been applied to blanks within the preform/point trajectory. Most projectile points (55.7%) appear to have been made on blanks heat-treated during an indeterminate stage of production. This is true for all point types, and, since many points have fully reduced ventral surfaces, it is not surprising that stage of heat-treatment is difficult to discern. Preforms, on the other hand, especially early stage forms, should retain greater proportions of their ventral detachment surface and thus should reflect heat-treatment stage better.

Table 66. Production-Related Heat-Treatment of Points and Preforms.

	Core HT		Flake HT		Blank HT		Poss/Post		No HT		
	n	%	n	%	n	%	n	%	n	%	Total
Projectile Point											
Late Archaic	3	3.4	32	36.0	47	52.8	4	4.5	3	3.4	89
Early/Mid Archaic	3	4.6	12	18.5	36	55.4	7	10.8	7	10.8	65
Out of Key/Fragments	1	0.7	37	25.7	83	57.6	13	9.0	10	6.9	144
Total	7	2.4	81	27.2	166	55.7	24	8.1	20	6.7	298
Preform											
Stage 2	8	11.8	28	41.2	12	17.6	6	8.8	14	20.6	68
Stage 3	5	8.1	31	50.0	11	17.7	6	9.7	9	14.5	62
Stage 4	3	3.5	17	20.0	35	41.2	8	9.4	22	25.9	85
Stage 5	1	14.3	1	14.3	1	14.3	2	28.6	2	28.6	7
Indeterminate	1	7.7	0	0.0	3	23.0	5	38.5	4	30.8	13
Total	18	7.7	77	32.8	62	26.4	27	11.5	51	21.7	235

93.3% Points Heat-treated
(most at indeterminate stage - extent of reduction obscures flake and core)
78.3% Preforms Heat-treated
(Most on H.T. flakes. Stage 4 reduced enough to obscure flake/core. Higher incidence of No H.T. probably related to mfg. failure during all stages.)

Table 66 indicates that Stage 2 and 3 preforms commonly were made on heat-treated flakes (41.2% and 50% respectively), and that, as with points, thinning of progressively later stage preforms allows assignment of heat-treatment only to an indeterminate level. Few preforms or points were made on flakes removed from heat-treated cores, and we assume that most were made on blanks heat-treated as flakes.

When compared to projectile points, higher frequencies of non-heat-treated preforms are observed. By stage however, slightly *lower* frequencies of non-heat-treated, early stage preforms suggest that thermal alteration may have been undertaken during the initial stages of shaping and thinning. The higher proportion of non-heat-treated preforms then, may reflect manufacturing failures of marginally reduced flakes prior to heat-treatment.

Use Wear

Use wear and breakage patterns on points and preforms can be segregated into products of use, manufacture, and taphonomy. Of 42 preforms examined, only one clearly appears to have been used. This supports the assumption that preforms are, indeed, unfinished pieces.

All projectile points and preforms were examined macroscopically and types of breakage recorded. Generally, fluting fractures, burin-like fractures, and haft rebound fractures are associated with damage from use, while notching failures occur during manufacture. Snap fractures may occur during manufacture, during use, or post depositionally. Table 67 indicates that two-thirds of the Tosawihi points exhibit snap fractures, 12.2% exhibit breakage characteristic of use, and only 2.5% were broken during manufacture. Most breakage appears to be related to post depositional processes rather than to use or manufacture; on points without snap fractures, however, most failures appear to have occurred during manufacture.

Table 67. Fragment Types of Broken Points.

	Manufacturing Failure			
Area	Notch	Other Mfg.	Total	
	n	n	n	%
North	2	3	5	5.1
East	2	1	3	3.2
West	2	-	2	1.1
Quarry	-	-	-	0.0
Total	6	4	10	2.5

	Use Failure					
Area	Flute	Burin	Haft	Combination	Total	
	n	n	n	n	n	%
North	9	-	1	1	11	11.2
East	2	-	-	3	5	5.3
West	23	2	1	3	29	15.6
Quarry	3	-	-	1	4	17.4
Total	37	2	2	8	49	12.2

	Other				
Area	Snap		Indeterminate/NA		Total
	n	%	n	%	n
North	68	69.4	14	14.3	98
East	64	67.4	23	24.2	95
West	120	64.5	35	18.8	186
Quarry	16	69.7	3	13.0	23
Total	268	66.7	75	18.7	402

In order to identify the proportion of points that may have been utilized as arrow or atlatl tips, a sample of points and fragments was examined microscopically for use wear patterns. Damage resulting from piercing soft materials or impact with bone or similar dense material includes striae oriented parallel to the long axis, small step fractures, micro-rounding, and micro-polish. Since microscopic use wear is most easily recognized on obsidian, all obsidian points and fragments were examined. We also looked at opalite points retaining enough original form to reflect use wear.

Table 68 shows that over 40% of the selected sample exhibit evidence of use. This suggests that many points were brought back to camps embedded in carcasses; hunting probably was carried out nearby. Highest frequencies occur at sites in the Northern Corridor and the Western Periphery, reflecting the more residential use of those areas. Extensive retooling and discard also may have occurred there.

Table 68. Frequency of Use Wear Observed on a Sample of Projectile Points.

Area	Micro-Use Present n	%	Indeterminate n	%	Not Used n	%	Total Sample n
North	24	47.1	27	52.9	-		51
East	19	35.9	34	64.1	-		53
West	43	40.6	62	58.5	1	.9	106
Quarry	5	38.5	8	61.5	-		13
Total	91	40.8	131	58.7	1	.4	223

Little evidence suggests that Tosawihi points often had alternative or multiple functions. Three obsidian specimens have wear traces consistent with being shot into soil, perhaps results of a missed shot; these traces consist of multiple parallel striations along the long axis of the point distributed across the entire surface. One point either was shot into soil or used as a knife, and another was used as a drill or perforator. One large, parallel flaked Humboldt point, broken in three pieces, was examined carefully for wear traces indicating use in cutting, but no use wear was observed.

Reworking

Forty-three projectile points (10.7%) exhibit reworking (Table 69). Most observable modification occurs along lateral margins or on the tips of broken points, and is revealed by asymmetrical forms (Figure 64). The Desert Series comprises nearly 36% of the classifiable assemblage, but few points (8.1% of the Series) appear to have been reworked. The highest incidence of reworking is observed in the Gatecliff (35%) and Elko Series (25.8%). Since Early and Middle-Archaic points are relatively large, their size may have invited higher incidence reworking.

Higher frequencies of reworking of Early to Middle-Archaic points might support the thesis that, owing to repair, projectile points are poor chronological indicators. In most cases observed, however, reworking is confined to lateral margins or to tips, and does not affect basal morphology. Basal modification is apparent on four specimens, all Late Archaic types. Reworking is confined only to the broken portion of the base (Figure 64a, b), and does not affect intact basal morphology significantly.

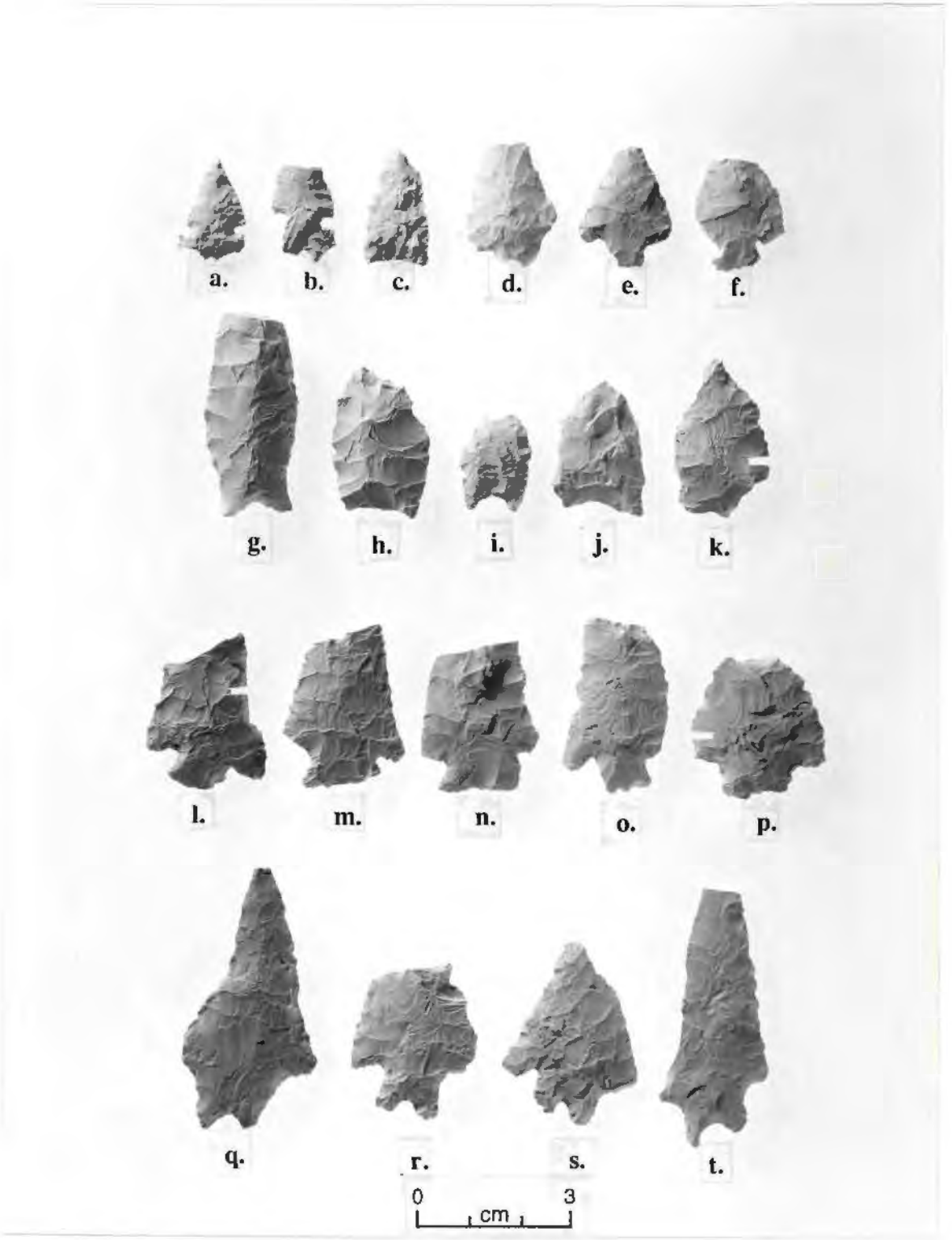


Figure 64. Reworked projectile points.

Table 69. Incidence and Type of Reworking Observed on Projectile Points.

Site Number	Reference/ Specimen No.	Type	Evidence of Reworking			Location of Reworking		
			Assym.	Work on Break	Non-Standard Form	Lateral	Tip	Base
26Ek3185	1015-1	DSN		X				X
26Ek3116	1007-1	DSN		X				X
3271	522-1	DSN	X				X	
3092	6362-1	DSN			X			X
3095	514-1	Cottonwood	X			X		
3106	2001-4	Cottonwood	X			X		
3160	6541-5	Cottonwood	x				X	
3102	500-10	Rosegate	X			X		
3160	500-103	Rosegate	X					X
	4032-1	Rosegate	X			X		
3271	500-138	Rosegate		X		X		
3251	1-10	Rosegate		X		X		
30327/20	4002-9	Elko	X			X		
3092	8302-1	Elko	X			X		
3123	78-1	Elko	X			X		
3160	1-190	Elko	X			X		
	4053-1	Elko	X			X		
3516	1-9	Elko	X			X		
3237	6744-1	Elko	X			X		
	6762-1	Elko	X			X		
3032/27	6062-2	Gatecliff	X			X		
3032/28	81-1a	Gatecliff	X			X		
3170	1-44	Gatecliff		X			X	
3095	5000-8	Gatecliff	X			X		
3237	6704-2	Gatecliff		X		X		
3238	500-1	Gatecliff	X			X		
3251	8001-1	Gatecliff	X			X		
	1-4	Humboldt	X				X	
3192	2203-2	Humboldt	X				X	
3237	6902-1	LSN	X			X		
3072/40	56-3	Unclassifiable		X		X		
3170	4060-2	Unclassifiable	X			X		
3177	2001-1	Unclassifiable	X			X		
3154	109-1	Unclassifiable	X			X		
3160	520-2	Unclassifiable	X			X		
3251	1-1	Unclassifiable			X	X		
3032/27	1-130	Fragment	X			X		
3032/72	66-9	Fragment		X		X		
3192	1055-1	Fragment	X			X		
3198	1018-3	Fragment			X			X
3160	6362-3	Fragment		X				X
3271	500-309	Fragment	X			X		
	1045-2	Fragment			X	X		

Characterization of Specific Activity Areas

Almost twice as many points were recovered from the Western Periphery as from any other sub-area (Table 70). This uneven distribution may owe partly to differential intensities of surface collection in the various subareas, but many points were recovered from the Northern Corridor, in which a much smaller area was sampled. The Northern Corridor and the Western Periphery exhibit the greatest degree of residential activity and the longest chronological sequences; the Quarries, the least and shortest.

Table 70. Point and Preform Frequencies by Subarea.

	Quarry		East		West		North		Total
	n	%	n	%	n	%	n	%	n
Points	23	5.7	95	23.6	186	46.3	98	24.4	402
Preforms	7	2.7	48	18.5	120	46.1	85	32.7	260
Total	30	4.5	143	21.6	306	46.2	183	27.6	662

The distribution of preforms largely reflects that of projectile points; few were recovered from the Quarries and the Eastern Periphery, while the highest relative proportions were found in the Northern Corridor and the Western Periphery. These differences in distribution may be related to different activity patterns or to variation in the temporal exploitation of sub-areas. Intensive exploitation of the East began fairly late in the Tosawihi sequence and probably accounts for the relatively low proportion of points and preforms recovered there.

Obsidian points and preforms occur in greater proportions in the Eastern Periphery and the Quarries, where points in general are least common (Table 71). Use of obsidian seems to intensify toward the end of the temporal sequence (Desert Series times), and may account for obsidian's greater relative frequency in the East the exploitation of which intensified then. Basalt and jasper points are more abundant in the Western Periphery and in the Quarry, where they occur naturally. Points made of chalcedony, a material favorable for its flaking properties, are found in the North, the East, and the West.

Table 71. Projectile Point-Preform Raw Material Types by Area.

	Opalite		Obsidian		Basalt		Chalcedony		Jasper		Opal		Other	
Area	n	%	n	%	n	%	n	%	n	%	n	%	n	%
North														
Points	76	77.5	15	15.3	-	-	5	5.1	-	-	1	1.0	1	1.0
Preforms	76	89.4	5	5.9	-	-	2	2.3	1	1.2	1	1.2	-	-
East														
Points	53	55.8	33	34.7	1	1.1	7	7.4	1	1.1	-	-	-	-
Preforms	32	66.6	14	29.2	-	-	2	4.2	-	-	-	-	-	-
West														
Points	123	66.1	40	21.5	2	1.1	12	6.5	4	2.2	3	1.6	2	1.1
Preforms	101	84.2	5	4.2	-	-	9	7.5	4	3.3	1	0.8	-	-
Quarry														
Points	8	34.8	11	47.8	2	8.7	-	-	2	8.7	-	-	-	-
Preforms	6	85.7	1	14.3	-	-	-	-	-	-	-	-	-	-
TOTAL														
Points	260	64.7	99	24.6	5	1.2	24	6.0	7	1.7	4	1.0	3	0.7
Preforms	215	82.7	25	9.6	-	-	13	5.0	5	1.9	2	0.8	-	-

Generally, points in the Quarry are heat-treated less frequently than those from other subareas. Lower apparent frequencies probably are due the relative abundance of stemmed points, which rarely are heat-treated. While the remaining three sub-areas all exhibit a relatively high proportion of heat-treatment, the Northern Corridor exhibits a slightly lower frequency (Table 72). Lower proportions in the North are influenced by a higher frequency of post-depositionally burned and possibly heat-treated specimens. As well, the Northern Corridor

exhibits a slightly higher proportion of points made on flakes removed from heat-treated cores. This may owe to the frequency of heat-treated biface reduction and the concurrent detachment of flakes suitable for point production.

Table 72. Heat-Treated Projectile Points and Preforms by Site Area.

Area	Core	HT	Flake	HT	Blank	HT	Poss/Post		No	HT
North										
Points	3	3.6	17	20.5	45	54.2	14	16.9	4	4.8
Preforms	8	10.0	28	35.0	30	37.5	7	8.7	7	8.7
East										
Points	2	3.3	24	39.3	30	49.2	2	3.3	3	4.9
Preforms	3	8.8	10	29.4	6	17.6	4	11.7	11	32.3
West										
Points	2	1.4	39	27.1	87	60.4	7	4.9	9	6.3
Preforms	7	6.1	38	33.0	25	21.7	14	12.1	31	27.0
Quarry										
Points	0	0	1	10.0	4	40.0	1	10.0	4	40.0
Preforms	0	0	1	16.7	1	16.7	2	33.3	2	33.3
TOTAL										
Points	7	2.3	81	27.2	166	55.2	24	8.0	20	6.7
Preforms	18	7.7	77	32.8	62	26.4	27	11.4	51	21.7

The pattern of thermal alteration of preforms is similar to that of bifaces. Proportions of preforms and projectile points made on blanks detached from heat-treated cores is slightly higher in the Northern Corridor, but heat-treatment of blanks is the predominant pattern in all subareas.

Tip orientation on preforms varies between subareas. In the North and West, the pattern is similar: tips tend to be located on the proximal ends of flakes. They comprise about one-half of the classifiable sample. The remaining half is divided equally between distal and transverse orientations. In the East, a distal tip orientation is most common (ca. 50% of the classifiable sample), while 30% of the tips are oriented proximally. Arrowpoints (Rosegate and Desert Series points) frequently have unflaked areas on their ventral surfaces, facilitating identification of tip orientation. They are most often made on distal ends of blanks. When ventral surfaces are observable, earlier points exhibit a variety of orientations.

The proportion of preforms made on biface thinning flakes does not vary much between subareas. The sample of projectile points for which blank form can be determined is too small to reflect areal differences.

The frequency of points broken during manufacture is highest in the Northern Corridor. If we also consider preforms and pressure flakes to be indicators of projectile point manufacture, some sites display concentrations of this activity (Table 73). Outside the Quarry, some sites in each of the other three subareas exhibit substantial point manufacture. Technological analysis was conducted on only a small sample of the debitage, and screening with 1/8 inch mesh (without the use of which pressure flakes rarely are recovered) was employed only on portions of sampled features; pressure flake quantities listed in Table 73, therefore, cannot be considered particularly representative. Many of the assemblages with the highest frequency of pressure flakes also contain other indicators of residential activity, but a few sites (e.g., 26Ek3251 and 26Ek3198) which have high frequencies of artifacts and evidence of point manufacture have little groundstone, and few flake tools. They may have served limited functions.

Table 73. Distribution of Artifacts Related to Projectile Point Manufacture.

Area	Points Broken During Manufacture	Preforms	Pressure Flakes
North	5	85	144
East	3	43	239
West	2	125	49
Quarry	-	7	1
Total	10	260	433

Greater frequencies of points broken in use were recovered in the Western Periphery, a subarea characterized by sites with a long temporal span and a wide range of activities (Table 74). Reworked points are found in all areas, with highest proportions in the Quarries, where the oldest types are common, and lowest frequencies in the Eastern Periphery, dominated by Late Archaic point types. The ratio between points broken in use and those broken in manufacture is highest in the Western Periphery.

Table 74. Projectile Point Breakage by Area.

	Quarry		East		West		North		Total	
	n	%	n	%	n	%	n	%	n	%
Broken in Use	4	17.4	5	5.3	29	15.6	11	11.2	49	12.2
Broken in Manufacture	0	0.0	3	3.2	2	1.1	5	5.1	10	2.5
Indeterminate	19	82.6	87	91.6	155	83.3	82	83.7	343	85.3
Total	23	100.0	95	100.0	186	100.0	98	100.0	402	100.0
Reworked	6	26.1	7	7.4	21	11.3	9	9.2	43	10.7
Points Broken in Use : Points Broken in Manufacture	4.0		1.7		14.5		2.2		4.9	

Preforms, pressure flakes, and projectile points with manufacturing failures indicate that a good deal of point manufacture was carried out in all sub-areas. Incidence of *use* is lowest in the Eastern Periphery, then increases westward through the Quarries, Western Periphery, and Northern Corridor.

The proportion of later points is greater in feature contexts and the proportion of earlier points greater in non-feature contexts. Obsidian hydration data from a variety of artifact classes also reflects differences in the age of feature and non-feature associated material (cf. Chapter 19). This pattern suggests that older materials have been dispersed over the landscape, while the later material is more tightly clustered (Table 75). As a result of dispersal, older activity areas may no longer be recognizable. The distribution of points and preforms at the site and feature level will be discussed and their co-occurrence with other artifact classes examined in Chapters 24-26.

Table 75. Point Types from Feature and Non-feature Contexts.

Point Type	Feature Contexts n	Feature Contexts %	Non-Feature Contexts n	Non-Feature Contexts %	Total
Desert Series	55	64.0	31	36.0	86
Rosegate	15	44.1	19	55.9	34
Elko	7	22.6	24	77.4	31
Gatecliff	4	20.0	16	80.0	20
Humboldt	5	38.5	8	61.5	13
Large Side-notched	4	44.4	5	55.6	9
Stemmed	5	25.0	15	75.0	20
Clovis	0	0	1	100.0	1
Unclassifiable	18	64.3	10	35.7	28
Fragmentary	106	66.3	54	33.7	160
Total	219	54.5	183	45.5	402

Summary

The projectile points in the Tosawihi assemblage include types that range from Clovis to the Desert Series. The Clovis preform, broken during manufacture, was found at a large, intensively occupied site. It is made from material available locally, but it may have been imported and served a broader function. Close to half the dateable points recovered are of Late Archaic age. Despite the pattern of late, intensive exploitation of the quarries (supported by carbon dates, pottery, and obsidian hydration) the presence of Stemmed points made of Tosawihi opalite indicates that the quarries were used as raw material sources in the Pre-Archaic.

Seventy percent of preforms are too small to have been made into points dating earlier than Rosegate times, and it is probable that some portion of the remaining preforms also were made into Late Archaic types. This allows us to use preforms as relative indicators of Late Archaic occupation.

The predominance of opalite points notwithstanding, obsidian clearly was favored as a raw material the projectile point production. Obsidian points compose a far greater proportion of the point assemblage than do obsidian specimens in other flaked tool categories. This probably is because obsidian is easier to pressure flake than the other available materials. Chalcedony, which also is easier to pressure flake than other non-heat-treated materials also comprises a greater proportion of the point assemblage than it does of other artifact categories. When the proportions of obsidian points and preforms are compared to all points and preforms, it is clear that some obsidian points were brought to Tosawihi in finished form.

The presence of pressure flakes and broken preforms indicates *in situ* manufacture of both opalite and some obsidian points. Tip orientations of points and preforms are not very similar, but preforms and Late Archaic points reflect a tendency to produce tips on the distal ends of flake blanks. This, and the more tightly clustered lengths of these point types, suggest a more standardized approach to point production during the Late Archaic.

To facilitate pressure flaking, the majority of opalite points were heat-treated. Heat-treatment of points and preforms is much more common than of other artifact classes. Except for stemmed examples, almost all opalite points were heat-treated.

Manufacturing techniques changed, but were not completely replaced, with introduction of the bow and arrow. Arrowpoints almost always were made from flake blanks, first slightly pressure flaked or abraded around the edges, then pressure flaked. Retouch usually covers all of the dorsal surface, but a portion of the ventral surface frequently remains unflaked. Dart points appear to have been made in two ways, i.e., with and without a percussion flaking stage before pressure flake finishing. The manufacturing stages of dart points are more difficult to document; their preforms probably resemble small bifaces, and we have not been able to distinguish them from failed or exhausted bifacial tools.

Although original blank form often is obscured by subsequent reduction, we assume that many points and preforms (with the exception of Stemmed points) are made on flakes detached from bifaces. Larger point types are derived from early stage biface manufacture, while smaller types could have been removed during any stage of reduction. Because they are heat-treated as flakes and not struck from heat-treated bifaces, however, flakes for smaller points probably were detached before middle Stage 3.

The proportion of complete points differs among types. Elko and Gatecliff Series points tend to be more fragmentary, perhaps indicating a greater degree of reworking, or reflecting changes in targets or velocities. Their larger size also may have facilitated reworking and repair. Breakage and use-wear patterns reflect a variety of activities. Failures during manufacture rarely are identifiable in the point assemblage, but broken preforms and pressure flakes signal loci where point manufacture took place. Points exhibiting breakage during use are more

common; they identify kill or butchery sites, sites where carcasses were processed or consumed, or places where points were reworked. While manufacture and reworking of points occurred in all areas, the evidence for point *use* is lower in the Quarries and the East, reflecting the non-residential character of these sub-areas.

Projectile point frequencies and distributions suggest a change in toolstone exploitation over time. The Western Periphery and Northern Corridor exhibit higher incidences of point use, and also exhibit the broadest temporal diversity. Points from the Quarries reveal an early focus; utilization of the Eastern Periphery is late. The high frequency of late points in the East may reflect an intensification of production and a concurrent restructuring of logistical organization.

Chapter 9

CORES AND MODIFIED CHUNKS

Kathryn Ataman and William W. Bloomer

Cores consist of blocks of raw lithic material from which pieces intended for use or for further modification have been detached. In biface industries, however, cores often cannot be distinguished from bifaces, since many bifaces may have functioned at times in their use cycles both as cores and as bifacial tools. Only cores *not* exhibiting biface morphology are considered here; relatively few pieces in the Tosawihi assemblage fit this narrow definition.

Modified chunks are angular pieces of debitage, as large as cores or bifaces, deliberately modified, but not exhibiting the morphology or patterned flake removals characteristic of *either* core or biface reduction. They may represent assayed pieces, expedient cores, failed bifaces, or unique products of quarry-related reduction. We consider modified chunks and cores in the same analytical framework, since both appear related to raw material procurement and early stage reduction.

Most cores and modified chunks included in this analysis were recovered from areas peripheral to the Tosawihi Quarries. While we expect that most were used and discarded at quarries, the presence of cores made on stream and colluvial cobbles indicates that some may have other origins and distributions. The small sample from the Quarries limits our ability to observe variation in cores and other quarry-related artifacts. Consequently, conclusions concerning the place of core reduction in the Tosawihi technological system are provisional.

Research Aims

The study was designed to examine whether a core reduction trajectory, separate from the clearly discernible biface reduction trajectory, can be observed at Tosawihi. Secondarily, if such a trajectory exists, we must know what was produced from core reduction flakes and how the production of such flakes varied temporally, spatially, and in relation to other artifact production.

Morphology and Technology of Cores and Modified Chunks

Tosawihi cores vary morphologically, but two predominant forms, irregularly shaped, blocky or spheroidal cores and well-shaped, often conical pieces exhibiting regular flake scar patterns, reflect distinct modes of production. Blocky or spheroidal cores may be by-products of core reduction used to produce large flake blanks in a biface reduction trajectory. They might, in fact, represent exhausted cores that initially yielded large flake blanks for the production of large bifaces; when no longer yielding sufficiently large flakes, they may have fallen out of the biface trajectory into a core reduction trajectory for the production of blanks for flake tools, projectile point preforms, or small bifaces. Alternatively, they may have entered the core reduction trajectory as relatively small, minimally reduced blocks for the production of small flake blanks. Since, for reasons outlined in more detail below, well shaped conical cores are less likely to be by-products of a biface trajectory, they constitute our strongest argument for the co-occurrence of an independent core reduction trajectory.

Core Reduction Technology

Our investigation of core reduction technology focuses on the dimensional and morphological parameters of flake blank production. Flake blanks used to produce flake tools, preforms, and bifaces are compared with data from core analysis to yield inferences on the types of artifacts produced from various core types. This information informs us if the reduction of cores proceeded along a distinct trajectory, and allows us to assess to what extent and in which cases biface and core reduction trajectories may have overlapped (e.g., as in the production of small bifaces).

Spatial and Chronological Variability in Core Reduction Strategies

Two distinct core production modes directed our attention to the possibility that each might vary spatially and/or chronologically, and might reflect variation in mobility strategies. If, for example, the earliest visitors understood the expedient use of stream cobbles as cores during hunting forays, and later visitors quarried toolstone from outcrops or quarry pits, we might expect to find cobble cores in earlier associations. Hence, we focused research on the spatial distribution of cores and their association with reduction and residential activities. These associations are discussed in subsequent chapters.

Data Collection Methods

Provenience, metric data, and raw material characteristics were recorded for cores and modified chunks. Cores were segregated into seven classes, consisting of assayed pieces, block cores, spheroidal cores, split nodules, fragments, possible cores, and other types (primarily conical cores).

Assayed Pieces consist of pieces discarded after the removal of one or more flakes had revealed undesirable features or proportions; they often are of inferior raw material and have flaws rendering them unsuitable as cores. *Block cores* are angular, with flat working faces and one or more platforms, while *spheroidal* cores are worked from multiple platforms, resulting in roughly spherical pieces. *Split nodules* most often are made from stream cobbles and exhibit cortex or weathered surfaces. *Possible cores* have less distinctly patterned flake removals than other types; they do not appear to be bifaces, however, and are more similar to cores than to modified chunks. *Other types* consist primarily of conical cores, the most patterned pieces in the core assemblage, usually with a single platform. Opalite, basalt, and obsidian cores are illustrated in Figures 65-68.

Only one core was found unquestionably to have been heat-treated. The paucity of heat-treated cores at Tosawihi may indicate that prehistoric tool makers found it difficult to heat a large chunk evenly or to cause it to reach the critical temperature.

Modified chunks were recorded in terms of flake tool attributes since the place of such pieces in Tosawihi lithic trajectories was unclear, and core attribute lists were less informative. Neither cores nor modified chunks were examined for traces of use.

The Core Assemblage

The analytical sample is composed of 136 cores. The sample is small because few quarry areas (where core reduction is expected to have occurred most often) have been examined in great detail.

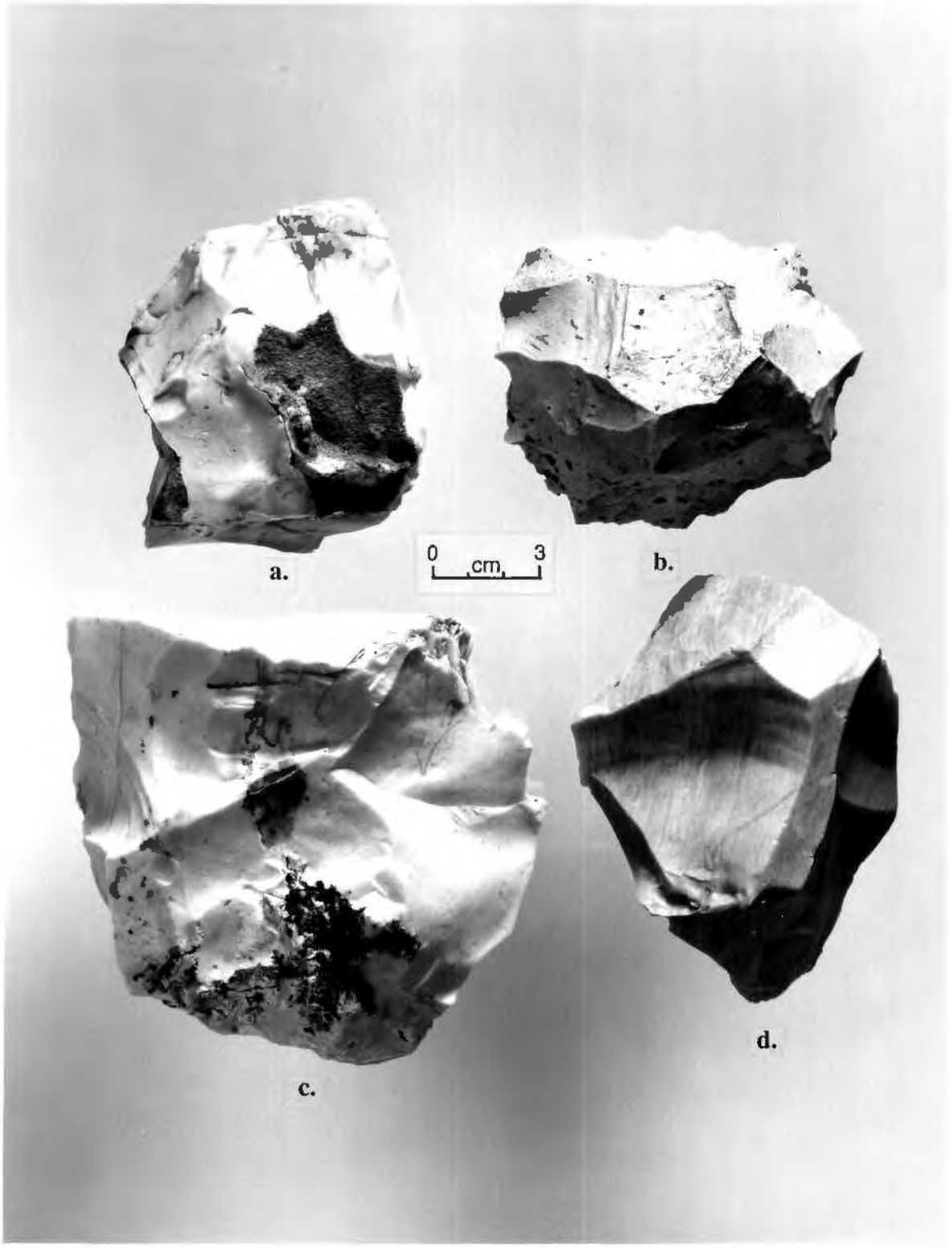


Figure 65. Selected opalite core types.

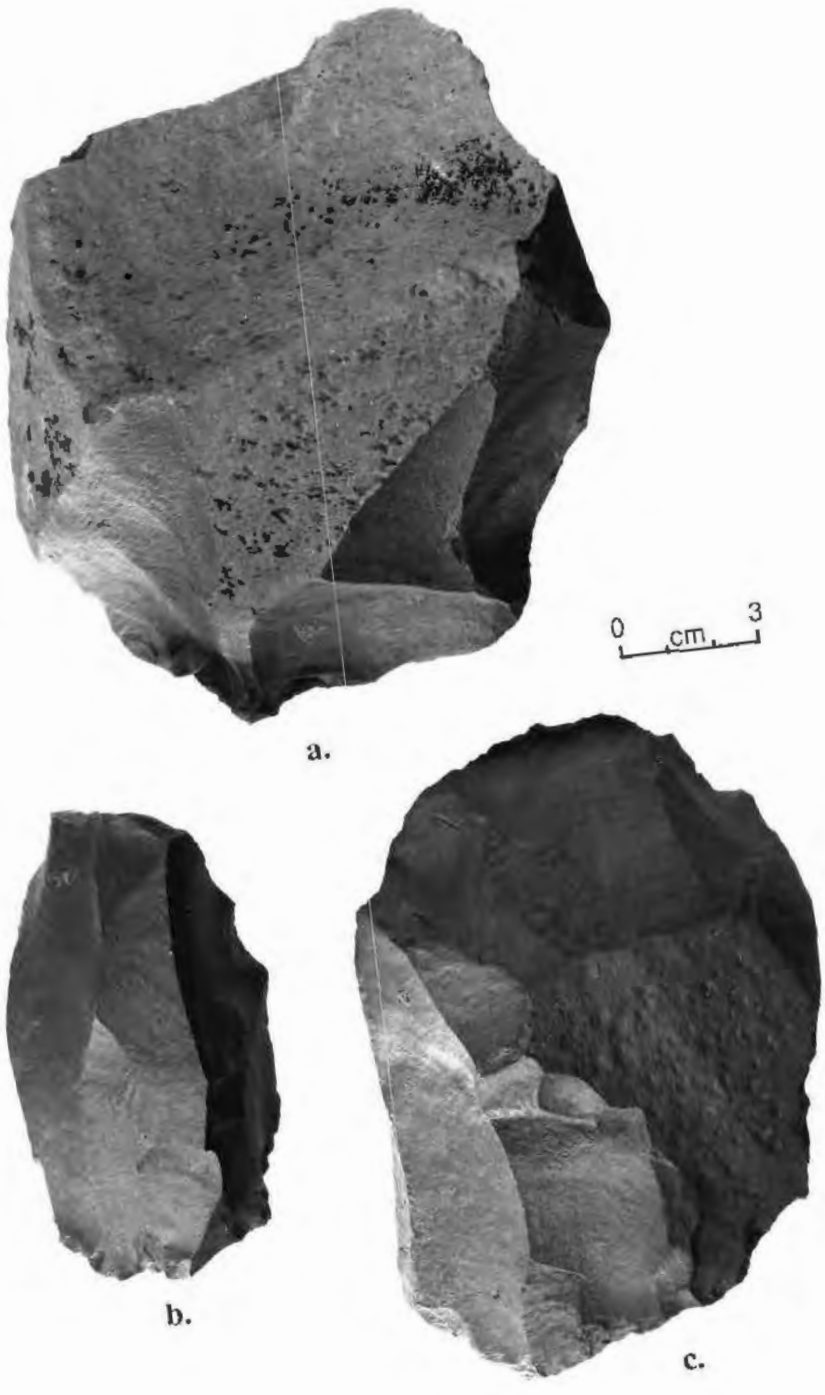


Figure 66. Basalt core types.

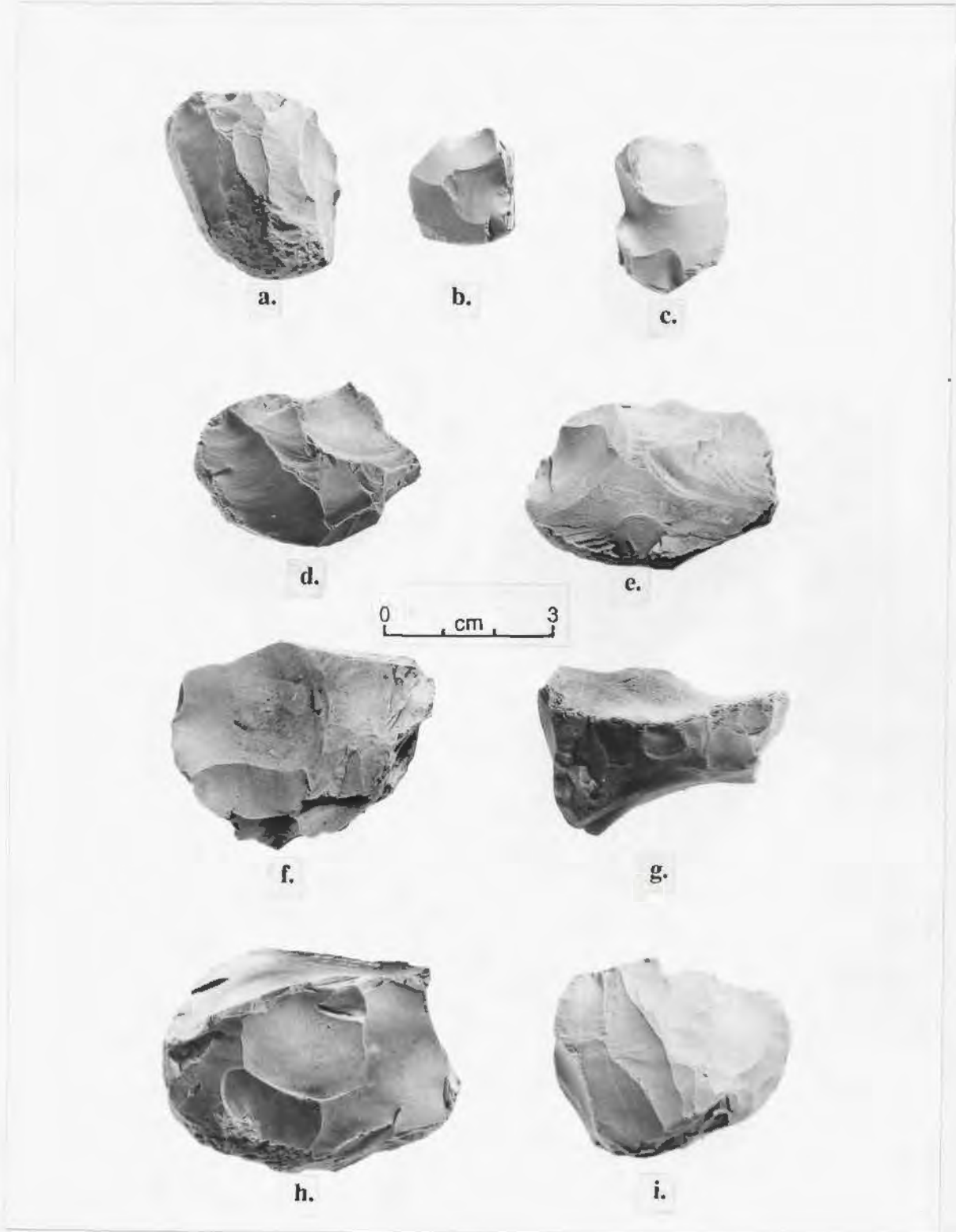


Figure 67. Obsidian cores.

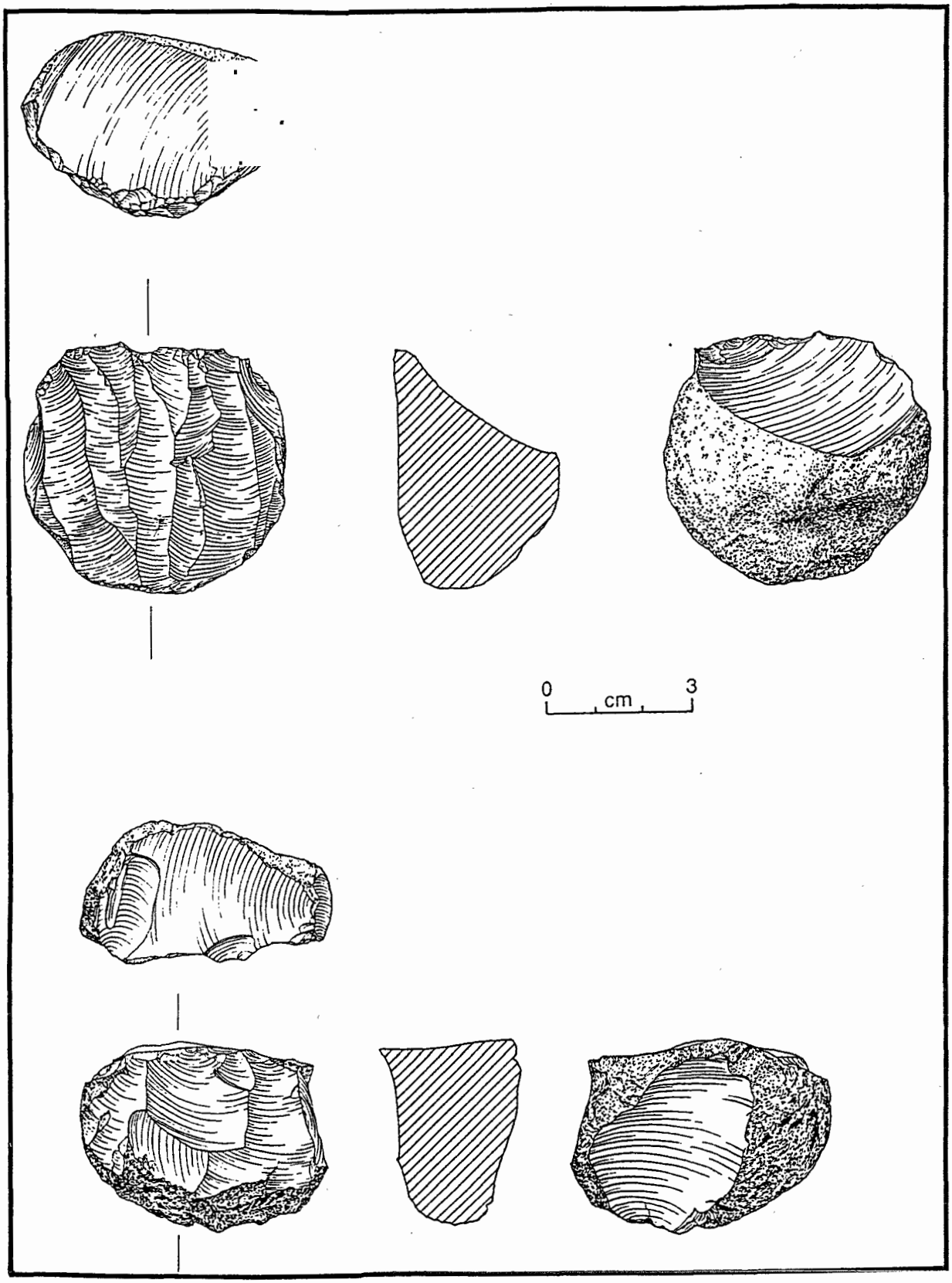


Figure 68. Obsidian cores.

The average weight of cores is 686 g, and the average longest dimension about 100 mm. The mean lengths of each core type do not differ greatly, save that assayed pieces are about 50% longer than most cores. Core dimensions were examined to suggest the probable dimensions of detached flakes. The maximum length and width of each core limits the size of flakes that could have been detached from it. Comparison with dimensions of flake blanks for other chipped stone artifacts indicates that most projectile points and preforms in the analytical sample were produced on flake blanks that could have come from *any* of the cores (Table 76); only some stemmed points and a Clovis preform appear too large.

Flake tool mean lengths are smaller than those of all core types, but the ranges overlap in several categories; almost all flake tools in our sample could have been detached from these cores independent of material type. Obsidian stemmed point blanks, however, probably were detached from cores larger than those in the obsidian core sample.

Table 76. Mean Lengths of Cores and Complete Flake Tools By Type.

Tool Type	n	LENGTH (in mm) Mean	Min/Max	SD
Side Scraper	22	69.8	28.1-117.3	24.5
End Scraper	67	58.6	20.8-110.4	21.1
Misc. Scraper/Frag.	24	67.2	21.3-120.2	27.2
Sym.Pointed Tool (elongate)	13	43.5	24.2- 69.3	13.5
Sym.Pointed Tool (short bit)	6	1.4	31.9- 63.3	11.4
Assym. Pointed Tool	15	3.4	25.0- 67.5	13.0
Trihedral Pointed Tool	5	85.6	71.1-104.2	14.2
Notch/Denticulate	25	68.4	34.4-107.4	21.1
Biface w/slightly sinuous profile	6	54.3	34.6- 75.3	15.5
Biface w/coarse sinuous profile	2	80.7	74.6- 86.8	8.6
Flake w/ cont. retouch -- one edge	36	48.1	20.8-131.3	19.9
Flake w/ cont. retouch -- multiple edges	14	68.1	34.0-112.9	24.1
Flake w/localized retouch	50	58.8	30.0-126.1	22.3
Crudely retouched flake/chunk	6	70.1	23.1-100.4	31.2
Flake w/ var. ret. pattern -- multiple edges	26	56.7	32.5-122.3	22.4
Microdenticulate	4	41	34.4- 50.3	6.7
Discoidal tool	8	102.6	45.0-143.5	33.4
Chopping Tool/Hammer	5	116.2	58.3-180.0	49.5
Other	3	81.8	61.1-100.0	19.6

Core Type	n	LENGTH (in mm) Mean	Min/Max	SD
Assayed Piece	11	148.1	41.0-230.0	50.8
Block	47	99.0	20.0-193.0	42.6
Spheroid	17	89.9	27.5-160.0	43.1
Split Nodule	4	93.1	32.2-167.0	63.8
Fragment	23	80.4	20.2-136.0	31.2
Other	28	98.1	30.1-200.0	35.8
Possible Core	7	100.3	40.3-185.0	50.5

Most cores probably are exhausted forms and were somewhat larger in earlier stages of reduction; their present sizes represent lower limits for comparison with other artifact classes. Core morphology, however, the paucity of flake scars, and that approximately one-third of the specimens were made on cobbles of estimable size suggest that they probably were not much larger at any previous stage.

Only the smallest biface flake blanks in the collection could have been detached from observed cores, but we collected a few Stage 1 bifaces (unreduced biface blanks) larger (mean length = 109.1 mm) than could have been detached from cores in our sample. Size distribution among bifaces is not bimodal (cf. Chapter 7:Figures 20 and 21), suggesting it is unlikely that a separate trajectory for small bifaces made on flake blanks struck from small, prepared cores was significant. A few small bifaces *could* have been produced from such flakes, however (cf. Chapter 21).

Most cores (82%) are made of opalite, but nine (6%) are of obsidian and eight (5.8%) of basalt (Figures 65-68). Cores of jasper and other varieties of opalite (chalcedony and opal) are infrequent. All assayed cores and possible cores are of opalite (Table 77). Obsidian cores are primarily spheroidal forms or split cobbles, while those of basalt are mostly blocky and conical. Obsidian and basalt cores are more regular and patterned than those of opalite, and are not likely to have been produced during biface manufacture; they reflect a flake/core trajectory for the production of blanks for flake tools, points, and even bifaces.

Table 77. Core Type by Material.

	MATERIAL					
Core Type	Opalite n	Obsidian n	Basalt n	Jasper n	Other n	Total
Assayed Piece	11	0	0	0	0	11
Block	36	3	5	1	2	47
Spheroid	14	3	0	0	0	17
Split Nodule	3	2	0	0	0	5
Fragment	19	1	1	2	0	23
Other	23	1	2	2	0	28
Possible Core	7	0	0	0	0	7
Total	113	10	8	5	2	138

Spatial Distribution

Cores were recovered most frequently from 26Ek3032, although surface collections are small and excavated volume is low (Table 78). The Northern subarea exhibits the lowest proportion of cores, probably because it is farthest from raw material sources. The Western and Eastern Peripheries both exhibit similar proportions of cores, indicating association with early stage reduction of tools and/or small bifaces. Assayed pieces and possible bifaces are most common in the East, while spheroids and split nodules are found most often in the Quarry. Blocky and conical cores (the most patterned types) as well as fragments occur in all areas.

Table 78. Core Type by Subarea.

Core Type	East n	West n	North n	Quarry n	Total
Assayed Piece	7	3	0	1	11
Block	10	15	3	19	47
Spheroid	3	3	0	11	17
Split Nodule	1	0	0	3	4
Fragment	4	9	1	9	23
Other	8	7	2	11	28
Possible Core	4	1	0	2	7
Total	37	38	6	56	137

Obsidian cores were found in all subareas (Table 79); the greatest proportion was recovered from the East. Basalt cores (excepting one example from the North) were found only in the West, where basalt is common both in drainages and on slopes. Site 26Ek3092 (in the Western Periphery) exhibits the widest range of material and types, although Localities 23 and 27 of 26Ek3032 also have high incidences of cores (all opalite). The North and West exhibit the widest range of materials, the East, only opalite and obsidian, and the Quarry, opalite only.

Table 79. Core Material by Subarea.

Material	East n	West n	North n	Quarry n	Total
Opalite	32	26	1	54	113
Obsidian	4	2	1	2	9
Basalt	0	7	1	0	8
Jasper	1	2	2	0	5
Other	0	1	1	0	2
Total	37	38	6	56	137

Core Procurement

Many core blanks (36%) are of indeterminate origin; of the remainder, we have sorted those made on flakes or blocks from those made on cobbles (Table 80). Most *probably* were made on chunks of opalite extracted from the quarry but, once reduced, this is difficult to recognize. Some cores (and some bifaces as well) were made on cobbles collected from stream beds or colluvial deposits. Cobbles infrequently provided raw material for bifaces, but close to one-third (28%) of the cores were made on cobbles of opalite, basalt, and obsidian; most frequently, they are assayed pieces, blocky cores, or split nodules. Opalite cobble cores are distributed widely, not restricted (as are opalite cobble bifaces) to sites along the middle reaches of Little Antelope Creek. The proportion of opalite cores made on cobbles increases with distance from the quarries.

Table 80. Core Blank Types By Subarea.

	SUBAREAS				
Blank Type	East	West	North	Quarry	Total
ALL CORES					
Flake	15	12	1	21	49
Cobble	8	17	4	9	38
Indeterminate	14	9	1	26	50
Total	37	38	6	56	137
OBSIDIAN CORES					
Flake	0	0	0	0	0
Cobble	1	1	1	0	3
Indeterminate	3	1	1	1	6
Total	4	2	2	1	9
BASALT CORES					
Flake	0	1	0	0	1
Cobble	0	6	1	0	7
Indeterminate	0	0	0	0	0
Total	0	7	1	0	8
OPALITE CORES					
Flake	15	11	1	21	48
Cobble	7	10	3	8	28
Indeterminate	11	8	0	25	44
Total	33	29	4	54	120

The Modified Chunk Assemblage

Sixty-seven modified chunks were recovered. They are of opalite almost exclusively and are slightly smaller than most cores, averaging 88.3 mm in length and weighing an average of 233.4 g. Twenty-two percent of them exhibit some cortex; they probably were made on cobbles (Table 81).

Table 81. Presence/Absence of Cortex on Modified Chunks by Subarea.

Cortex	East n	East %	West n	West %	North n	North %	Quarry n	Quarry %	Total
Presence	7	22.6	5	20.8	1	33.3	2	22.2	15
Absence	24	77.4	19	79.2	2	66.7	7	77.8	52
Total	31	100.0	24	100.0	3	100.0	9	100.0	67

This proportion is slightly less than that for cores, and (also in contrast to cores, which almost *never* are heat-treated) 12% of the modified chunks were thermally altered (Table 82). Most were worked on more than one edge, and worked edges are generally irregular.

Table 82. Heat-Treatment of Modified Chunks by Subarea.

Thermal Alteration	East n	East %	West n	West %	North n	North %	Quarry n	Quarry %	Total
Blank from Heat-Treated Core	2	6.5	-	-	-	-	-	-	2
Heat-Treated as a blank	1	3.2	3	12.5	-	-	-	-	4
Heat-Treated during reduction	-	-	1	4.2	-	-	-	-	1
Post-Depositional thermal alteration	1	3.2	-	-	-	-	-	-	1
Not Heat-Treated	27	87.1	20	83.3	2	66.7	9	100.0	58
H/t but Stage Indication	-	-	-	-	1	33.3	-	-	1
Total	31	100.0	24	100.0	3	100.0	9	100.0	67

Modified chunks are distributed somewhat differently from cores. While cores are found in the East, West, and Quarry areas, modified chunks are found primarily in the East and West. However, the distribution of modified chunks exhibiting cortex is more evenly distributed; suitable alluvial and colluvial material occurs in many areas, and probably was exploited opportunistically.

The incidence of thermal alteration of modified chunks resembles that of bifaces more than cores; most thermally-altered modified chunks were found in the Western and Northern subareas.

The morphology of modified chunks, their spatial distributions and frequency of heat-treatment indicate that they probably were by-products of early stage biface reduction. Fewer examples are found in the Quarry than in other subareas, owing to smaller samples collected there; fewer examples were recovered from the North because less early stage reduction was conducted there.

Discussion

We do not believe that most cores in our sample represent exhausted cores used for the production of large bifaces. Several observations support this conclusion. First, the number

of bifaces greatly exceeds the number of cores; it seems that cores, at least in the forms we recognize, were not common by-products of biface blank production. Second, observed cores probably were not much bigger than they are now, and thus were not large enough to have yielded the blanks on which most bifaces were made. Third, recent observations of material from a Tosawihi quarry location not reported herein indicate that bifaces were made not only on flake blanks *detached from* blocks of material extracted from bedrock but also *directly* on the blocks without an intervening flake stage. It is possible, however, that cores used for the production of small bifaces commonly were reduced to unrecognizable form, or that they were worked into bifaces subsequent to detaching large flake blanks; modified chunks, then, (but not cores) might be by-products of either process.

If Tosawihi cores represent a separate trajectory for the production of small blanks for opalite flake tools, preforms, and even small bifaces, it was a distinctly minor trajectory. It seems likely that most pieces classified as cores were used to produce flake blanks for flake tools, points, or small bifaces. Over half the flake tools were made on flakes clearly detached from bifaces, reinforcing our view of the relative unimportance of a core/flake trajectory. This is less clear for preforms and points (although 10% of the preforms were made on biface thinning flakes), of which the origin of the majority of blanks is indeterminate.

Obsidian and basalt trajectories differ from that of opalite. Obsidian flakes used for the production of flake tools, points, or bifaces apparently were produced from small obsidian cobble cores. We found few obsidian bifaces and few obsidian biface thinning flakes, so it seems particularly unlikely that obsidian tool blanks were detached from bifaces. Basalt flakes for the production of tools and bifaces were produced from cobbles and tabular pieces in the West and North. Obsidian and basalt cores are much more patterned than those of opalite, and a core trajectory is clear for both (Figures 66-68; cf. Chapter 21).

Modified chunks are reduction by-products that *probably* resulted more from early stage biface reduction than from core reduction; they might, however, represent the fragmentary remains of exhausted cores. The distributions of cores and modified chunks differ sufficiently, however, to suggest that if modified chunks are flake core fragments, cores were reduced differently in the East and West than in the Quarry. The infrequent occurrence of cores in Tosawihi assemblages indicates the intentional production of small blanks for tools or bifaces; modified chunks reflect early stage reduction, whether of bifaces, biface blanks, or blanks for other classes of tools. The distribution of these two artifact types in specific feature and non-feature loci is examined in later chapters.

Chapter 10

DEBITAGE ANALYSES

William W. Bloomer and Eric E. Ingbar

Debitage has been perceived both as an ideal artifact class ands a millstone around the necks of archaeologists. It is common, generally has a short use-life (Schiffer 1975), and endures most depositional settings. It should be an ideal venue for the study of chipped stone reduction and stone tool use and, in fact, debitage analyses have contributed to the study of a broad range of topics, ranging from style (Close 1989) to site function and technological organization (Camilli 1989). There is ongoing debate about the degree to which debitage analyses contribute useful information to all of these topics, but the data class undoubtedly offers important evidence concerning the production, use, and modification of stone tools. The ubiquity of flakes, however, also can be a liability. Sheer frequencies and masses of debitage sometimes are overwhelming, especially at quarry and workshop localities, and the time necessary to analyze debitage collections, even at a gross level, can be so great that such analysis often is deferred in favor of investigation of less common artifacts. At Tosawihi, debitage is undoubtedly the most common artifact class; billions of flakes occur in and around the quarries. The present analyses address more than 900,000 specimens.

Two approaches have been used in most debitage studies. One processes the materials in "bulk" (e.g., by size grading), and the other collects information on individual flakes through classification or attribute data. The latter has the disadvantage of requiring much time to record even a moderate assemblage. Bulk techniques of analysis are quicker, but they sacrifice the documentation of variation provided in piece by piece analysis.

Given the immense numbers of flakes present in the Tosawihi samples, our analytical techniques focus more on assemblage characteristics than on detailed characterizations of chipped stone production. We employ two complementary approaches: mass analysis (Ahler 1989b) and technological analysis (Flenniken 1987; Flenniken and Ozbun 1988). Controls for both techniques are provided by documented replications produced by colleagues using Tosawihi opalite, as well as by replicative exercises conducted by Ahler (1989b).

Research Goals

Quarries are important sources of information about the technological organization (as well as higher levels of organization) of prehistoric peoples (Ericson and Purdy 1984); they divulge the "starting point" of stone tools. Toolstone reduced at quarries ultimately was used for tools within other parts of the settlement and subsistence system (Binford 1979; Gould and Saggers 1985). Size, shape, numbers, and variability among stone tools all contribute information to models of lithic economies (cf. Chapter 3). One goal of our analysis of debitage from Tosawihi, therefore, has been to determine the sizes, shapes, and numbers of tools and other products (such as cores) produced for "consumers" in the regional settlement and subsistence system. These are rough measures of the prehistoric importance of Tosawihi. In turn, the importance of lithic sources may have determined which raw materials were used and the tool forms they yielded (Kelly 1988).

Debitage analysis is one way to discover the forms and numbers of products that left the quarries prehistorically. Core forms are indicated by distinctive kinds of debitage and characteristic size and mass profiles. The frequencies of distinctive flake types also suggest how many different cores or bifaces were reduced. The mass of debitage in an assemblage is a minimal estimate of the mass of material reduced; compared to experimental ratios of debitage

to core weights, it can be used to estimate the original numbers of cores. The organization of reduction activities also is measured indirectly by the occurrence of heat-treatment; since debitage reflects these values only equivocally, our results are considered here in concert with the results of analyses of other artifact classes. Debitage, however, rarely is transported away from its place of creation (especially in bulk), and it therefore reflects the full range of lithic reduction activity occurring at a place without the bias of differential transport costs (Frison 1967; Yerkes 1987).

A second goal of our study was the delineation of temporal change in the use of the quarries. If present, and detectable, temporal variation in Tosawihi debitage may reflect changes in reduction strategies and variation in the intensity with which the quarries were used.

A third goal has been to examine how visits to the quarries were scheduled and organized. Visits to Tosawihi required some degree of mobility on the part of prehistoric peoples, but what strategies enabled such forays? On opposing ends of a continuum we can envision use of the quarries by logistical forays and by long-term residential forays (cf. Chapter 4). Logistical forays should have involved few people visiting for short times only to procure and process toolstone for transport. In contrast, long-term residential forays should have involved large, diverse groups moving to the quarries and procuring toolstone as one activity among many routine domestic ones.

Distinctly different debitage assemblages should characterize these strategies. Because logistical forays would have entailed visits to the quarries for short periods to procure toolstone, primary reduction debitage (generally large in size) should be their predominant trace. Archaeologically, prehistoric processing of opalite for transport from the quarries seems to have been done by reducing bifaces to approximately early Stage 3 (cf. Chapter 6). Domestic activities, which often include tool maintenance, should produce debitage assemblages characterized by high frequencies of small retouch flakes, flakes from later stages of reduction (e.g., biface production beyond early Stage 3), and (if primary reduction of quarry blocks was undertaken) the same kinds and sizes of flakes as logistical forays. Thus, domestic foray assemblages should be distinguished by a greater diversity of flake types and sizes, and perhaps a greater diversity of raw material sources. Debitage distinctive of different tool and core reduction techniques can be used roughly to monitor these activities, as can debitage assemblage size profiles.

Methods

Two techniques were employed to analyze debitage samples. Mass analysis (Ahler 1989a), in which weights and counts of samples retained in nested sieves are recorded, was our primary approach. We also employed technological analysis, classifying individual flakes into types without measurement of distinct attributes, inferring reduction activities from relative proportions of flake types. Because the procedures are distinct, we discuss their rationales and techniques separately; we also describe replicative experiments which we used as a control for both approaches.

Mass Analysis

Mass analysis, based on proportional frequencies and weights of size-graded samples, was pioneered by Ahler (1986, 1989a, 1989b; Ahler and Christensen 1983); we have followed the analytical procedures he prescribes.

The approach is based on the commonly observed phenomenon of diminution of flake size through the lithic reduction process. In general, reduction debris shrinks throughout the course of formal tool production. In fact, the presence of larger debris is the factor most useful for differentiating different core reduction strategies from biface reduction, since small flakes are produced throughout the reduction sequence. The procedure is simple; flake assemblages are shaken through nested sieves, and counts and weights are tallied for each size-grade and converted to proportional frequencies across size-grades. The data can be used to assess similarities to experimentally derived values through Kolmogorv-Smirnov tests of cumulative proportional differences, discriminant analysis, and linear regression.

Mass analysis reliably distinguishes three modes of flaking when tested on experimentally produced debitage assemblages: unifacial-bifacial reduction, core reduction, and bipolar reduction. Finer divisions also may be distinguished with slightly less statistical reliability. Ahler (1986, 1989a, 1989b) used discriminant analysis to classify unknown (archaeological) cases with linear discriminant functions derived from controlled experiments; his database included debitage from core reduction/flake production, biface production, tool production and maintenance, and bipolar reduction. Inclusion of other variables, such as counts of cortex-bearing flakes in each size-grade and ratios of flake shatter to platform remnant-bearing flakes were found to enhance classificatory accuracy (Ahler 1989b).

Similarly, Stahle and Dunn (1982, 1984) examined size distributions of debitage from various stages of biface production. Sieving debitage through nested, size-graded screens, they transformed the resulting data into an approximately straight linear function using a Wiebull transformation and then applied discriminant analysis, finding fairly good separation of experimental assemblages from different stages. Another study (Stahle and Dunn 1984) attempted to control for mixing of assemblages resulting from the inclusion of more than one stage of reduction in a sample; a constrained least squares regression analysis separated the components in mixed samples moderately well.

Mass analysis is relatively quick and requires little training of laboratory personnel, but it is not a panacea for the flake-ridden. An important requirement of the approach is that a statistically valid sample size must be available; this has been no problem at Tosawihi. A grave problem, however, has been separating samples that reflect mixtures of different core reduction strategies from mixtures of stages from the same reduction strategy. Such mixtures do not "fit" the experimental data very well, because experimental assemblages are not mixed, and the usual measure of analytical success is how well controlled assemblages can be classified (Ingbar et al. 1989). Stahle and Dunn (1984) examined this problem in detail, but were only moderately successful in developing a technique to circumvent it. Nonetheless, it probably is more often the case that archaeological assemblages are mixtures of different kinds of reduction.

Data Collection Methods

All Tosawihi debitage samples were subjected to mass analysis. Samples were processed according to Ahler's (1989a:99-100) procedures; first they were sorted by material type (Table 83), and particularly large samples were split using a standard geological sample splitter into 1/2, 1/4, 1/8, or 1/16 samples. Samples were passed through a column of U.S. Standard sieves, topped by meshes of one inch (testing phase assemblages), or two inch (data recovery phase assemblages) with smaller screens beneath (Table 84). The sieve column was then shaken mechanically for 30 seconds. Counts, weights of flakes were recorded for each size-grade, and cortical flakes were counted separately. The counts of cortex-bearing flakes are not reliable, since Tosawihi opalite contains unsilicified chalky veins identical to cortex; cortex counts are reliable for other materials.

Table 83. Variables Recorded During Mass Analysis of Debitage.

Material Type: 1. Opalite 2. Jasper 3. Obsidian
4. Basalt 5. Other

Split Type: N, split is 1/n, where n = 1, 2, 4, 8, 16, 32

Size Grade: G0 -- >2 in.+
G1 -- 1 in. to 2 in.
G2 -- .5 to 1 in.
G3 -- .25 to .5 in.
G4 -- .125 to .25"

Weight: Weight of debitage in size grade.

Count: No. of pieces of debitage in size grade.

Count w/Cortex: No. of pieces w/cortex in size grade.

Table 84. Size-grades, Nominal Sizes, and Actual Sizes of Sieves Used in Mass Analysis.

Size-Grade	Nominal Opening	Actual Opening (inches) Square	Diagonal	U.S. Standard Sieve Size
G0*	2 in.	2	2.82	2 in.
G1	1 in.	1	1.41	1 in.
G2	1/2 in.	0.5	0.71	1/2 in.
G3	1/4 in.	0.22	0.32	No. 3 1/2
G4	1/8 in.	0.10	0.07	No. 7

*Size grade 0 was used only on samples recovered during Data Recovery.

To evaluate the bias introduced by splitting samples we conducted a series of experiments in which whole samples first were counted and weighed by size-grade, then split into 1/2 and 1/4 segments for counting and weighing. Predictions for the total frequencies and weights within each size-grade were compared to the known counts and weights, as were cumulative percentages of weight and count by size-grade. In general, weight was found to be somewhat more sensitive to skewing than count, especially in quarter samples. The largest size-grade was always the most variable, since no upper size limits were imposed. The conversion of split sample extrapolations to proportions by size-grade largely eliminate statistical differences between split samples and total debitage counts and weights.

Analytical Models and Interpretive Methods

The models and techniques used to interpret debitage relied on controlled or known cases. Experimental data used to build our models came from two sources: Ahler's (1989a) analytical database, which he graciously made available to us, and replications of core and biface reduction made by colleagues and IMR staff using Tosawihi opalite (described below). Ahler's (1989a) database does not include the largest of our size-grades (G0 -- 2 inch nominal mesh). Too, assemblages recovered and analyzed during the testing phase of investigations do not include the smallest size-grade (G4 -- 1/8 in. nominal mesh) because we used mostly 1/4 in. screens in the field. So, in building discriminant models with the experimental data, all G0 data were summed with G1 data for each sample, and G4 weights and frequencies were excluded. The raw data are too voluminous to tabulate, but the variables used are shown in Table 85.

Table 85. Variables Used in the Creation of Discriminant Models.

REDTYPE: 1. Core 2. Biface production 3. Tool edge maintenance

GENSTAGE: (bifaces only) 1. Early (stage 1-3.5) 2. Mixed (Early and Late 3. Late (stage 3.5+)

NOG0	Count of flakes in 2"+ size grade
NOG1	Count of flakes in G1 size grade
NOG2	Count of flakes in G2 size grade
NOG3	Count of flakes in G3 size grade
NOG4	Count of flakes in G4 size grade
WTG1	Weight of flakes in 2"+ size grade
WTG1	Weight of flakes in G1 size grade
WTG2	Weight of flakes in G2 size grade
WTG3	Weight of flakes in G3 size grade
WTG4	Weight of flakes in G4 size grade
WTG1P13	Proportion of weight in G1 across G1, G2, and G3
WTG2P13	Proportion of weight in G2 across G1, G2, and G3
WTG3P13	Proportion of weight in G3 across G1, G2, and G3
NOG1P13	Proportion of frequency in G1 across G1, G2, and G3
NOG2P13	Proportion of frequency in G2 across G1, G2, and G3
NOG3P13	Proportion of frequency in G3 across G1, G2, and G3
NRAT13	NOG1/NOG3
NRAT23	NOG2/NOG3
WRAT13	WTG1/WTG3
WRAT23	WTG2/WTG3
MEANG1	Mean weight of debitage in G1 size grade (0 if NOG1=0)
MEANG2	Mean weight of debitage in G2 size grade (0 if NOG2=0)
MEANG3	Mean weight of debitage in G3 size grade (0 if NOG3=0)
G1G3	Ratio of mean weight of G1 size grade to mean weight of G3 size grade(MEANG1/MEANG3)
G2G3	Ratio of mean weight of G2 size grade to mean weight of G3 size grade (MEANG2/MEANG3)

Experimental data from Ahler's database and from our replication program were used to create discriminant models that first segregated block core reduction, tool edge maintenance, and biface production. Block core reduction is the removal of flakes from a large block of stone, without intending to shape the stone itself into any other implement. Tool edge maintenance comprises fine retouching or resharpening of either bifacially or unifacially shaped tools. Biface production is the reduction of a block or flake of stone by flaking on both faces to produce a regularized core (i.e., biface). This first model does not distinguish stages of biface reduction.

A second model then was built to separate early stage biface production (prior to Stage 3.5, following Callahan [1979]; cf. Chapter 6) from late (Stage 3.5 and later) and mixed (early and late) biface production. A third model was generated to separate mixed from late biface production. The classificatory pathway for each debitage sample is shown in Figure 69. Discriminant models were built using SPSS procedure Discriminant (SPSS 1986). Stepwise inclusion and exclusion of variables in the models were permitted to create the most accurate models.

The first set of discriminant functions separates reduction type into three general groups: core reduction, biface production, and tool edge maintenance or resharpening. These correspond roughly to block core flaking (including, to some extent, the production of flakes suitable for biface production), biface production from Stage 2 (initial bifacial flaking) to finished product, and sharpening or rejuvenating tool edges, often by pressure flaking. The data used to build the discriminant model consisted of 550 assemblages drawn from Ahler's database (n=492) and our own replicative program (n=58). Reclassification of the experimental cases achieved close to 80% accuracy. Examination of misclassified cases indicated that misclassified

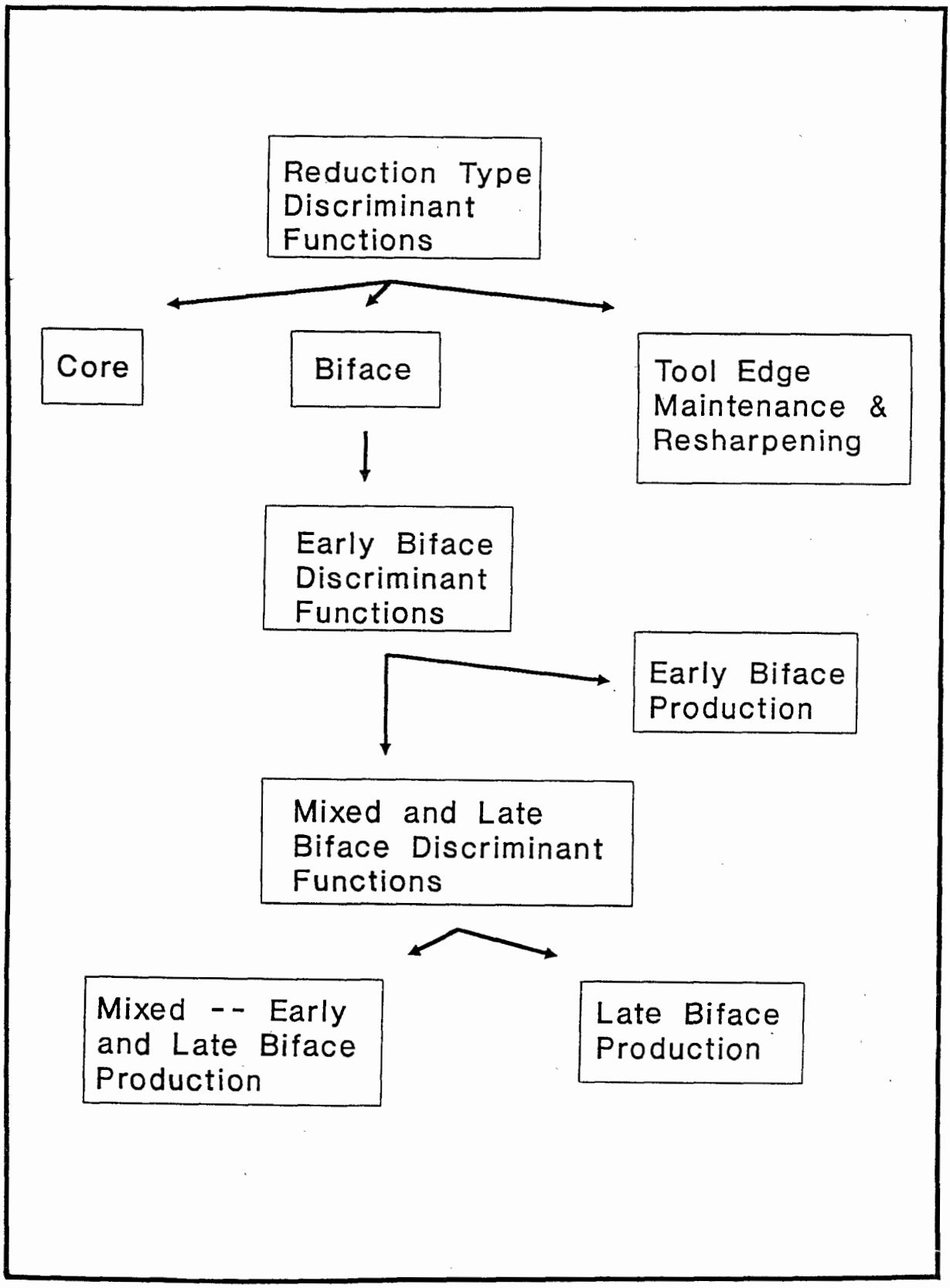


Figure 69. Classificatory pathway for mass analysis debitage samples.

core reduction cases (11% of the 290 cases) were small initial cores. Misclassified biface production cases were from unusually large cores (17.5% of the 246 cases) misclassified as core reduction assemblages by the discriminant function, or from unusually small initial bifaces (3.3% of the 246 cases) misclassified as tool edge maintenance assemblages. None of the tool maintenance debitage assemblages were misclassified.

The second set of discriminant functions separates mixed and late biface production debitage assemblages from early stage assemblages. Initial attempts to classify biface production debitage assemblages sought three functions in a single discriminant analysis to separate these three groups. This strategy, however, produced less reliable *post hoc* reclassification of the experimental assemblages. The use of two distinct sets of discriminant functions provides a more accurate classification, at least of the experimental assemblages.

One hundred eighty-one assemblages from our own experiments and Ahler's database were used in the creation of the first biface production discriminant function (58 and 123 cases, respectively). This set of discriminant functions correctly reclassified more than 87% of the experimental cases. Examination of the misclassified cases revealed that early stage bifaces wrongly classified as late bifaces were all quite small and may have started from more regular blanks. The converse errors, in which late and mixed assemblages were misclassified as early stage assemblages, also seem to reflect blank morphology. In the latter case, blanks generally were larger and, perhaps, less regular than those used to produce other cases in these groups.

The third and final set of discriminant functions (derived from 77 experimental assemblages) separates late stage biface production from mixtures of late and early stages. This set of discriminant functions accurately classified more than 83% of the experimental cases from which it was built. The misclassified cases are more nearly correct in this function than in either of the other two. That is, the mixed cases wrongly classed as late stage biface production (16% of the 50 mixed cases) are all experiments in which reduction began just prior to manufacturing Stage 3.5, and so are almost entirely "late." The single misclassified late stage production assemblage came from a larger initial biface than any of the other late assemblages.

Before turning to the archaeological cases, it is important to consider some of the shortcomings of these models. As the discussion of each model shows, the discriminant procedure seems to be quite sensitive to variations in initial core form and size. The frequent association of misclassified debitage assemblages and unusually large or small cores (whether bifacial or not) suggests that core morphology and size are very important components in determining the outcome of discriminant modelling. Most of Ahler's experimental assemblages are scaled to the products which he has studied -- tools at the Knife River flint source area in North Dakota. It is our impression that Knife River flint generally occurs in nodules somewhat smaller than the essentially unrestricted core sizes available at Tosawihi. The nature of Tosawihi opalite deposits places no effective stricture on the size of artifacts than can be produced. To work around this problem, only cases from Ahler's experimental database within the size range of recovered Tosawihi bifaces were used in deriving the two biface discriminant functions. The accuracy of the discriminant functions in classifying archaeological assemblages is subject to the *a priori* assumption that prehistoric flintknappers produced products similar to those made in the experimental programs. While several lines of evidence suggest that this is so, that it *is* an assumption should be borne in mind when considering mass analysis results.

Technological Debitage Analysis

The goal of technological analysis is to characterize the production of debitage assemblages. The importance of the approach lies in its ability to examine both core forms and (for biface reduction assemblages) stages of biface reduction present in a debitage sample. The occurrence of distinctive production actions, such as heat-treatment, at specific times in tool

production also can be discovered through technological analysis. Such analysis is an independent line of inquiry into reduction activities that produced debitage assemblages. The results thus serve as a control and refinement of mass analysis results. Because lithic reduction at Tosawihi is dominated by extraction and reduction of quarry blocks into biface blanks or flakes suitable for biface blanks, and by the production of bifaces, technological analysis of debitage can address both the techniques, as well as the organization, of biface production.

Two methods of technological analysis are common in current lithics research: "attribute analysis" and "typological analysis." In attribute analysis the analyst objectively records specific attributes of individual flakes. Relationships between attributes are then analyzed and combined to interpret the reduction techniques present in an assemblage (e.g., Mauldin and Amick 1989; Ingbar et al. 1989). In contrast to attribute analysis, typological analyses record the "flake type" of individual flakes (Ahler 1989a:88, Table 1; Flenniken 1987; Flenniken and Ozbun 1988). Recognition of flake types relies on the subjective observation of many of the same attributes measured and recorded in attribute analyses, but these are observed as morphological characteristics or sets of associated attributes. The typological analyst must recognize morphological characteristics diagnostic of reduction technique.

Typological analysis is used in technological analysis of selected Tosawihi debitage assemblages, an approach favored over attribute analysis because different reduction techniques tend to generate morphologically distinct kinds of flakes. These distinctive kinds of flakes are better indicators of reduction technology than are clusters of individual flake attributes (Ahler 1989a:88; Flenniken 1984). Clustering of individual attributes often can be misleading, in that not all flake attributes are equally important. Typological analysis skirts this problem by allowing subjective differential weighting of attributes in creating flake type classifications. As well, flakes can be classified relatively quickly by a trained analyst without the time consuming task of measuring attributes precisely.

Data Collection Methods

Significantly fewer samples underwent technological analysis than mass analysis. The technological analysis samples were selected carefully to provide a contrast to mass analysis, a glimpse of the spatial organization of lithic reduction, and some data on the internal spatial arrangement of biface production activities at specific sites.

All debitage samples selected for technological analysis first were subjected to mass analysis. Size-graded samples then were sorted into three categories of flakes: angular debris or shatter, "whole" flakes, and flake fragments (Figure 70; cf. Sullivan and Rozen 1985). Angular debris or shatter has no distinctive flake morphology. Whole flakes and flake fragments have flake morphology. Whole flakes generally retain platforms, and are interpretable through technological analysis. Flake fragments are pieces of flakes (usually flake margins) uninterpretable by technological analysis. The two categories not analyzed technologically were separated into four groups: pieces with cortex, pieces with heat-treatment, pieces with neither attribute, and pieces with both. The frequencies of these groups were recorded, but no further technological analysis of angular debris or flake fragments took place.

Whole, size-graded flakes were classified further, first by raw material sources. Opalite was the predominant material analyzed, though jasper was classified when present. Opalite color was not recorded specifically, although general color diversity was noted. Obsidian and basalt were analyzed separately. Thermal alteration or heat-treatment provided a second level of segregation of opalite flakes. Within each flake sample, six general flake types and five subtypes were distinguished:

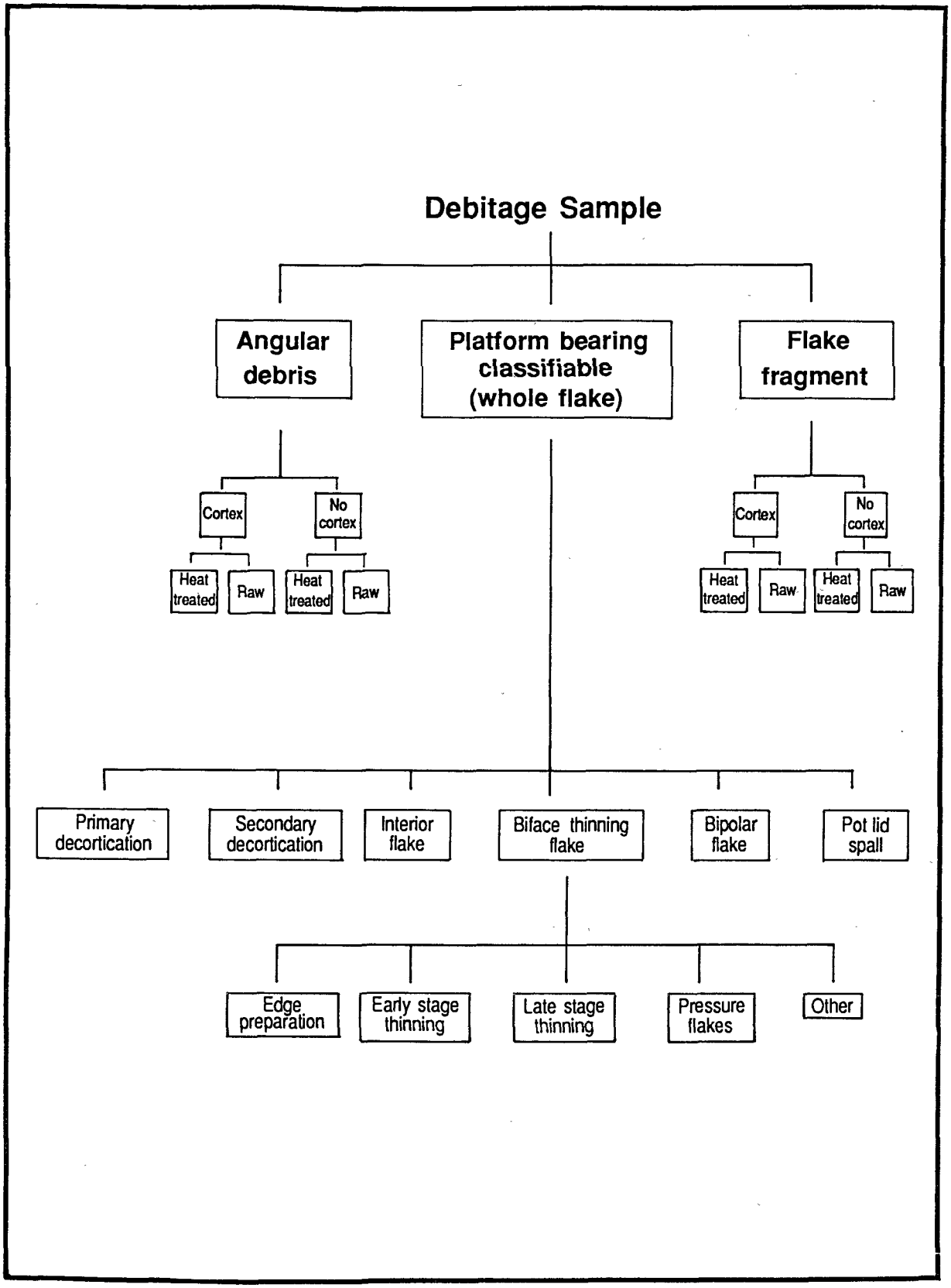


Figure 70. Classificatory pathway for technological analysis debitage samples.

Primary Decortication Flakes have cortex covering the entire dorsal surface. Platforms may be cortex covered, or may be unweathered interior surfaces. They are indicative of primary core reduction.

Secondary Decortication Flakes have cortex on the dorsal surface, but lack complete cortex cover. The platform surface may be cortex covered, or may be an interior surface. Like primary decortication flakes, secondary decortication flakes generally indicate initial core reduction.

Interior Flakes have no cortex on the dorsal surfaces and lack characteristics that would permit placing them in any other flake type. Usually, they are relatively thick, have straight longitudinal profiles, and lack complex patterns of dorsal flake scars. Interior flakes generally are produced during the later stages of core reduction. Biface reduction flakes lacking characteristics distinctive to biface reduction also are classed as interior flakes; these usually are produced early in biface reduction.

Bipolar Flakes are created by block-on-anvil percussion of a core (Binford and Quimby 1963). They are flat or wedge shaped in lateral cross-section, may have pronounced concentric rings, and can have crushed platforms and distal ends. No bipolar flakes were found in the Tosawihi samples.

Pot Lid Flakes result from thermal exposure that causes differential expansion inside a piece of stone. They are not a product of intentional knapping. They often are approximately circular in plan view with a flat dorsal surface and a convex ventral surface. They are thickest in the center, and taper rapidly toward the edges.

Biface Reduction Flakes have one or more characteristics distinctive to flakes removed in biface reduction. These characteristics include acute angled platforms, lipping of ventral surfaces of platforms, complex flake scar patterns on the platform surface, evidence of platform preparation through abrasion or release flakes adjacent the platform, complex dorsal scar patterns, and overall ribbon-like flake morphologies. Among biface reduction flakes, five subgroups were distinguished:

> **Edge preparation flakes** consist of flakes struck to remove the bulb of a flake blank, flakes resulting from alternate edge removals to strengthen an edge to be used as a platform, and flakes removed to prepare an edge to serve as a platform (but not removed in alternate fashion). Edge preparation flakes generally are indicative of Stage 2 biface reduction.
>
> **Early stage thinning flakes** are struck by percussion to remove the mass of material on the faces of the biface. Early stage thinning flakes are percussion struck, generally with somewhat blocky morphology and low dorsal scar pattern complexity. Early stage thinning flakes generally are indicative of Stage 2 and early Stage 3 biface reduction.
>
> **Late stage thinning flakes** are struck by percussion to regularize the cross-section profiles of the biface. They reduce mass less than early stage thinning flakes. They generally are thinner and more even in longitudinal section than early stage thinning flakes, and can have more complex dorsal and platform scar patterns. Late stage thinning flakes are generally indicative of late Stage 3 and Stage 4 biface reduction.

Pressure flakes are removed by pressure and so generally have diffuse bulbs of percussion and less pronounced platforms. Notch flakes form a specific subtype, consisting of pressure removals to form the basal notches of eared projectile points. Pressure flakes generally are indicative of late Stage 4 and Stage 5 biface reduction.

Other biface reduction flakes include margin removal flakes that remove the edge of a biface accidentally, and outrepasse (or overstruck) flakes that cross a face to remove a portion of the opposite edge as the termination of the flake. They are not considered good indicators of the biface reduction stage, although outrepasse flakes are at least Stage 2 or later in biface reduction.

Previous typological analyses (Flenniken 1987; Flenniken and Ozbun 1988) have shown a strong relationship between these analytical flake classes and reduction technology. For core reduction, the general flake types listed above serve as the primary analytical data. Further analysis of biface reduction is accomplished using the biface reduction analytical classes.

Most debitage samples examined in technological analysis were quantified using the flake classes described above. Analytical models for these are described below. In addition to debitage samples selected for quantified data collection, some samples from the same proveniences and some from backhoe trenches were analyzed qualitatively. Qualitative technological analysis consists of observation of the same diagnostic flake types as in quantitative analysis, but without tabulation of frequencies. Instead, the ability of the analyst to interpret reduction by general examination of flake types is employed. While less rigorous than quantitative analysis, the technique is rapid. The samples selected for qualitative analysis often came from proveniences not as well sampled by quantitative analysis (especially backhoe trenches), so the qualitative characterizations serve as adjunct data; in some cases, they constitute the only characterization of a sample.

Analytical Models and Interpretive Methods

Although the analytical flake classes described above have strong general linkages to reduction technology, specific reduction sequences and technologies can cause their occurrence to vary. Thus, an important element of any technological analysis is a program of replication. Replication experiments provide controls on the frequencies and types of debitage generated in the production of specific tool forms (Ahler 1989a, 1989b; Callahan 1979; Flenniken 1981, 1985).

Replication requires context, however, so we first examined the Tosawihi assemblages to determine which stone tool forms and reduction technologies should be replicated. Bifaces are the primary tool forms produced at Tosawihi, so most of our replication experiments attempted to reproduce the sizes and shapes of bifaces recovered, using some of the same techniques of blank procurement, platform preparation, and thinning that we observed on the archaeological specimens. Preliminary analysis of both whole and incomplete bifaces indicated a reduction continuum approximating the first five stages of the biface reduction trajectory described by Callahan (1979; cf. Chapter 6). The continuum proceeds from core reduction producing large flake or slab blanks (Stage 1), through edge preparation and initial shaping (Stage 2), primary thinning (Stage 3) and secondary thinning (Stage 4), to final shaping of the biface prior to use or further reduction to produce hafting elements (Stage 5).

Beginning in 1988, we initiated a series of replication experiments that (to date) has resulted in 15 quantitatively analyzed replications and 43 qualitatively analyzed ones, all produced on Tosawihi opalite. The replications began with the production of large Stage 1 flake

blanks, by reducing large angular opalite boulders recently quarried from a bulldozer cut at the east edge of the quarries. Reduction Stages 2 through 4 were replicated, in turn, as raw or heat-treated opalite flake blanks were reduced. Archaeological evidence of heat-treatment is common in certain contexts at Tosawihi, and appears to have been a significant step in biface reduction. Heat-treatment increases the compliance of silicious toolstone. Because heat-treatment occurs in different biface reduction stages in the archaeological assemblages (cf. Chapter 6), samples of experimental bifaces from each stage were heat-treated regardless of whether the knapper perceived a need for it. Heat-treatment was conducted in the laboratory using an electric deep fryer and pyrometer. Specimens were bedded in silty sand to facilitate an even radiance of heat and subsequent cooling. Experiments using different durations of exposure to heat and various maximum temperatures revealed that gradual heating to a maximum temperature of between 210 and 232 degrees produces successful heat-treatment of Tosawihi opalite.

Fifteen replications comprise the quantitatively analyzed experimental data set; Table 86 lists comparative data for every replication within the analytical data set. Replications were conducted sporadically over the course of two years, but all followed the trajectory of biface reduction suggested above. Two methods were employed most often. During the earliest experiments, size data were recorded at the beginning and end of each replication, debitage was collected only at the end of the replication, and notes on various aspects of knapping technique and compliance of the toolstone were taken. Throughout later replications, under better controlled circumstances, size data were recorded at the beginning of each stage of reduction and at the end of the continuum. Debitage was collected after each stage of reduction, and was kept separate for subsequent analysis. Knappers recorded the time used to complete each stage, compiled technical notes, and commented on toolstone compliance.

Table 86. Comparative Data on Replications Used in Quantitative Technological Analysis.

Specimen ID	Treated	Reduction Stages	EP/EBT	INT/EBT
1/1	No	Core reduction	5.08	6.62
51/1	No	Stages 1 to 3	0.79	0.30
55/1	Yes	Stages 1 to 3.4	0.35	0.25
none	No	Stages 1 to 3.6	1.20	2.58
16/1	No	Stages 1 to 3.7	0.88	0.47
19/1	No	Stages 1 to 3.7	0.47	1.05
52/1	Yes	Stages 1 to 3.7	0.21	0.01
54/1	No	Stages 1 to 3.8	0.46	0.13
56/2	Yes	Stages 1 to 4.5	0.19	0.09
none	No	Stage 2	0.53	1.11
none	Yes	Stages 2 to 4.5	0.39	0.11
30/1	No	Stages 2.5 to 3.7	0.68	0.05
none	No	Stages 3 to 4.5	0.06	0.18
51/2	Yes	Stages 3 to 4.9	0.18	0.26
52/2	Yes	Stages 3.7 to 6	0.10	0.00

EP/EBT = Ratio of edge preparation to early biface thinning flakes
INT/EBT = Ratio of interior to early biface thinning flakes

The resulting debitage was analyzed using the technological and mass analysis techniques described above. We then examined the relative ratios and proportions of debitage types to see if they usefully reflected core reduction, biface reduction, and the stages of biface reduction that we employed in analysis of the Tosawihi biface collection (cf. Chapter 6). Determination of core reduction is relatively straightforward, since core reduction assemblages contain mostly primary decortication flakes, secondary decortication flakes, and interior flakes with few flakes exhibiting the morphology of biface thinning flakes. As well, core reduction assemblages have high frequencies of shatter.

Determining biface reduction stages on the basis of technological analysis is less straightforward. Each biface reduction flake class has a relatively ordinal place in the overall production scheme; as reduction continues through the trajectory from flake blank production (Stage 1) to final shaping (Stage 5), the relative proportions of each flake type vary. High proportions of a flake class reflect the stage(s) of biface reduction most likely to produce it. Relative proportions of the flake types were graphed as cumulative curves or ogives (Blalock 1979); the ogive indicates the contribution of each flake type to the analyzed assemblage. Specific patterns of ogives indicate predominance of a generally early (Stage 1 to 3.3) or late (Stage 3.4 to 5.0) stage of biface reduction (Figure 71a).

The Kolmogorov-Smirnov two sample test (Blalock 1979) was applied to compare the cumulative proportions of flake types generated by biface reduction replications, to test whether distinctions among cumulative graphs were statistically significant, and to test for significance among replication curves that were not obviously distinct. At the 0.05 probability level, Kolmogorov-Smirnov tests distinguished early from late stage experimental biface reductions in only 60% of the replicated assemblages. The tests were not run again at lower confidence levels because both early and late stage debitage assemblages apparently can produce ogives of similar shape that the Kolmogorov-Smirnov test cannot separate. For example, in one case a replication beginning at Stage 1 and ending approximately middle Stage 3 biface was compared to a replication beginning early in Stage 3 and ending late in Stage 4. The Kolmogorov-Smirnov test did not distinguish between the two, possibly because the proportions of interior flakes were similar and the cumulative proportions of early biface thinning flakes were similar. By considering all classes of equal importance, the Kolmogorv-Smirnov test ignored what turns out to be an important difference in the ratios of edge preparation flakes to early biface thinning flakes (denoted as the EP/EBT ratio). The early stage replication had an EP/EBT ratio of 0.35, and the late stage replication had a ratio of 0.18.

The two gross characterizations of biface reduction stages, "early" and "late," are segregated better by ratios than by Kolmogorov-Smirnov tests (Figure 71b). Ratios of edge preparation (EP) to early biface thinning (EBT) flakes have a bimodal distribution that matches early and late stage biface reduction. The EP/EBT ratios for experimental reductions that include early stages are generally greater than 0.35. This pattern is reflected in 84% of the replications, and all the cases that do not fit this pattern have been heat-treated. Heat-treatment increases the number of successful removals resulting in distinctive biface thinning flakes rather than edge preparation or interior flakes. To a lesser extent, idiosyncratic variation in knapping technique and variation in flake blank proportions probably also account for some of the assemblages that do not follow this pattern.

A second useful measure is the ratio of interior (INT) flakes to early biface thinning flakes (denoted as the INT/EBT ratio). It is a less consistent separator of early and late stages of biface reduction, because interior flakes can be generated during later stages of reduction (though usually in low frequencies), and their creation depends in part on the technical preferences of individual knappers. Bimodal patterning is not as apparent as EP/EBT ratios (Figure 71b), but low INT/EBT values generally correlate with later stages of reduction.

We used both EP/EBT and INT/EBT ratios to discover whether early or late stage biface reduction is evident in archaeological samples. A third, cross-cutting, measure of reduction activities in archaeological samples is the ratio of heat-altered to unaltered debitage. In the archaeological biface assemblage, the proportion of heat-altered specimens correlates positively with increasing reduction stage (cf. Chapter 6). So, the proportion of heat-altered debitage is an indirect measure of biface reduction stages represented in a sample. Since all debitage resulting from a heat-altered biface will exhibit heat-alteration, separate INT/EBT and EP/EBT ratios were calculated for heat-altered and unaltered portions of the debitage samples, as well as for overall heat-altered proportions of debitage in the sample as a whole.

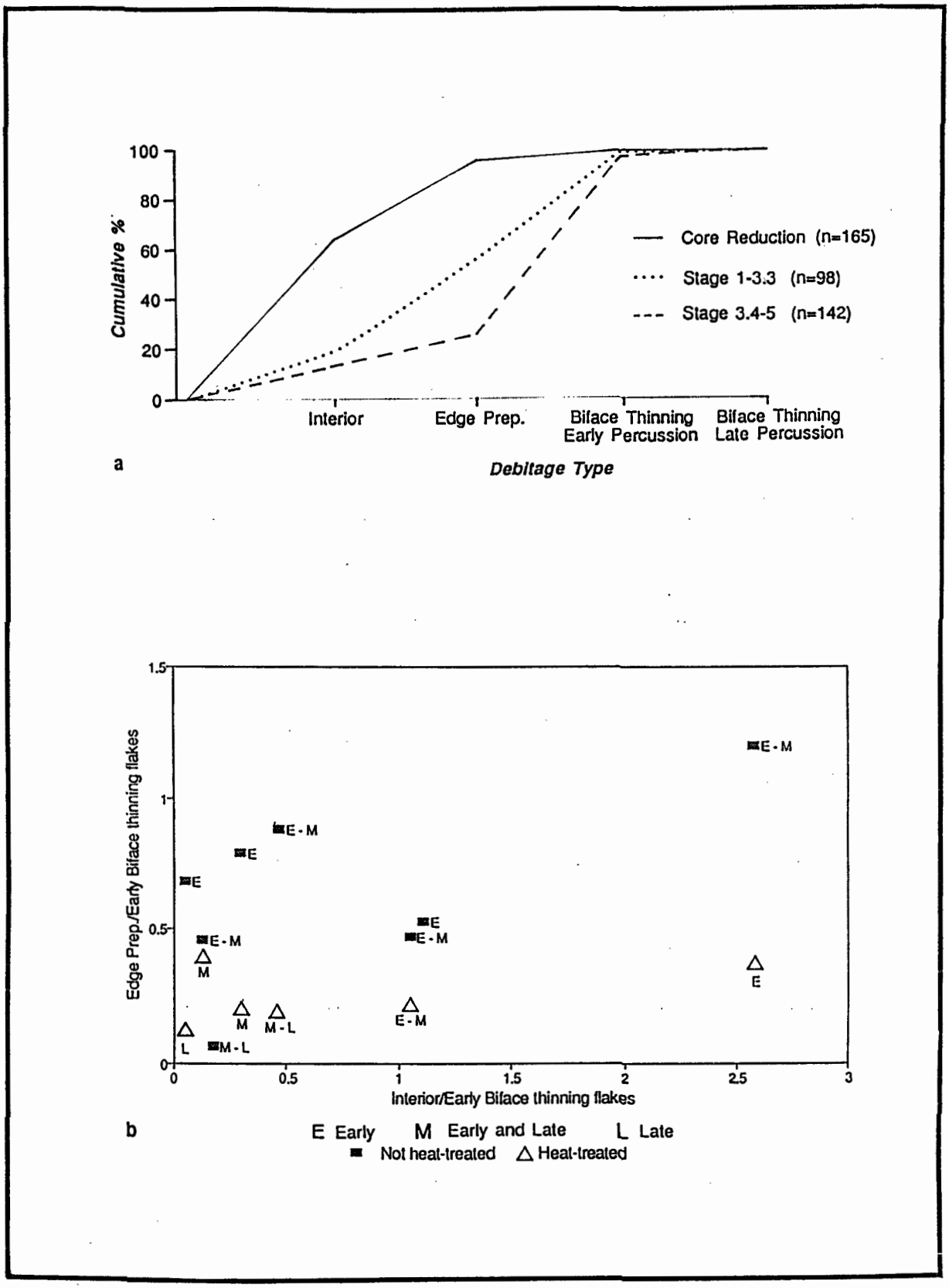


Figure 71. a. Cumulative proportions of flake types, quantitatively analyzed biface replications; b. EP/EBT vs. INT/EBT values for quantitatively analyzed experimental biface replications. Stages are indicated adjacent symbols, heat-treated cases are shaded.

Analytical Results

Mass Analysis of Archaeological Samples

Five thousand four hundred thirty-one debitage samples were recovered. Screened surface scrapes and excavations contributed the majority of these assemblages, from 2724 locations. Four hundred thirteen additional samples were collected from stratigraphic units in trench walls. The results presented here reflect composite site samples, composite feature samples, and trench wall samples, discussed by general geographic area. Cases having fewer than 50 flakes were excluded from sample classification, since below this threshold a single error in counting or size-grading would result in a 4% or greater error in proportions. Samples lacking flakes in the G3 size-grade also were excluded from classification, since G3 values were used as denominators in the discriminant functions. Variation in finer-grained provenience units is discussed for only a few cases. Not all obsidian samples were subjected to mass analysis, and of those that were, many are too small to characterize reliably; consequently, obsidian mass analysis results are not discussed here.

Characterization of Site Samples

The data used to characterize reduction within discrete sites and localities are compilations of all feature and non-feature samples. The compiled data were classified using the discriminant procedures described above. Further analysis of the classifications of sites was undertaken to examine whether different raw materials were reduced in different ways among the four geographical subareas of investigation. Table 1 in Appendix I summarizes characterizations of composite site samples.

Opalite reduction follows a regular pattern (Table 87). Opalite occurs naturally in and around the Quarry and in some parts of the Eastern and Western Peripheries. The seven localities in the Quarry are dominated by core reduction debitage samples. Early stage biface reduction dominates the Eastern and Western Peripheries, but core reduction is present in over a quarter of the composite site samples. In the Northern Corridor, mixed stage biface reduction characterizes most sites. These results are at least intuitively sensible, in that distance from opalite sources generally is reflected in site samples: close to sources, the mass analysis characteristics of composite samples indicate core reduction. Within a few kilometers of opalite sources, at non-quarry sites in the Eastern and Western Peripheries, early stage biface reduction prevails. Finally, at an even greater distance from raw material, a full range of biface reduction is evident.

Table 87. Mass Analysis Composite Site Sample Characterizations by Geographic Area.

Material	Characterization	Geographic Area North	East	West	Quarry	Total
Opalite	Core reduction	0	10	5	7	22
	Early stage biface	2	20	13	0	35
	Early and late biface	5	7	1	0	13
Jasper	Core reduction	0	3	1	0	4
	Early stage biface	1	1	2	0	4
	Early and late biface	1	0	4	0	5
Basalt	Core reduction	0	0	3	0	3
Other	Early stage biface	0	0	1	1	2
	Early and late biface	1	0	0	0	1

The use of jasper (Table 87), which outcrops in the West, differs from that of opalite. Most known sources of jasper lie in the Western Periphery, yet the seven sites in this area are dominated by mixed stage biface reduction and some early stage biface reduction. Farther from jasper sources, in the Eastern Periphery, three of four site samples containing jasper reflect core reduction. No localities in the Quarry contained jasper debitage samples with more than 50 flakes. In the Northern Corridor, the two sites with jasper samples are split evenly between early and mixed stage biface reduction. The latter distribution suggests that jasper may have been used differently from opalite, insofar as it was transported as cores, rather than bifaces, to the Eastern Periphery.

Basalt (Table 87) occurs naturally in the West, and the three sites yielding basalt samples are all in this subarea; each reflects as core reduction.

Miscellaneous, non-local raw materials were collected in frequencies greater than 50 from only three sites; as a group, they reflect biface reduction (Table 87).

Characterization of Feature Samples

The site characterizations presented above yield generally simple patterns. However, most sites or localities contain discrete individual features. Since there is every reason to consider site samples as the result of many visits to the same place over time, it is instructive to break down the monolithic site sample characterizations into their component features, and examine variation in feature debitage sample characterizations. This, of course assumes that features have some integrity or a high degree of repetitive use, so that samples provide a characterization that is meaningful. Composite samples from surface scrape units and excavation units were compiled for each feature, and mass analysis results from all non-feature surface scrape and excavation units were compiled into a single non-feature ("Feature 0") sample. The results are presented in Table 2, Appendix I. Only opalite raw materials are discussed here, since very few features or sites contain the other four materials, and at the feature sample level, virtually never in numbers exceeding 50.

The pattern of opalite reduction observed above in the overall site samples is more complicated at the feature level (Table 88). As Table 88 shows, the relationship between geographic areas and reduction type characterizations is not independent, nor is it easy to summarize on the basis of frequency alone. Everitt (1977) suggests the use of standardized adjusted chi-square residuals to isolate significant dependencies in cross-tabulations, and we rely on the technique here. In essence, this simple technique examines the probability of obtaining a particular chi-square residual; the standardized adjusted residual is a z-score, so probability can be directly equated with it. Thus, the cells with asterisks next to the standardized adjusted residuals in Table 88 have z-scores greater than 1.96 or less than 1.96, and so have associated probabilities of less than 0.05. These are the most significant cells in the matrix.

Table 88. Mass Analysis Composite Feature Sample Characterizations by Geographic Area. (Opalite samples only)

Material	Characterization	Geographic Area North	East	West	Quarry	Total
Opalite	Core reduction	0	24	8	8	40
	adjusted std. resid.	*-2.3	*2.3	*-2.9	*3.8	
	Early stage biface	3	32	36	2	73
	adjusted std. resid.	*-2.1	-0.2	*2.5	*-2.0	
	Late stage biface	1	0	0	0	1
	adjusted std. resid.	*3.2	-0.9	-0.8	-0.3	
	Early and late biface	9	9	13	0	31
	adjusted std. resid.	*4.4	*-2.0	0.3	*-1.7	

*Adjusted standardized residuals with p<.05

The use of opalite in the Northern Corridor is dominated by higher than expected frequencies of late stage biface and mixed stage biface feature samples. At the same time, core reduction and early stage biface reduction is much less frequent than would be expected in a chi-square model.

In the Eastern Periphery, opalite debitage samples grouped at the site level were characterized as predominantly early stage biface reduction. At the feature sample level, the use of opalite is revealed to be much more variable. Features with core reduction samples are much more frequent and those with mixed biface reduction samples are much less frequent than would be expected in a chi-square model.

The Western Periphery, characterized at the composite site sample level as similar to the Eastern Periphery, is quite different from it at the feature sample level. There are significantly fewer feature samples characterized as core reduction, and many more characterized as early stage biface reduction, than would be expected.

Characterization of localities within the Quarry does not change much when samples at the feature level are examined. As would be expected, core reduction is the predominant activity in Quarry features.

In summary, examination of the opalite composite feature samples shows a much more complex pattern of opalite use than revealed when debitage is compiled into overall site samples. While the general patterns indicated by the site level of analysis still hold, the Eastern and Western Peripheries are not as similar to each other when considered as aggregations of features.

Characterization of Quarry Feature Strata

Trenching of quarry pits often revealed well-stratified deposits containing lenses of debitage. These lenses tend to exhibit a regular pattern of variation, with generally smaller items at the edges of the feature, and large pieces of debitage in the center (usually its lowest point). The assumption employed above was that features provide a meaningful grouping for samples. Yet, analysis of samples drawn from distinct stratigraphic lenses of debitage in quarry pits lends only partial support to this notion, since within any given quarry feature there sometimes is variation in the mass analysis characterizations of different strata. Table 3, Appendix I presents characterizations of stratigraphically recovered debitage samples from the trenched features at several sites. Samples of the same material type from the same stratum and feature are lateral samples along the face of the trench.

In general, core reduction is the predominant characterization of all trench strata samples. Variation in the location of reduction activities around quarry pits, often quite evident visually within a single stratum, is detected by mass analysis in only some cases. For example, in Stratum 2 of Feature 1 at 26Ek3170, three opalite samples are characterized as core reduction and one sample as mixed stage biface reduction. The latter sample is from the edge of the quarry pit, the others, closer to its center. Other examples include the opalite samples from Stratum 2 of Feature 2 at 26Ek3171, where the four samples closest to the center of the feature are characterized as core reduction, and a fifth sample away from the center is characterized as early stage biface reduction. As discussed above, mass analysis in many ways is a gross characterization of debitage samples. Yet, the results of strata characterization show that this technique is capable of detecting fairly detailed variation within a single stratum. Variation between strata, or vertical variation, is evident as well. For example, in Feature 2 at 26Ek3195 many strata are characterized differently by mass analysis. This could owe to earlier quarrying in adjacent features, with post-quarrying reduction occurring in the (then) unused Feature 2 (cf. Chapter 22).

Discussion

Mass analysis of composite site and feature samples revealed patterns in chipped stone reduction at two levels. At the composite site sample level, it is evident that with greater distance from natural sources of opalite, chipped stone reduction is increasingly late in stage, and is predominantly bifacial. Basalt exhibits this pattern as does jasper, although there also is indication of reduction of jasper cores away from source areas. Only opalite seems to have been transported extensively in the Tosawihi vicinity, since the frequencies of jasper and basalt are quite low in the Northern Corridor. Nonetheless, basalt and jasper may have been important sources for expedient tools (cf. Chapter 8).

At the composite feature sample level, much more variation is evident in the use of raw opalite. The role of site setting becomes important, since those sites with feature samples characterized as core reduction outside of the Quarry are on or very close to opalite sources as well. The general tendency is for feature samples from the Eastern and Western Peripheries to be distinct: in the East, the portion of the reduction spectrum represented is earlier than that in the West. This is due largely to the presence of opalite quarries in the East; when samples associated with quarry pit features are removed from the comparison, the two areas are substantially similar. Mass analysis clearly shows samples from features in the Northern Corridor to be different from all other areas. Features in the North area are primarily lithic scatters, mostly characterized as late stage biface reduction or mixed biface reduction. Very few early stage biface reduction, and no core reduction, debitage samples were recovered from the Northern Corridor.

Mass analysis supports the field observation that bifaces were the primary product produced at and around the Tosawihi Quarries. Over half the composite site and composite feature samples of opalite debitage are characterized as biface reduction, even though core size and morphology can influence mass analysis results.

Mass analysis can be used to estimate the number of bifaces and cores produced to create the debitage sample as a whole. The average weight of debitage produced in experimental replications of biface production from Stages 1 to 3.5 is 1330 grams. The average weight of debitage produced in Stage 3.5 to later stage reduction is 1082 grams. Since analysis of the Tosawihi bifaces (cf. Chapter 6) shows that the majority of opalite biface reduction occurs up to Stage 3 and not beyond, the 1330 gram average can be used to estimate the number of bifaces that could have been produced in the sampled features. For each feature sample, the areal proportion of the feature scraped or tested was used to estimate the total mass of debitage in the feature. This estimate was then divided by the 1330 gram average to yield a very rough approximation of the number of bifaces produced within a feature (cf. Table 2, Appendix I). This calculation assumes that the estimated total weight of debris is entirely biface reduction debitage. This assumption probably is not true, skewing upward the estimated number of bifaces produced. However, subsurface volumes of debitage are not included in the estimated debitage weights and, since many of the features are fairly deep, the estimated number of bifaces probably is much too low. This latter factor almost certainly is more influential than the former, so the estimated number of bifaces actually is conservative.

Table 89 summarizes the estimated number of opalite bifaces for each feature type. The estimated total number of opalite bifaces from all sampled features (n=123) excluding non-feature contexts is 28,913. Since 378 features (of all kinds) were recorded at the Tosawihi sites discussed here, the sampled features constitute only about one-third of the total feature population. Extending the estimated number of opalite bifaces produced across all of these features yields nearly 89,000 bifaces. While this is only a very rough estimate (and probably is conservative), it gives some picture of the scale of quarrying and reduction activities in and around Tosawihi quarries.

Table 89. Summary of Estimated Opalite Biface Frequencies by Feature Type, for Features Having Known Percentages Sampled.

Feature Type	Estimated No. of Bifaces	n of cases
Quarry	11,600	14
Reduction locus	1,002	58
Unknown type	14,002	36
Other	2,309	15
Total	28,913	123

Technological Analysis of Archaeological Samples

Technological analysis was employed as a technique secondary to and supportive of mass debitage analysis, but not all debitage samples could be analyzed. Even though typological analysis is the least time consuming form of technological analysis, time limitations necessitated the analysis of only a few specific contexts. Field records from the testing and data recovery programs, as well as personal recollection, were employed in the selection of samples. One aim of our sample selection was to discover the range of reduction present in the Tosawihi vicinity. Investigation of the degree of redundancy among debitage samples was another important goal, so samples were chosen that seemed to illustrate this issue as well. A third target of sample selection was the association of debitage assemblages with evidence of other activities (e.g., hearth use), and samples were drawn subjectively from appropriate settings.

Discrete lithic scatters formed the primary contexts for sampling; these had been designated *reduction features* during fieldwork. Sample proportions varied with feature size and inferred complexity. Generally, the majority of samples from most reduction features were collected from surface scraped 1 x 1 meter units. At most such features the upper two centimeters of deposit contain almost all of the debitage, so surface scrapes should provide a comprehensive sample of the debitage assemblage.

Trench samples are debitage samples collected from distinct strata in profiled walls of backhoe or hand-excavated trenches. Trenching was employed to investigate the subsurface structure of quarry pits and debitage deposits adjacent outcrop quarries (cf. Chapter 16, Chapter 17). Four trenched quarry features were chosen for technological debitage analysis; two quarry pits from the Eastern Periphery (26Ek3032/Locality 23 and 26Ek3200) and two outcrop quarries from the Western Periphery (26Ek3084 and 26Ek3208) were selected. These offered the clearest and most distinctive stratigraphy for sampling.

Qualitative technological analysis was employed primarily to characterize the large quantities of debitage recovered from trench strata; quantitative analysis examined single localities in greater detail. The goals of analysis were to identify the reduction activities which created the sampled strata and to examine patterns within strata relative to their position in the quarry feature. To this end, we selected from various stratigraphic contexts in quarry pit bottoms, the inward pit slope, the pit berm, and the outer berm slopes. We expected distinct assemblage characteristics to be evident in each of these settings, even within the same stratum, because of our assumptions about the use of space around quarry features (cf. Chapter 3, Chapter 22; Jones and White 1988). In brief, we expected that debitage in pit bottoms should consist primarily of angular quarry debris and tuff resulting from the quarrying of opalite. The inward pit slope was expected to be a complex mixture of primary quarrying debris tossed up on the slope, primary core reduction debris, and, perhaps,

later reduction debris. The latter two could have been generated on the pit slope itself, or could have slumped onto the inward pit slope from the top of the berm. Slumping of berm deposits into a small pit also could cause the pit bottom to appear similar to the pit berm. Since the berm and outward berm slopes are the most level and generally comfortable places around a quarry pit, we expected that a considerable amount of actual core and biface reduction would have occurred in these settings (cf. Binford and O'Connell 1984; Jones and White 1988:76-77). At outcrop quarries we expected the same general patterns, but with fewer constraints, since outcrop topography may not place equal restrictions on physical activity.

The results of technological analysis presented below proceed from a discussion of debitage resulting from quarrying and early stages of biface reduction in quarry-related contexts, then tracks the continuum of reduction activities across the East, West, and North subareas.

Quarry Pits and Outcrop Quarries

In the following discussions, the reader should assume the presence of debitage from quarrying unless its absence has been noted specifically. Quarrying debris is quite common, characterized by shattered tuff, shattered toolstone, fragmentary flakes, and low proportions of interior flakes. A greater proportion of interior flakes, especially those with prepared platforms, was considered indicative of core reduction. The flake types indicative of all other stages of reduction reflect those presented above in the discussion of the reduction models.

Quarry Pit, 26Ek3032/Locality 23. Locality 23 is a relatively large feature with two adjacent pits on the southeastern margin of 26Ek3032 and at the northwestern edge of 26Ek3170 (cf. Chapter 17). A trench was cut through the middle of the principal pit, exposing 43 strata along the south wall (cf. Figure 156). Structures visible in the profile include pits excavated through colluvium and into bedrock, the pit berm, and the inward and outward slopes of the berm. Thirty-four samples were collected from 29 strata dominated by debitage; they span the range of variation in stratum composition perceived in the field.

Toolstone quality varies from poor quality opal and poorly silicified tuff to good opalite. The best material appears to be somewhat brittle, resembling more the jasper from other locales. Opalite color varies from white through pink, blue, and purple; much of the best quality material is mottled and variegated. Debitage from bifacial thinning often occurs as the better quality mottled or white opalite. Quarry debris more often is white or pink opalite and poorly silicified tuff.

Many of the debitage samples are too small or only minimally sufficient for interpretation by qualitative analysis. Interpretation of the larger samples was less problematic.

Most of the analyzed samples resulted from quarrying and core reduction (Table 90). Of the 27 interpreted samples, 16 (59%) exhibit definite evidence of Stage 2 biface reduction, while six (22%) contain debitage indicative of blank preparation (the removal of major irregularities from a flake blank). Blank preparation thus overlaps early Stage 2 reduction, but does not extend to edge preparation for primary thinning. It usually reflects the reduction of large irregular flake blanks, and often comprises the first step in Stage 2 reduction of such blanks.

Table 90. Qualitative Technological Analysis Characterizations of Trench Strata Samples from 26Ek3032, Locality 23.

Reference-Specimen No.	Trench Number	Stratigraphic Unit	TECHNOLOGICAL CHARACTERIZATION Core Reduction	Blank Prep.	Stage 2 Biface Red.	Stage 3 Biface Red.
2599 74	Trench 1	1	-	-	++	++
2599 280	Trench 1	1	++	-	++	-
2599 86	Trench 1	1	++	++	+	-
2599 69	Trench 1	5	+	+	++	++
2599 70	Trench 1	6	+	+	++	++
2599 71	Trench 1	7	-	-	-	-
2599 73	Trench 1	8	-	+	++	++
2599 72	Trench 1	10	-	-	-	-
2599 75	Trench 1	11	-	++	++	-
2599 77	Trench 1	12	++	++	+	+
2599 76	Trench 1	13	+	-	+	-
2599 78	Trench 1	14	++	-	++	+
2599 102	Trench 1	17	++	+	-	-
2599 103	Trench 1	19	++	-	-	-
2599 104	Trench 1	21	+	-	-	-
2599 85	Trench 1	23	++	-	-	-
2599 83	Trench 1	24	++	-	+	-
2599 105	Trench 1	25	-	-	-	-
2599 101	Trench 1	26	++	-	+	-
2599 82	Trench 1	28	++	++	++	-
2599 79	Trench 1	30	-	++	++	-
2599 81	Trench 1	31	+	-	+	+
2599 106	Trench 1	32	-	-	-	-
2599 97	Trench 1	33	+	-	-	-
2599 92	Trench 1	35	++	++	++	++
2599 87	Trench 1	36	++	-	+	-
2599 91	Trench 1	36	-	-	-	-
2599 94	Trench 1	36	++	-	++	++
2599 88	Trench 1	38	++	-	-	-
2599 95	Trench 1	38	++	-	+	-
2599 90	Trench 1	40	++	++	++	-
2599 89	Trench 1	41	++	-	+	-
2599 96	Trench 1	42	-	-	-	-
2599 93	Trench 1	43	-	-	-	-

\+ reduction type present in minor amounts
++ reduction type present in major amounts

Stage 3 biface reduction is evident in seven samples (25%). Most of the evidence for Stage 3 reduction occurs on the pit berm or on the outer berm surfaces. Some Stage 3 reduction is evident in the pit bottom and inward slopes, but only in strata that appear to have slumped inward from the berm. Stratum 14 may contain *in situ* deposits of debitage indicative of Stage 3 reduction in the very bottom of the pit. It is noteworthy that before the Stratum 14/Stratum 15 contact was buried, the pit bottom would have been fairly flat with gently sloping sides (cf. Figure 156).

In addition to the backhoe trench, three separate 1x1 m units were surface scraped in concentrations of debitage (cf. Figure 155. Unit 1 was placed on the berm of the quarry pit, Unit 2 centered on a reduction locus approximately 10 m northwest of the pit, and Unit 3 was placed at the center of a third concentration approximately 10 m northeast. The northwest quadrant of each unit was screened through 1/8 in. mesh, while the remainder was screened through 1/4 in. mesh. The debitage from each unit was analyzed quantitatively.

Unit 1 sampled a concentration of debitage on the pit berm. The sample is comprised overwhelmingly of large, non-heat-treated interior flakes indicating core reduction (Figure 72a, Table 91). Some early stage reduction of large flake blanks is indicated by the presence of edge preparation flakes and early stage biface thinning flakes (Figure 72a). In light of our data from replicated core reduction assemblages, the high frequencies of flake fragments and shatter are further indication that core reduction was the primary reduction activity occurring on the berm of the pit.

Table 91. Quantitative Technological Analysis Results and Data from 26Ek3032, Locality 23 Samples.

Unit	Feature/ Locus	Feature Type	Character-ization	Non-heat-treated EP/EBT	Non-heat-treated INT/EBT	Heat-treated EP/EBT	Heat-treated INT/EBT	% heat-treated	sample n
All	F1	Quarry pit	ESB	0.16	0.76	0.17	0.33	4.0	224
1	F1	Quarry & Reduction	Core red. & ESB	0.25	2.40	0	0	3.3	30
2	F1	Reduction	ESB	0.04	0.45	0.20	0.20	5.3	131
3	F1	Reduction	ESB	0.57	1.40	0	0	1.6	63

Characterizations: Core red. = Core reduction; ESB = Early biface

EP/EBT = Ratio of edge preparation to early biface thinning flakes
INT/EBT = Ratio of interior to early biface thinning flakes

Unit 2 was placed to sample a distinct debitage concentration within the general out-of-pit scatter; we wanted to investigate the diversity of reduction occurring close to the pit. The quantitative data indicate an early biface reduction assemblage (Figure 72b, Table 91). A high proportion of interior flakes indicates that core reduction or the reduction of large irregular flake blanks contributed importantly to the sample, and that biface production extended from Stage 1 to approximately early Stage 3. This sample reflects the latest stage of biface production evident near the pit.

Unit 3 sampled another concentration of obvious, but less discrete biface reduction activity. It reflects very early biface reduction, probably initiated on large irregular flake blanks, and perhaps some core reduction (Figure 72c, Table 91).

Together, the three units exhibit the same diversity of stone reduction found in qualitative analysis of debitage recovered from the quarry pit strata. Predominant reduction activity shifts from core reduction near the pit to increased early stage biface reduction away from it. There is no evidence in either trench strata or surface scrapes of systematic heat-treatment of opalite. The very few heat-treated flakes recovered in each of the three surface samples (Table 91) probably resulted from lithic reduction associated with activities other than quarrying, or from initial quarry processing of opalite.

Quarry Pit, 26Ek3200. 26Ek3200 is located at the eastern margin of the Eastern Periphery and contains a single quarry pit (cf. Chapter 17). During testing, one east/west trench was excavated to investigate the quarry pit deposits (Elston 1989). The south wall was profiled and 17 debitage samples were collected, comprising most of the strata. Eight additional samples were collected later, but, due to slumping of the walls, their relationship to the profiled stratigraphic units is problematic and their proveniences, at best, are approximations. Six samples from each of the two sample sets were subjected to qualitative technological analysis (Table 92). They were selected to reflect variation in the spatial arrangement of reduction activities relative to the subsurface structure of the quarry pit (cf. Figure 165).

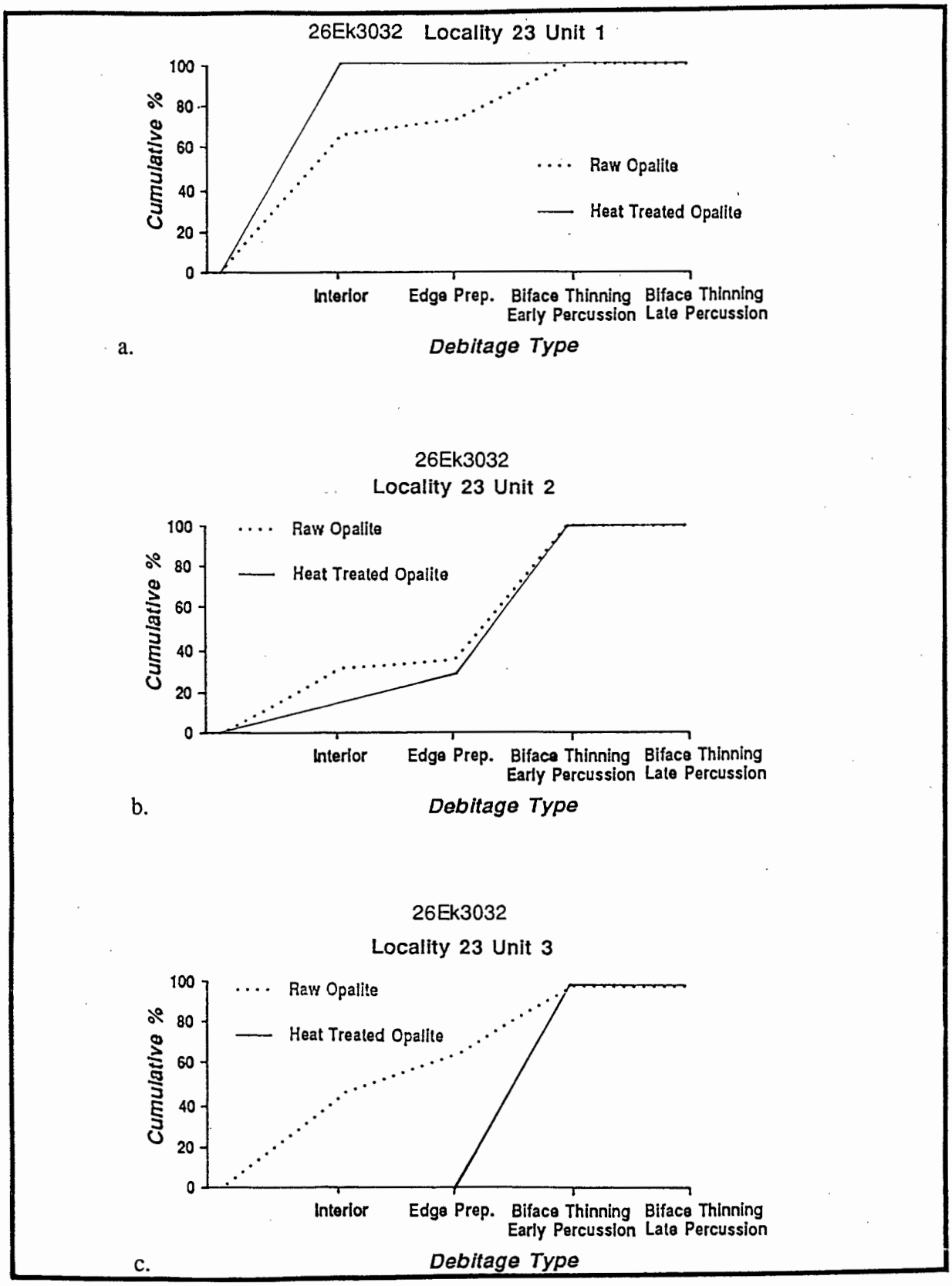


Figure 72. Ogives of diagnostic flake types, 26Ek3032, Locality 23.

Table 92. Qualitative Technological Analysis Characterizations of Trench Strata Samples, Trench 1, 26Ek3200.

Reference-Specimen No.		Trench Number	Stratigraphic Unit	TECHNOLOGICAL CHARACTERIZATION Core Reduction	Blank Prep.	Stage 2 Biface Red.	Stage 3 Biface Red.
636	8	Trench 1	11	++	++	-	-
636	12	Trench 1	6	+	-	+	-
636	13	Trench 1	6	-	-	++	+
636	15	Trench 1	3	-	-	++	++
636	16	Trench 1	2	++	-	++	-
636	17	Trench 1	1	-	-	++	-
2599	136	Trench 1	3	+	-	-	-
2599	141	Trench 1	4	+	-	+	-
2599	137	Trench 1	6	+	-	-	-
2599	138	Trench 1	6	+	-	+	-
2599	139	Trench 1	13	++	-	++	-
2599	140	Trench 1	16	++	-	++	-

\+ reduction type present in minor amounts
++ reduction type present in major amounts

Toolstone quality in the analyzed debitage is variable, ranging from pink/white poorly silicified opal-like material to white, white/pink, and white/blue well-silicified material. The well-silicified material may have occurred in small pockets within a poorly silicified matrix. Much of the quarry debris reflects the breakup of this poor opalite and tuff to gain access to better toolstone. Once good quality material was attained, it was reduced to late Stage 2 and early Stage 3 bifaces at the pit; even some of the poorer material was reduced to Stage 3 bifaces.

Stage 3 reduction debitage *in situ* in Stratum 3 (Table 92, Sample #15) at the bottom of the pit indicates some indifference to the location of early primary thinning. In fact, Stage 3 reduction is represented clearly only in the lower strata. Most other strata contain evidence of core reduction and Stage 2 biface reduction. Sample 13 from Stratum 6 may have slumped into the pit from higher on the berm, but the debitage in Sample 15 from Stratum 3 formed a mound in the pit bottom, undoubtedly in primary depositional context.

Outcrop Quarry, 26Ek3208. 26Ek3208 is located in the eastern part of the Western Periphery (cf. Chapter 16). It contains a large outcrop of excellent quality white and bluish white opalite. The base of the outcrop is surrounded by an apron of quarry waste and debitage two to four m deep and over approximately 45 sq. m. Three backhoe trenches were excavated into this apron perpendicular to the face of the outcrop (cf. Figures 103, 104, 105, 108). These give a merely adequate window into this huge deposit of debitage. Each stratum is a complex mixture of *in situ* reduction debris, redeposition from prehistoric excavation into older debitage deposits, and natural redeposition on the sloping surfaces of the strata. Although the strata undoubtedly are complex in origin, and the three trenches have not been linked directly to each other stratigraphically, general technological patterns can be discerned.

Trench 1 consists of 48 sampled lenses, each of which was analyzed qualitatively (Table 93). As in all quarry localities, debris from extraction of toolstone from bedrock is common. Aside from toolstone extraction, forty (83%) of the sampled lenses indicate core reduction as the predominant reduction activity, and 94% of the samples exhibit some evidence of core reduction. Blank preparation is apparent in 83% of the samples, occurring without core reduction in only three samples. Stage 2 biface reduction is evident in 52% of the sampled lenses, and always appears in association with core reduction or blank preparation. Stage 2 biface reduction occurs in all topographic contexts: in the bottom of the quarry pit, on the inward pit slope (though slump from the top of the slope may have created this association), and on the berm and flat margins above the pit. Stage 3 biface reduction is an important component of only one debitage sample, from Stratum 18. Other evidence of Stage 3 biface reduction occurs chiefly on the back slope of the berm or in the pit near the present surface.

Table 93. Qualitative Technological Analysis Characterizations of Trench Strata Samples, 26Ek3208, Feature 3.

Reference-Specimen No.		Trench Number	Stratigraphic Unit	TECHNOLOGICAL CHARACTERIZATION Core Reduction	Blank Prep.	Stage 2 Biface Red.	Stage 3 Biface Red.
2599	199	Trench 1	3	++	++	+	-
2599	200	Trench 1	4	++	++	++	-
2599	192	Trench 1	4	++	-	++	+
2599	188	Trench 1	12	++	++	++	+
2599	174	Trench 1	18	++	+	-	+
2599	175	Trench 1	17	++	++	-	-
2599	156	Trench 1	23	++	++	++	-
2599	155	Trench 1	24	++	-	-	-
2599	163	Trench 1	25	-	++	-	-
2599	165	Trench 1	24	++	++	++	-
2599	164	Trench 1	26	++	++	++	-
2599	171	Trench 1	26	++	+	-	-
2599	168	Trench 1	27	++	++	-	-
2599	167	Trench 1	29	++	++	+	-
2599	189	Trench 1	29	++	++	++	-
2599	166	Trench 1	30	++	++	+	-
2599	191	Trench 1	31	++	+	-	-
2599	169	Trench 1	31	++	+	-	-
2599	190	Trench 1	32	++	-	-	-
2599	170	Trench 1	33	++	+	-	-
2599	159	Trench 1	34	++	-	-	-
2599	162	Trench 1	35	++	++	++	-
2599	161	Trench 1	37	++	++	+	-
2599	160	Trench 1	38	++	++	+	-
2599	172	Trench 1	39	++	+	-	-
2599	176	Trench 1	40	++	++	++	-
2599	193	Trench 1	41	++	++	-	-
2599	194	Trench 1	42	++	++	+	-
2599	198	Trench 1	43	-	++	+	-
2599	186	Trench 1	44	++	++	-	-
2599	185	Trench 1	45	++	-	-	-
2599	178	Trench 1	47	+	+	-	-
2599	184	Trench 1	48	++	-	-	-
2599	187	Trench 1	49	++	++	-	-
2599	177	Trench 1	50	++	++	++	-
2599	183	Trench 1	51	++	++	++	-
2599	182	Trench 1	52	++	++	-	-
2599	181	Trench 1	53	++	++	-	-
2599	180	Trench 1	54	++	++	-	-
2599	179	Trench 1	55	++	-	-	-
2599	152	Trench 1	56	++	++	+	-
2599	154	Trench 1	57	++	++	+	-
2599	151	Trench 1	58	++	++	++	-
2599	153	Trench 1	59	++	++	-	-
2599	42	Trench 2	7	++	-	-	-
2599	45	Trench 2	10	++	-	-	-
2599	46	Trench 2	10	++	-	-	-
2599	50	Trench 2	19	++	+	+	-
2599	51	Trench 2	21	++	-	+	-
2599	63	Trench 2	25	++	-	+	-
2599	62	Trench 2	26	++	-	+	-
2599	68	Trench 2	39	++	-	++	+
2599	150	Trench 2	41	++	+	+	-
2599	145	Trench 2	43	++	++	++	-
2599	144	Trench 2	44	++	-	++	-
2599	233	Trench 3	4	++	+	-	-
2599	230	Trench 3	9	++	-	-	-
2599	227	Trench 3	12	++	++	+	-
2599	226	Trench 3	13	++	-	-	-
2599	224	Trench 3	15	++	+	-	-
2599	212	Trench 3	34	++	+	-	-
2599	207	Trench 3	39	++	+	-	-
2599	206	Trench 3	41	+	-	-	-
2599	263	Trench 3	42	++	-	-	-
2599	260	Trench 3	43	++	-	-	-
2599	261	Trench 3	43	++	+	-	-

+ reduction type present in minor amounts
++ reduction type present in major amounts

Most of the Trench 2 profile is composed of turbated lenses that are remnants of inward pit slopes and outward edges of old berms (cf. Chapter 16). Many pits evidently were excavated through previous deposits, truncating most earlier strata (cf. Figure 105). Only a few samples were analyzed, selected on the basis of expectations generated from the analysis of Trench 1 (Table 93). Overall, reduction activities in the vicinity of Trench 2 consisted of core and Stage 2 biface reduction (Table 93). Stage 3 reduction is minimally evident in only one sample (from stratum 39); its provenience on the berm, however, away from quarrying activity and above the more steeply sloping sloped lenses, fits the expected organization of reduction.

Trench 3 resembles Trench 1 more than Trench 2 in profile; long lenses of reduction debitage and quarry debris slope in toward the pit at the base of the opalite outcrop. The sloping strata occupy the upper portion of the profile and overlie remnants of a more complex association of relatively flat, inslope, and outslope strata. Eleven samples were chosen for qualitative analysis on the basis of expectations derived from Trench 1 (Table 93). Core reduction predominates in all samples (Table 93); Stage 2 reduction is evident only in two of them.

Quarrying, core reduction, and some Stage 2 biface reduction were the major lithic reduction activities at 26Ek3208. Stage 2 biface reduction does not exhibit a clear spatial pattern, but in general it occurs adjacent, but not within, the quarry feature. The contexts of the few samples with early Stage 3 biface reduction debitage suggest that edge preparation may have occurred in or adjacent the quarry feature, but that further facial thinning was undertaken elsewhere.

Outcrop Quarry, 26Ek3084. 26Ek3084 is located in the eastern part of the Western Periphery, approximately 200m southwest of 26Ek3208 (cf. Chapter 16). Toolstone available at 26Ek3084 consists of an outcrop of jasper. The jasper is less silicious and more brittle than high quality opalite, but it is quite flakeable. The material is dominantly golden yellowish brown or dark chocolate brown; white, pink, dark red, and purple variants occur less frequently. Different colors often co-occur in mottled or variegated combinations.

One hand-excavated trench (Trench 1) was dug in the apron of debris and debitage adjacent the outcrop during testing. Debitage samples from various strata were collected, but were not analyzed technologically. During data recovery, a second trench (Trench 2) was excavated over Trench 1, expanding the original trench. Eighteen samples were collected from most of the debitage lenses in the east wall of this trench (Chapter 16:Figure 102). These samples were subjected to technological analysis (Table 94).

Table 94. Qualitative Technological Analysis Characterizations of Trench Strata Samples, Trench 2, 26Ek3084.

Reference-Specimen No.	Trench Number	Stratigraphic Unit	TECHNOLOGICAL CHARACTERIZATION Core Reduction	Blank Prep.	Stage 2 Biface Red.	Stage 3 Biface Red.
2599 913	Trench 2	1	-	-	-	-
2599 919	Trench 2	1	++	-	++	-
2599 917	Trench 2	6	++	-	++	-
2599 918	Trench 2	7	++	-	++	-
2599 911	Trench 2	10	+	-	-	-
2599 915	Trench 2	11	+	-	-	-
2599 909	Trench 2	13	+	-	-	-
2599 908	Trench 2	14	-	-	-	-
2599 905	Trench 2	15	+	-	-	-
2599 920	Trench 2	15	++	-	++	-
2599 914	Trench 2	17	++	-	+	-
2599 906	Trench 2	18	-	-	-	-
2599 908	Trench 2	20	-	-	-	-
2599 904	Trench 2	21	++	-	+	-
2599 903	Trench 2	24	++	-	++	-
2599 901	Trench 2	25	-	-	-	-
2599 900	Trench 2	34	-	-	-	-
2599 921	Trench 2	35	++	-	++	-

\+ reduction type present in minor amounts
++ reduction type present in major amounts

Only Stratum 25 and Stratum 34 in the pit at the bottom of the outcrop exhibit evidence of primary toolstone extraction. Perhaps other evidence was cleaned out successively and thrown to the southern edge of the pit during later quarrying episodes. Most samples indicate the occurrence of core reduction. Stage 2 biface reduction is evident in 44% of the samples. Samples indicating edge preparation lie mostly on the gentle inward berm slope, adjacent the actual quarry area. No Stage 3 biface reduction was recognized.

The Eastern Periphery

Many sites in the Eastern Periphery were characterized as lithic reduction sites during testing (cf. Chapter 17), yet several also contain features that appear to have resulted from activities other than reduction. Samples from the Eastern Periphery were selected for technological analysis to investigate differences both between small and large lithic scatters and between lithic scatters and seemingly more complex features. Seven features from four sites were sampled for quantitative technological analysis (Table 95).

Table 95. Quantitative Technological Analysis Results and Data, Eastern Periphery Samples.

Site	Feature/ Locus	Feature Type	Character- ization	Non-heat-treated EP/EBT	Non-heat-treated INT/EBT	Heat-treated EP/EBT	Heat-treated INT/EBT	% heat-treated	sample n
3170	F8/Loc A	Reduction	Mixed Bif (ht) ESB	0.40	0.39	0.26	0.13	26.3	457
3170	F8/Loc B	Reduction	ESB	0.55	0.42	0.88	0	5.1	897
3184	F8	Reduction	Mixed Bif (ht) ESB	0.82	0.42	0.33	0.13	57.2	236
3184	F12	Reduction	ESB	0.33	0.63	0	0	1.7	359
3184	F23	Reduction	LSB	0.15	0.18	0	0	2.4	1307
3192	F1	Residential?	LSB	0.22	0.14	0.17	0.03	11.9	1084
3198	F1	Reduction & residential?	LSB	0.12	0.16	0.09	0.27	7.2	418

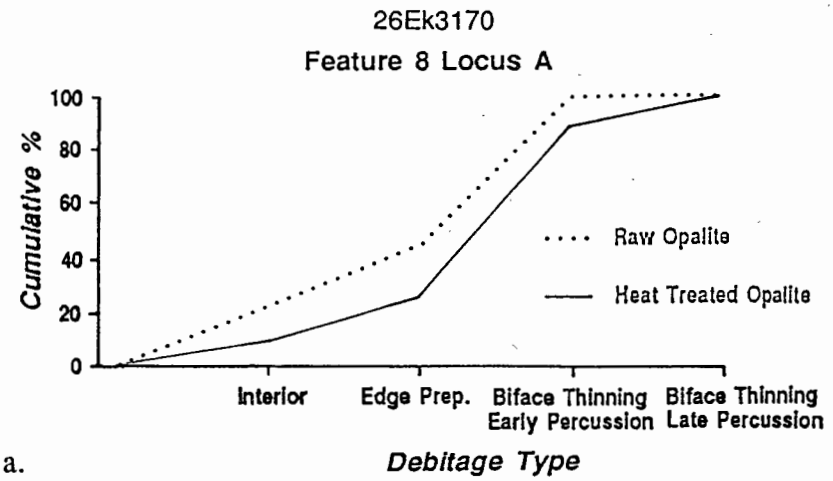
Characterizations: ESB = Early biface, Stage 1 to Stage 3.5
LSB = Late biface, Stage 3.5+
Mixed Bif = early and late biface.

EP/EBT = Ratio of edge preparation to early biface thinning flakes
INT/EBT = Ratio of interior to early biface thinning flakes

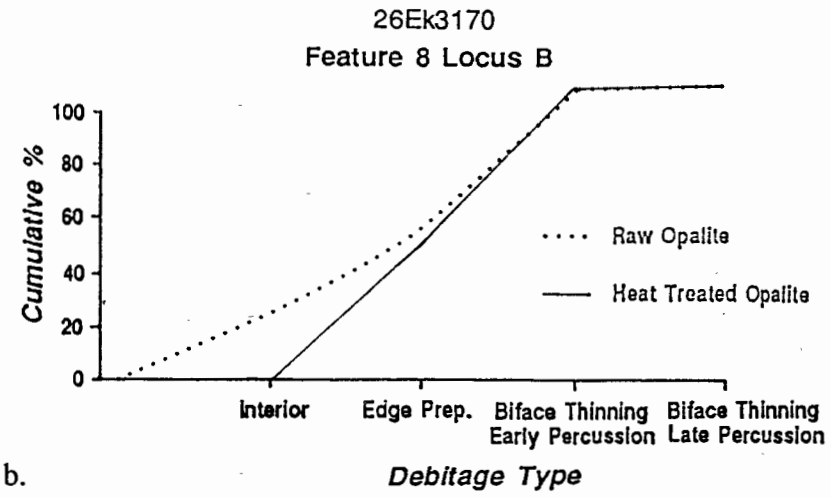
In general, technological analysis of the Eastern Periphery samples indicates a wide range of reduction activities, ranging from core reduction and early biface production on non-heat-altered opalite to projectile point manufacture on heat-treated opalite. Overall, complex features are strongly associated with debitage samples from later stages of biface production and projectile point manufacture. Later stage biface reduction is not *restricted* to complex features, however, so it cannot be used as a likely indicator of multiple activity features or sites.

26Ek3170. 26Ek3170 is a generally diffuse lithic scatter covering a gently sloping ridge (cf. Chapter 17). Within it, broad areas of high and low debitage density, distinct concentrations of debitage, and quarry pits are present. Feature 8, consists of a large area of higher debitage density; two concentrations were designated, Locus A and Locus B. Each locus of Feature 8 was collected in 16 1x1 m surface scraped units.

Debitage from five randomly selected units from Locus A of Feature 8 (roughly 31% of the surface area of the feature) was analyzed technologically (Figure 73a, Table 95). Quantitative



a.



b.

Figure 73. Ogives of diagnostic flake types, 26Ek3170, Feature 8.

analysis of this sample shows that reduction of non-heat-treated opalite (74% of the flakes in the sample) is dominated by early stages of biface production. Heat-treated opalite (26% of the sample) reflects reduction of already heat-treated Stage 2 and late Stage 3 bifaces to produce late Stage 3 and perhaps some Stage 4 bifaces.

Four randomly selected units from Locus B of Feature 8 (approximately 25% of the surface area of the feature) were analyzed as well (Figure 73b, Table 95). A high ratio of flake fragments to whole flakes indicates that core reduction contributed importantly to the sample. High frequencies of interior flakes and edge preparation flakes within the larger size-grades indicate that the reduction of relatively large flake blanks into early Stage 2 bifaces also was important. Heat-treated flakes comprise only 5% of the sample, and cannot be distinguished from background scatter; heat-treated bifaces were reduced infrequently, if at all, in this part of Feature 8.

26Ek3184. 26Ek3184 is a moderately dense lithic scatter with 26 discrete, concentrated features (cf. Chapter 17). Three features were chosen for technological analyses. Feature 12 and Feature 23 are tightly bounded concentrations which may have resulted from single reduction events. Feature 8 contrasts with these because it contains a fairly high number of artifacts; it may be a complex deposit of many different reduction events.

Feature 12 covers approximately 22 sq. m and contains two distinct concentrations of debitage. The larger concentration was collected in fifteen 1 m x 1 m surface scrapes. Three of these units were selected randomly for technological analysis. Opalite, generally in larger size-grades, is the major raw material. Heat-treatment is infrequent, and is not distinguishable from background scatter. The debitage sample exhibits reduction from large Stage 1 blanks or irregular early Stage 2 bifaces, yielding early Stage 3 bifaces (Figure 74a, Table 95). High values for EP/EBT and INT/EBT ratios as well as the presence of large (G1 size-grade) thinning flakes all support this interpretation.

Feature 23 covers approximately 63 sq. m, of which 25 were surface scraped; five 1 m x 1 m units were selected for technological analysis (Figure 74b, Table 95). White opalite is the most common raw material, and heat-treatment frequencies are not distinguishable from background scatter. Biface production is the dominant activity evident in the sample. High values of EP/EBT and INT/EBT flake ratios, large size-grade biface thinning flakes, and the reduction profile indicate the reduction of non-heat-treated middle Stage 2 bifaces or symmetrical flake blanks to produce late Stage 3 and early Stage 4 bifaces.

Feature 8 covers a 64 sq. m area and was collected with 30 1 m x 1 m surface scrapes. Four units were chosen randomly for technological analysis; three were analyzed qualitatively and one was analyzed quantitatively.

The single sample analyzed quantitatively from Feature 8 (Unit 134; Figure 74c, Table 95) contains two distinct biface production stages. Non-heat-treated opalite debitage was generated by early stages of biface production. Flakes from heat-treated bifaces or cores (57% of the flake sample) reflect both early and late biface production. Heat-treatment of flake blanks, followed by their reduction, is evident as differential luster on approximately one-third of the edge preparation flakes. Heat-treated flake blanks probably were reduced surficially prior to Stage 3 primary thinning, because some interior flakes and a few early biface thinning flakes show differential luster from heat-treatment. Very few later biface thinning flakes display this luster.

Qualitative analyses of three other units support the interpretation that the feature consists largely of debris from heat-treatment of flake blanks and subsequent reduction of them to approximately early Stage 3 of biface production. Two units (Units 129 and 132) are similar to Unit 134. The third (Unit 145) differs in that it is dominated by large, thermally fractured flake fragments and shatter. Although natural fire cannot be ruled out entirely as the cause of thermal alteration, a lack of crazing on flakes, minimal darkening of most heated flakes, and

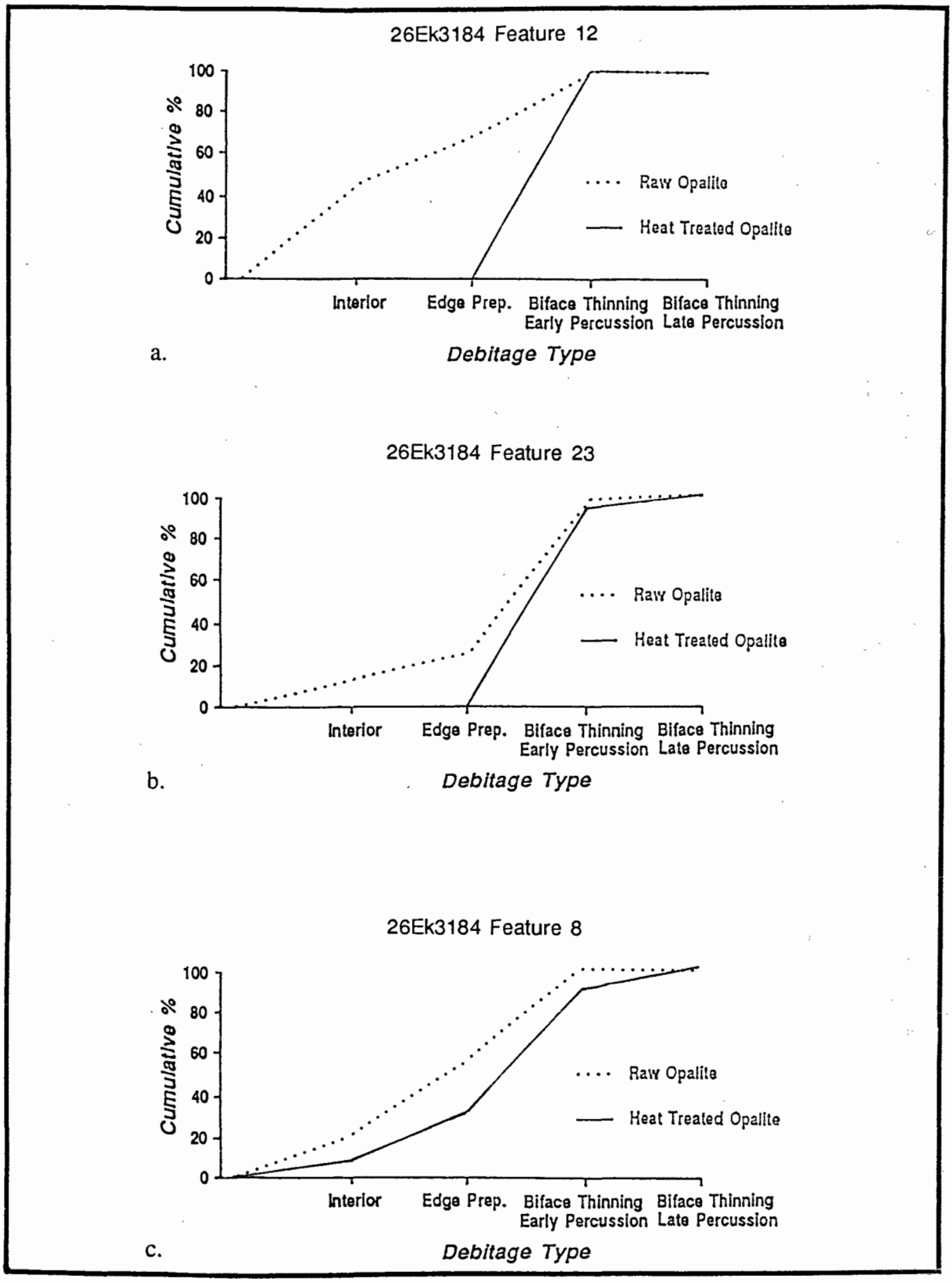


Figure 74. Ogives of analytical flake classes, 26Ek3184.

evidence of continued reduction of thermally altered specimens all make natural fire an improbable agent. Among the 794 pieces of debitage from Unit 145, 607 (76%) are fragmentary specimens; of those 164 (27%) are shatter, and, overall, 492 of the pieces (81%) are thermally fractured. All of the evidence from this unit points to failed heat-treatment, but flakes from the reduction of overly heated bifaces occur as well. These flakes indicate that overly heat-treated material still could be reduced without failing. Analysis of the Tosawihi biface assemblage (cf. Chapter 6) supports this conclusion.

26Ek3192. Feature 1 at this site was selected for technological analysis because it appeared in the field to have resulted from residential use (cf. Chapter 17). The 19 sq. m area of Feature 1 was sampled by 24 sq. m of surface scrape units which revealed a cache of 41 bifaces (cf. Chapter 6, Chapter 17). The 6 sq. m adjacent the biface cache were selected for technological analysis to evaluate whether the cache could have been produced on the spot. Two additional units were selected randomly to evaluate other parts of the feature.

Debitage from the six units around the biface cache was visually compared to the cached bifaces. The material qualities and colors in the debitage are generally quite similar to the bifaces; the larger size-grade (G1 and G2) specimens are especially close matches. Heat-treated debitage is not distinguishable from background scatter in these samples. Non-heat-treated debitage has a late biface production stage technological profile (Figure 75; Table 95), even though the cached bifaces represent early to middle stages of production (Stages 2 and 3). It is possible that late stage bifaces were transported away from the feature, and earlier stage bifaces cached there, but the late stage debitage is also explicable in terms of the biface blank morphology. The blanks apparently were already relatively thin and symmetrical (cf. Chapter 6) so, in proportion to early biface thinning flakes, fewer interior flakes and edge preparation flakes were struck. Low ratios of INT/EBT flakes and EP/EBT flakes are products of this blank morphology. In sum, it is likely that the debitage sample associated with the biface cache resulted from reduction of the cached bifaces or bifaces similar to them that were transported away.

The two randomly selected samples (Unit 2 and Unit 20) allow some assessment of feature integrity, at least as evident in the reduction profiles. These samples are similar in interpretation to those from the cache vicinity. A greater diversity of raw material is evident, however, so away from the cache more production events apparently helped create the feature.

26Ek3198. 26Ek3198 contains 24 features interpreted as lithic reduction areas and includes a small outcrop quarry (cf. Chapter 17). Feature 1 contained artifacts indicative of residential use. It was sampled with 30 1 m x 1 m surface scrape units. Eleven (37%) of these units were selected randomly for technological analysis. Two excavation levels in Unit 17 (2-10cm and 10-20cm below surface) were analyzed as well to test the densest concentration of debitage within the feature. Overall, Feature 1 reflects late stage biface reduction of mostly non-heat-treated opalite and some raw translucent chalcedony (Figure 75b, Table 95). Less than 8% of the debitage in the sample was heat-treated, suggesting that heat-treatment was not required for late stage reduction of this opalite and chalcedony. A distinctive characteristic of this locus consists of many small pressure flakes recovered from a small concentration on the surface and to a depth of 20cm below surface in Unit 17. Material colors include white, salmon pink, red, brown and yellowish white. The pressure flakes show heat-treatment and are more diverse in materials than other biface reduction debitage from the feature. They most likely were created in the manufacture of projectile points and preforms; direct support of this is offered by a single opalite notching flake.

The Western Periphery

The Western Periphery contains several very large sites, characterized during testing as both reduction and residential sites (cf. Chapter 16). Four small lithic scatters and three features from sites that may have been used residentially were subjected to technological analysis.

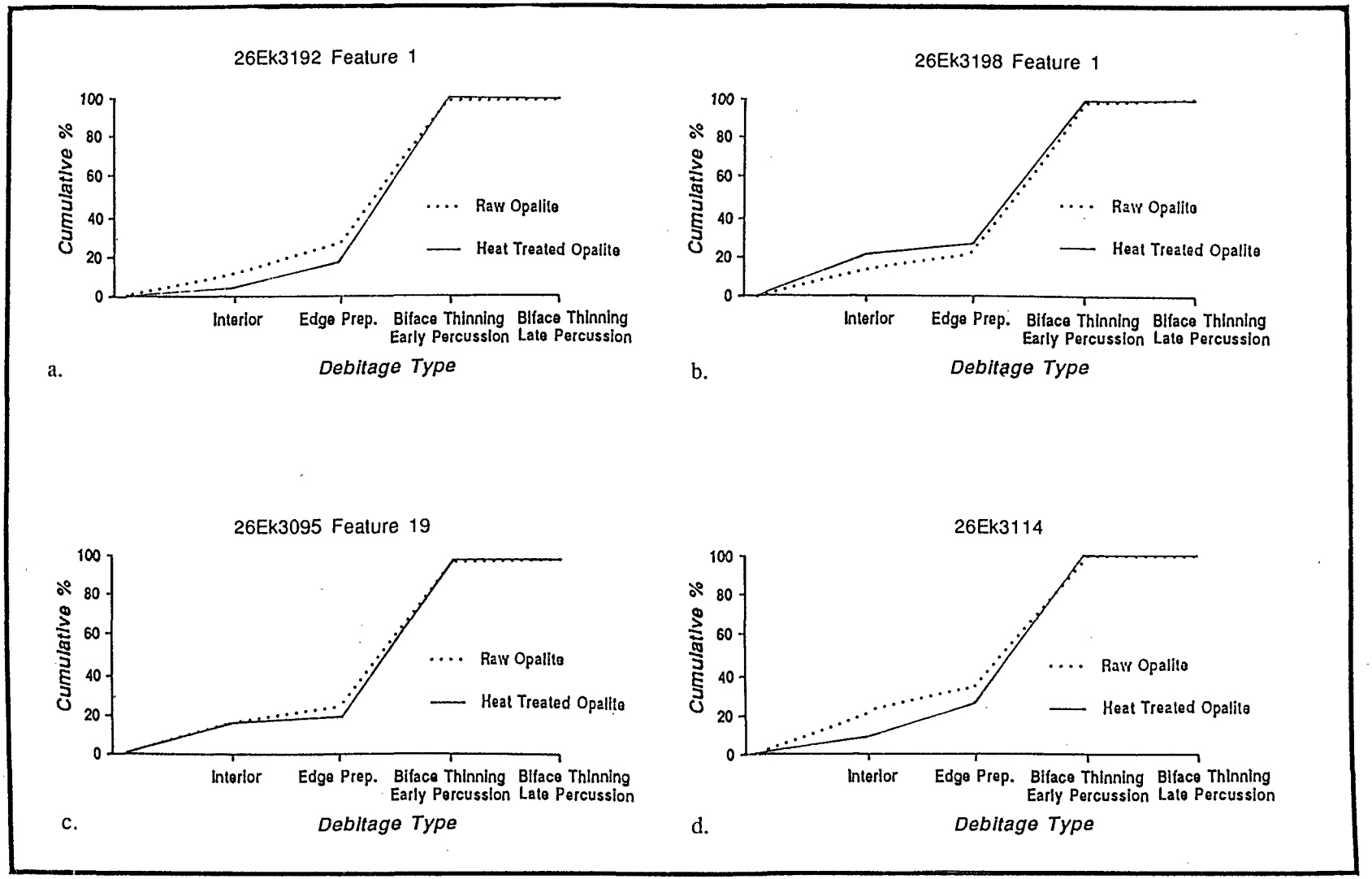


Figure 75. Ogives of analytical flake classes.

26Ek3095. This site contains 25 surface features (cf. Chapter 16); only Feature 19 was analyzed technologically. This feature was chosen for analysis because it appears to reflect both residential and lithic reduction activities. Two loci are present; only Locus 1, a dense debitage concentration associated with groundstone and a probable hearth, was analyzed. The debitage from the upper levels of two excavation units (Units 24 and 29) was selected for analysis. These samples were collected partially through 1/8 in. mesh and so provide an opportunity to distinguish debitage resulting from pressure flaking. Sampling in both units was restricted to the 0 - 10 cm. excavation level, which accounted for almost all the debitage recovered from Unit 29 and more than half that from Unit 24.

Debitage from the two units is predominantly white and pink opalite. Approximately 15.3% of the debitage was heat-treated. Pressure flakes were not found in the samples. The reduction profile for non-heat-treated and heat-treated debitage reflects late stage biface production (Figure 75c, Table 96). The EP/EBT ratios are low, indicating Stage 2 biface production contributed little to the assemblage. The larger, but still small, portion of interior flakes most likely is indicative of early Stage 3 biface thinning. Therefore, biface reduction at Feature 19/Locus 1 most often was initiated on late Stage 2 and early Stage 3 bifaces to produce late Stage 3 and Stage 4 bifaces. A scarcity of larger size-grade flakes suggests that bifaces at all stages were relatively small.

Table 96. Quantitative Technological Analysis Results and Data, Western Periphery Samples.

Site	Feature/ Locus	Feature Type	Character-ization	Non-heat-treated EP/EBT	Non-heat-treated INT/EBT	Heat-treated EP/EBT	Heat-treated INT/EBT	% heat-treated	sample n
3095	Feat. 19	Residential?	LSB	0.11	0.23	0.05	0.19	15.3	825
3106	Feat. 1	Reduction	ESB	0.34	0.95	0.17	0.50	11.9	793
3114	N/A	Reduction	Mixed Bif	0.21	0.28	0.20	0.10	15.4	254
3115	N/A	Reduction	Mixed Bif	0.09	0.29	0.11	0.11	31.4	70
3116	N/A	Reduction	ESB	0.34	0.45	0.13	0.13	7.0	142
3160	Feature 1	Residential?	LSB	0.11	0.15	0.20	0.10	25.3	1534
3160	Feature 2	Reduction		0.16	0.13	0.15	0.17	82.1	223
3160	Feature 3	Reduction	Mixed Bif	0.23	0.19	0.40	0.67	10.8	288
3160	Feat. 23	Residential?	Mixed Bif	0.26	0.36	0.16	0.29	25.4	437

Characterizations: ESB = Early biface, Stage 1 to Stage 3.5
LSB = Late biface, Stage 3.5+
Mixed Bif = early and late biface

EP/EBT = Ratio of edge preparation to early biface thinning flakes
INT/EBT = Ratio of interior to early biface thinning flakes

26Ek3114, 26Ek3115, and 26Ek3116. These three sites consist of small (less than 16 sq. m each), elongate lithic scatters clustered on a gentle southeastern slope (cf. Chapter 16). All were sampled with surface scrapes. The sampled area on each site was divided into upslope and downslope halves, and one unit from each half was selected randomly for technological analysis.

Analytical results (Figure 75d, Table 96) show that 26Ek3114 and 26Ek3115 are similar in material diversity and reduction profile. The frequency of heat-treated debitage is minimal in all analytical samples and cannot be interpreted. A low count of debitage from 26Ek3115 also constrains interpretation of cumulative debitage proportions, so the samples were not graphed. Comparisons of ratios thus constitute the primary data for interpretation of these samples. EP/EBT and INT/EBT ratios for 26Ek3114 are high for later stage reduction. These ratio values indicate biface production was initiated on irregular flake blanks, continued through Stage 2, and finished by producing late Stage 3 or early Stage 4 bifaces. At 26Ek3115, the EP/EBT ratio

is lower, suggesting that Stage 2 reduction was not a major contributor to the assemblage. Because the sample itself is small, this interpretation is tentative.

26Ek3116 is characterized by early stages of raw biface reduction (Figure 76a, Table 96). The consistent diversity of opalite colors across debitage types and among size-grades indicates a continuous reduction of possibly four to six raw flake blanks into the early and middle phases of Stage 3 primary thinning. The reduction of heat-treated bifaces is even less evident here than among the other two sites.

26Ek3160. 26Ek3160 is a large lithic scatter covering a long, gently sloping ridge (cf. Chapter 16). Twenty-three concentrations of debitage were designated as features. Some are large and have indistinct boundaries; they may have been generated during residential use of the site. Small discrete features are distinct from larger ones, and may have resulted from a limited number of lithic reduction events. Two of each kind of feature were sampled to characterize lithic reduction; Features 1 and 23 as representative of large lithic scatters, Features 2 and 3, to characterize small lithic scatters.

Feature 1 is a dense concentration of debitage and other artifacts (cf. Chapter 16) covering approximately 100 sq. m. Nine of the 43 sq. m collected from the feature were chosen for analysis, six units near the feature center and three toward its edge. The overall reduction profile shows low cumulative proportions of interior flakes and edge preparation flakes (Figure 76b), suggesting late biface production debitage; low values of the EP/EBT and INT/EBT ratios support this interpretation (Table 96). The proportion of heat-treated debitage is high at 25% (Table 96), and the overall reduction profile for heat-treated debitage indicates initiation of biface production on heat-treated blanks. Higher proportions of heat-treated late biface thinning flakes indicates that heat-treated bifaces more often were reduced further than non-heat-treated ones (Figure 76b). The production of bifaces on non-heat-treated pieces usually started with Stage 2 and early Stage 3 bifaces to produce late Stage 3 bifaces.

Feature 23 is a light density lithic scatter associated with artifacts suggesting food processing (cf. Chapter 16). The surface of the elongate scatter was scraped entirely in 21 1 m x 1 m surface scrape units. To choose a sample of these, we divided the feature into three segments based on grid locations relative to site slope (upper, middle, and lower slope). Two units from each division were analyzed technologically; two excavation levels from a randomly selected unit (Unit 55) were analyzed as well. The reduction profile for Feature 23 is early/late (Figure 76c, Table 96), i.e., both the cumulative curves and the diagnostic debitage ratios fall between those expected for either early or late biface reduction. The ratios of INT/EBT and EP/EBT for non-heat-treated opalite indicate that reduction of non-heat-treated bifaces was initiated frequently on irregular blanks and produced relatively few later stage bifaces. Heat-treated debitage comprises 25% of the samples. Reduction of heat-treated blanks from more regular Stage 1 blanks or early Stage 2 bifaces to produce late Stage 3 and Stage 4 bifaces is evident in low EP/EBT and INT/EBT ratios.

Feature 2 is a small (4.7 sq. m), isolated debitage concentration. The surface debitage is burned and fragmented. It was sampled to investigate the cause of thermal alteration and to characterize the lithic reduction that originally produced it. Two of the 4 1 m x 1 m surface scraped units were selected for technological analysis. The low frequency of whole flakes precludes meaningful graphical and statistical comparisons. Thermal alteration has affected most heavily the larger and thicker interior and early biface thinning flakes, further biasing interpretations based on frequencies of whole flakes. Many of these flakes probably were created during the reduction of large early Stage 2 and early Stage 3 bifaces. It also is possible that cores were reduced at Feature 2 to yield flake blanks for small bifaces, but no core fragments were found in the feature. The feature surface apparently burned after its use; the thermally altered debitage is extremely crazed, discolored, and often broken into blocky fragments.

Feature 3 covers approximately nine sq. m. It was selected for technological analysis because the scatter is tightly delineated and the debitage appears to vary little. Two of eight

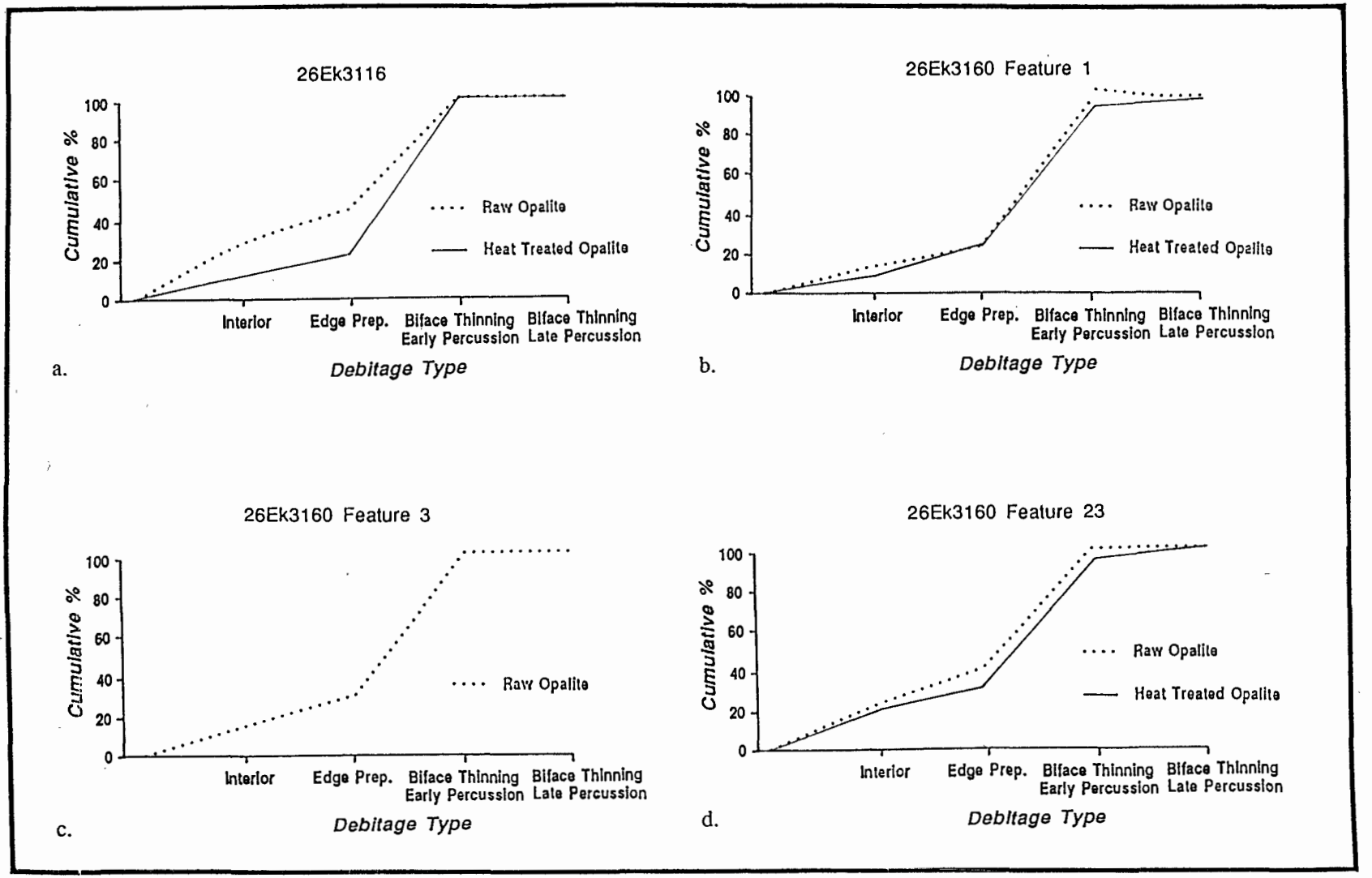


Figure 76. Ogives of analytical flake classes.

surface scrape units were selected for technological analysis. The reduction profile (Figure 76d) is late, but also is slightly skewed to the earlier part of late biface production by a high EP/EBT ratio of non-heat-treated flakes (cf. Table 96). The contrasting INT/EBT ratio of 0.19 for non-heat-treated opalite reflects late reduction. This difference in ratios indicates that blanks reduced here already were relatively symmetrical. Blanks of non-heat-treated opalite were reduced through Stages 2 and 3, and perhaps into early Stage 4. The thermal alteration evident in much of the debitage assemblage from Feature 3 probably is post-depositional; the feature lies close to Feature 2, and many of the thermally altered flakes are similar to those in Feature 2 in discoloration, cuboid fragmentation, and crazing.

26Ek3106. This site is situated in Rodent Valley, a portion of the Western Periphery in many ways similar to the Eastern Periphery (e.g., high proportions of heat-treated bifaces; cf. Chapter 6). The reduction profile for Feature 1 reflects early biface production (Figure 77a, Table 96). A fairly high proportion of non-heat-treated interior flakes indicates that much of the biface production occurred on large irregular blanks, producing early Stage 2 and Stage 3 bifaces; core reduction also may have contributed interior flakes to the sample. The proportion of heat-treated interior flakes is high, indicating the heat-treatment of irregular blanks and probably early Stage 2 bifaces as well (Figure 77a, Table 96). Many flakes and some bifaces (Chapter 6) exhibit failure due to heat-treatment. Successful reduction of heat-treated bifaces is evident in a higher than usual proportion (but not frequency) of heat-treated biface thinning flakes relative to non-heat-treated biface thinning flakes. Overall, the feature appears to have been near a quarry, and to have been a place where heat-treatment of blanks and roughly edged Stage 2 bifaces was followed by production of large, late Stage 2 and early Stage 3 bifaces.

The Northern Corridor

The Northern Corridor begins approximately 6 km from the northern edge of the quarries (cf. Chapter 2, Chapter 18). Technological analysis examined samples from two sites here because they are the best candidates for residentially used locations unrelated to the Tosawihi quarries. 26Ek3237 is located at the south end of the corridor and thus is closest to the quarries; 26Ek3251 is located at the north end of the subarea, approximately 12 km from the quarries.

Site 26Ek3237. 26Ek3237 is a large site adjacent Ivanhoe Creek (cf. Chapter 18). Three loci of concentrated debitage and other artifacts lie within a larger, generally light lithic scatter. Debitage from Locus C was selected for technological analysis because of the presence of stratified and dated hearths (Features 3 and 4); these features were the focus of technological analysis.

Debitage samples from surface and subsurface proveniences in the vicinity of Features 3 and 4 were analyzed qualitatively to discover if distinct assemblages were associated with each feature. Debitage from a surface scrape and from 2 to 10 cm below surface in Unit 59 was analyzed quantitatively. The qualitative analysis found that debitage samples associated with Features 3 and 4 are not qualitatively distinct from each other. The dominance of early and late stage biface thinning flakes in the G3 size-grade of the samples indicates thinning of small Stage 2 bifaces to produce Stage 3 and Stage 4 bifaces, as well as thinning of Stage 3 and Stage 4 bifaces. Quantitative technological analysis of Unit 59 (Figure 77b, Table 97) supports this interpretation.

A relatively large proportion of heat-treated debitage (Table 97) contains a high frequency of biface thinning flakes, indicating the reduction of heat-treated bifaces. An almost complete lack of differential luster on the dorsal surfaces of the biface thinning flakes shows that initial reduction of the bifaces after heat-treatment did not occur around the features.

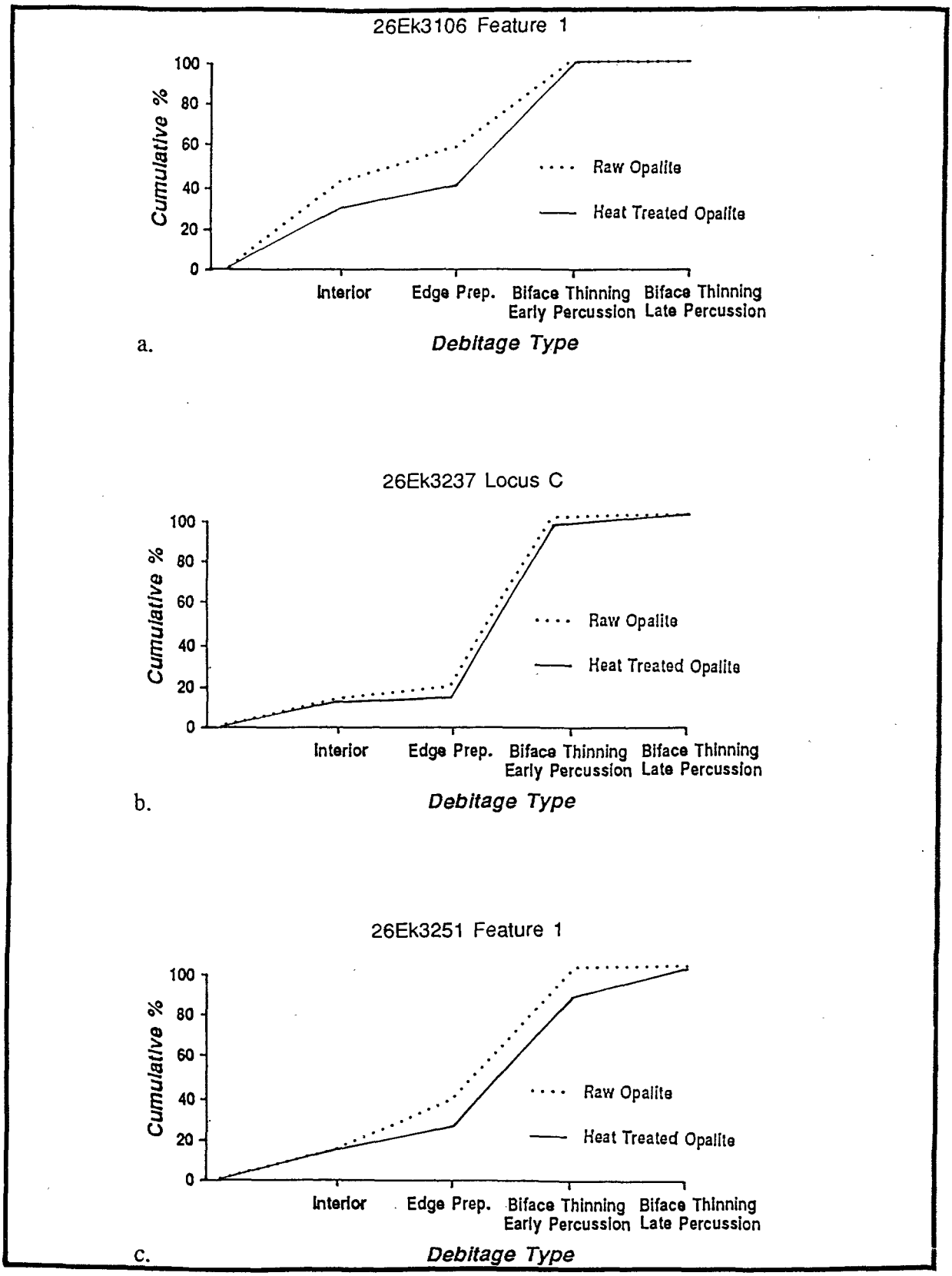


Figure 77. Ogives of analytical flake classes.

Nonetheless, a few biface fragments exhibit distinctive thermal fractures, suggesting that some heat-treatment occurred near (but not necessarily in) Features 3 and 4.

Table 97. Quantitative Technological Analysis Results and Data, Northern Periphery Samples.

Site	Feature/ Locus	Feature Type	Character- ization	Non-heat-treated EP/EBT	Non-heat-treated INT/EBT	Heat-treated EP/EBT	Heat-treated INT/EBT	% heat- treated	sample n
3237	Locus C	Residential?	LSB	0.06	0.15	0.03	0.13	47.3	448
3251	Feat. 1	Residential?	Mixed Bif LSB (ht)	0.39	0.21	0.23	0.19	85.0	1235

Characterizations: ESB = Early biface, Stage 1 to Stage 3.5
LSB = Late biface, Stage 3.5+
Mixed Bif = early and late biface

EP/EBT = Ratio of edge preparation to early biface thinning flakes
INT/EBT = Ratio of interior to early biface thinning flakes

Toolstone in the samples is diverse in quality and color; this is particularly true of interior flakes. Toolstone sources other than Tosawihi opalite undoubtedly were reduced adjacent these two features. Some non-opalite toolstone probably was obtained locally as stream cobbles, since there are a few G1 and G2 size-grade fragments and secondary flakes with incipient cones and cobble cortex.

Conjoinable fragments also occur; their proveniences often are fairly widely separated, indicating turbation of the deposit. For example, a large potlid recovered in the 2-10 cm level of Unit 59 conjoins a burned biface in the 30-40 cm level. Turbation may have increased the apparent homogeneity of all the debitage samples.

In order to examine lithic reduction outside feature contexts, a sample from Unit 60 was examined qualitatively. Technologically, the assemblage resulted from the reduction of non-heat-treated opalite bifaces. Raw material color and quality are typical of Tosawihi opalites. The debitage indicates reduction of early Stage 2 bifaces to produce middle Stage 3 to early Stage 4 bifaces. The opalite bifaces reduced around Unit 60 apparently were larger than those reduced around Feature 3 and Feature 4, since the proportion of G2 size-grade specimens is higher in the Unit 60 sample than in those from around the two features.

In sum, the debitage samples from Locus C of 26Ek3237 suggest the presence of two distinct reduction technologies. One, which can be considered a "non-Tosawihi" strategy, is the reduction of local toolstone, perhaps collected as stream cobbles, to produce small bifaces and probably a variety of other tools. The second technology, yielding a more characteristic "Tosawihi assemblage," is the reduction of fairly large opalite bifaces. The debitage samples from around Feature 3 and Feature 4 reflect combinations of both technological strategies, and those from Unit 60 reflect solely the latter.

26Ek3251. This site contains six lithic concentrations (features) subsumed by a lighter density scatter (cf. Chapter 18). Technological analysis was restricted to Feature 1, apparently a composite of multiple activities containing food processing artifacts as well as lithic reduction debris. The feature covers approximately 66 sq. m, and was sampled with a grid of 22 1 m x 1 m units. Samples for technological analysis were drawn from two randomly selected units (Units 15 and 21) and from two other units sieved through 1/8 in. mesh (Units 14 and 16). The latter samples were selected to assess the presence of pressure flakes. All samples underwent quantitative technological analysis.

The reduction profiles reflect reduction of non-heat-treated bifaces from Stage 2 to approximately early Stage 4 or late Stage 3 and late stage reduction of heat-treated bifaces (Figure 77c, Table 97). Heat-treated debitage comprises 85% of the sample (Table 97). Differential luster is common on the dorsal surfaces of interior flakes, edge preparation flakes, and biface thinning flakes in the small size-grades. This indicates the reduction of small heat-treated flake blanks and bifaces. Absence of G1 size-grade debitage and a paucity of G2 size-grade debitage indicates that reduction of small bifaces predominated in creating the samples. These observations concur with the results of biface analysis (cf. Chapter 6). Pressure flakes are abundant in each of the 1/8 in. samples examined, and also were recovered in 1/4 in. mesh. Pressure flaking was restricted to the reduction of heat-treated small bifaces, some of which probably were projectile point preforms.

Discussion

The results of technological analysis disclose regular patterns in debitage samples from the Tosawihi vicinity. Samples (containing more than fifty items) analyzed technologically can be compared to each other reliably by plotting the values of the INT/EBT ratio against the EP/EBT ratio values for each sampled site (Figure 78).

A scatter plot of non-heat-treated opalite samples encompasses most of the sites examined by technological analysis (Figure 78a). Among the sites characterized as early biface reduction, the majority lie in the Eastern Periphery and the main quarry area. Eastern Periphery sites differ from those in the main quarry in more subtle ways. Samples from the main quarry area always have a higher INT/EBT ratio than EP/EBT ratio. In Eastern Periphery samples, the order of ratio values is reversed. These ratios indicate that the main quarry samples are dominated by core reduction and the Eastern Periphery samples by early biface reduction. The Western Periphery samples mostly are characterized as late stage biface production, although there is a secondary trend of early *and* late stage biface production. The two Northern Corridor sites sampled show very late stages of biface production on Tosawihi opalite, and early to late stage biface production on probably local toolstone.

Debitage from heat-treated bifaces, blanks, or cores occurs most commonly in samples interpreted as late stage biface production and early to late stage biface production (Figure 78b). In the main Quarry, heat-treated debitage shows that heat-treatment regularly occurred near the middle of Stage 3 biface thinning. Samples from the Eastern Periphery suggest much more variable occurrence of heat-treatment, ranging from early stages to late stages of biface production. Western Periphery samples containing heat-treated debitage are late in the biface reduction continuum, although some early reduction of heat-treated bifaces was found in the Rodent Valley assemblage. In Northern Corridor samples, heat-treatment is associated only with late stages (late Stage 3 or early Stage 4) of biface reduction.

Summary and Conclusions

The debitage analyses indicate clearly that biface production was the major focus of toolstone exploitation at Tosawihi. While there are differences in how the two analytical techniques characterize debitage samples, the overall results are substantially similar.

Biface sizes and shapes are documented directly in the analysis of opalite bifaces recovered here, and our analytical results simply reinforce the conclusions drawn in Chapter 6. Although bifaces themselves provide direct testimony of lithic production at Tosawihi, they do not provide an accurate estimate of how many bifaces were made there. We have attempted

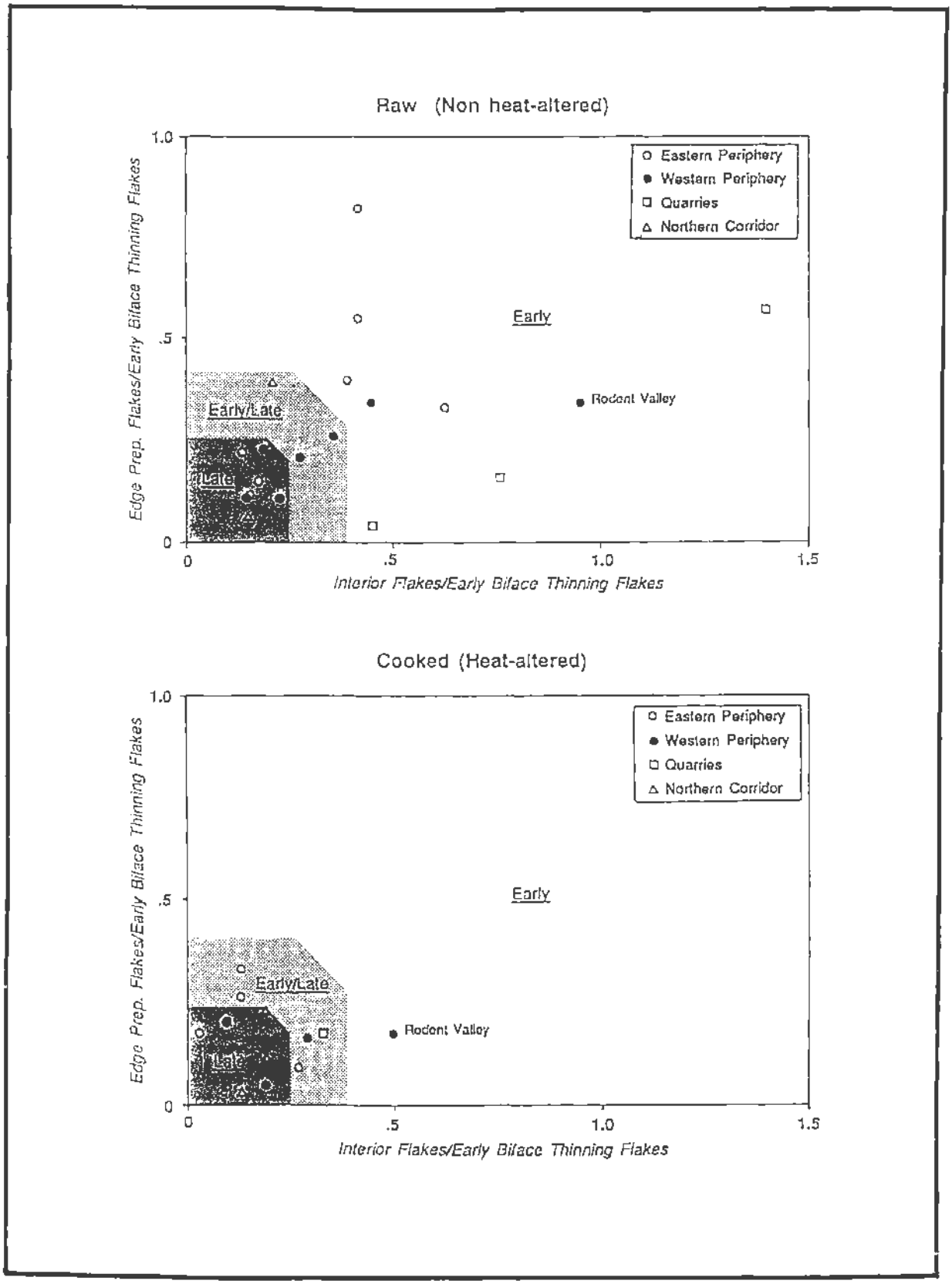


Figure 75. INT/EBT vs. EP/EBT values for technologically analyzed sites.

to answer this question by examining the extrapolated weight of debris present in the Tosawihi vicinity, and by calculating the number of bifaces that this extrapolation represents. The result is a conservative estimate of approximately 87,000 bifaces having been produced in the Tosawihi vicinity. There can be no doubt that biface production at Tosawihi exceeded by far the demands of local use around the quarries.

Both the analytical techniques applied to debitage shed some further light on the form in which bifaces departed the Tosawihi vicinity. Technologically distinctive debitage samples are directly associated with toolstone sources. The dominant reduction activity in quarry pits and outcrops was core reduction and probably the direct reduction of bedrock to produce large flake or slab blanks. A large proportion of the interior flakes (which indicate core reduction) probably resulted from removing irregularities from large thick slabs of opalite. Technically, these are not flake blanks, but block or slab blanks (Mark Moore, personal communication 1990). Biface production was a secondary activity in the immediate vicinity of toolstone quarry pits or outcrops. When present, biface production ceased with preparation and regularization of blank edges (Stage 2) or after a few initial thinning flakes had been removed (early Stage 3). Technological analysis even of surface scraped biface reduction assemblages outside, but near, the Locality 23 quarry pit reflect the early part of Stage 3 reduction.

While the procurement of suitable blanks for bifaces left the unsurprising bulk of evidence in quarry features, opalite biface production is the dominant technological action away from quarries. There are differences between the three areas peripheral to the Quarry proper. The general trend is for increasingly late stage biface reduction to be associated with increasing distances from opalite sources. Yet, part of these differences may be due more to how places or sites were used than to a direct relationship between distance to opalite sources and biface reduction stage.

In broad terms, biface production at Tosawihi, as evident from technological analysis of the debitage, can be divided into two distinct parts. The first involves the procurement of toolstone, production of blanks, initial edging (Stage 2), and some initial thinning (early Stage 3). The second involves the continued thinning (Stage 3), often accompanied by heat-treatment, final thinning (Stage 4), and edge shaping (Stage 5), of bifaces. Initial procurement and production is very closely associated with toolstone sources, i.e., early stages of biface production diminish with distance from sources. The later portion of the biface production sequence appears to be unrelated to distance to toolstone source.

If later reduction of bifaces, and heat-treatment of bifaces, are not parts of lithic procurement *per se* but instead parts of "normal" lithic reduction strategies, then we expect late biface production debitage assemblages to be associated with a greater diversity of activities than earlier ones. Insofar as a greater diversity of activities in a given location may be invited by residential use of a place, it is possible that late biface production is an indirect measure of "residentiality."

If the occurrence of late biface production is due more to how prehistoric forays to toolstone sources were scheduled and organized, then we also should expect to see an association between the heterogeneity of debitage sizes (as discussed above) and the characterization of debitage samples as late stage biface reduction. Mass analysis characterizations, because they are based on distributions within size-grades, are a partial measure of heterogeneity. Mixed (early and late) biface reduction characterizations indicate the most heterogeneous debitage samples in terms of item size. At the other end of the spectrum, the core reduction characterizations generally are dominated by items in large size-grades, while edge maintenance characterizations almost uniformly are composed of small flakes. Between these extremes, debitage size distributions in early and late stage biface characterizations are more heterogeneous than core reduction samples, and less heterogeneous than mixed bifacial reduction. Early stage biface reduction characterizations are skewed toward larger size-grades, and late stage biface reductions towards smaller ones.

There is a general association between mass analysis characterization of composite feature samples as late stage biface reduction and the associated presence of other features characterized as mixed biface reduction on the same sites (cf. Table 2, Appendix I). This lends partial support to the hypothesis that Tosawihi toolstone most often was exploited as part of a larger round of resource collection, and not through specific logistical forays. Alternatively, however, logistical use of toolstone sources may have left few traces except at outcrops and pits, where they are indistinguishable from diurnal or residential exploitation debris. Thus, we can provide support only for a model of residential use, but this in no way negates the likelihood of logistically organized forays having also been used. In any case, the testable implication of this argument is that evidence of late biface production should be positively associated with artifact classes whose use is independent of biface production. For example, late stage biface production could be associated with flake tools, groundstone, or food preparation hearths. Although examination of such associations is not undertaken here, it is feasible to do so (cf. Chapter 24).

Chapter 11

HAMMERSTONES AND OTHER COBBLE TOOLS

Dave N. Schmitt

Some things never change.
- Anonymous

Throughout hominid evolution and especially in the recent past, we have witnessed many dramatic changes in the types, shapes, and sizes of prehistoric artifacts. Clearly, the metamorphosis of implements and the introduction of new tools owe to many sources, including environmental, behavioral, and technological factors, none of which operates independently. In the prehistoric Great Basin, for example, changes in projectile point morphology over the past 8,000 years include numerous innovations in size and style (cf. Thomas 1981); these temporally constrained modifications were the result of a number of ecological and technological adaptive responses, including the replacement of the atlatl with the bow and arrow.

While most prehistoric tool forms changed in response to local conditions and within local technologies, the simple cobble tool has remained virtually the same, due, in part, to its low cost of procurement and its functional efficiency. Whether unmodified for rough percussion tasks or minimally flaked to achieve a sharp working edge, hammerstones and choppers are persistent features of the archaeological record global in extent and spanning more than a thousand millennia.

Simple percussion and processing tools were recovered from most sites at Tosawihi (Table 98). Not surprisingly, hammerstones are common and occur in a variety of contexts, including quarry sites as well as small, isolated reduction stations (cf. Schmitt 1989a). This chapter describes hammerstone assemblages collected at Tosawihi (cf. Table 98), together with discussions of choppers, scratched stones, stone shovels, and scraper planes. Materials recovered from initial testing of excavated sites are combined with data recovery collections. Although some attributes and locational data are mentioned here, piece-specific proveniences and metric data are presented in Appendix J (also cf. Schmitt 1989a).

Hammerstones

The assemblage of 82 hammerstones (from 19 sites; cf. Table 98) contains an array of shapes and sizes (cf. Appendix J); most abundant are fist-sized cobbles that can be held and used with one hand (e.g., Figure 79a, c), usually exhibiting two or more battered edges/surfaces. Two hammerstones, however, are spalls from large basalt cobbles recovered from quarry pits (at 26Ek3084 and 26Ek3208); they probably represent fragments of "throw-stones" (i.e., projectile hammerstones) employed in the removal of opalite from bedrock exposures. More than half of the hammerstones (n=46, 57%) are complete.

Excavations and surface collections at nine sites returned 10 shaped hammerstones. Bifacial percussion flaking has produced one or more thin, often "pointed" working edges, probably to facilitate controlled flake removal when used in biface reduction (cf. Figure 79d). A few additional specimens may have been shaped superficially, but extensive use wear (e.g., spalling, step fracturing) and/or fragmentation precludes inferences on purposeful shaping. Similarly, two shaped opalite hammerstones may have functioned as cores before they were battered (cf. Thomas and Bierwirth 1983:230); their "shaping" thus may have been a product of assaying or flake removal rather than enhancement as percussion tools.

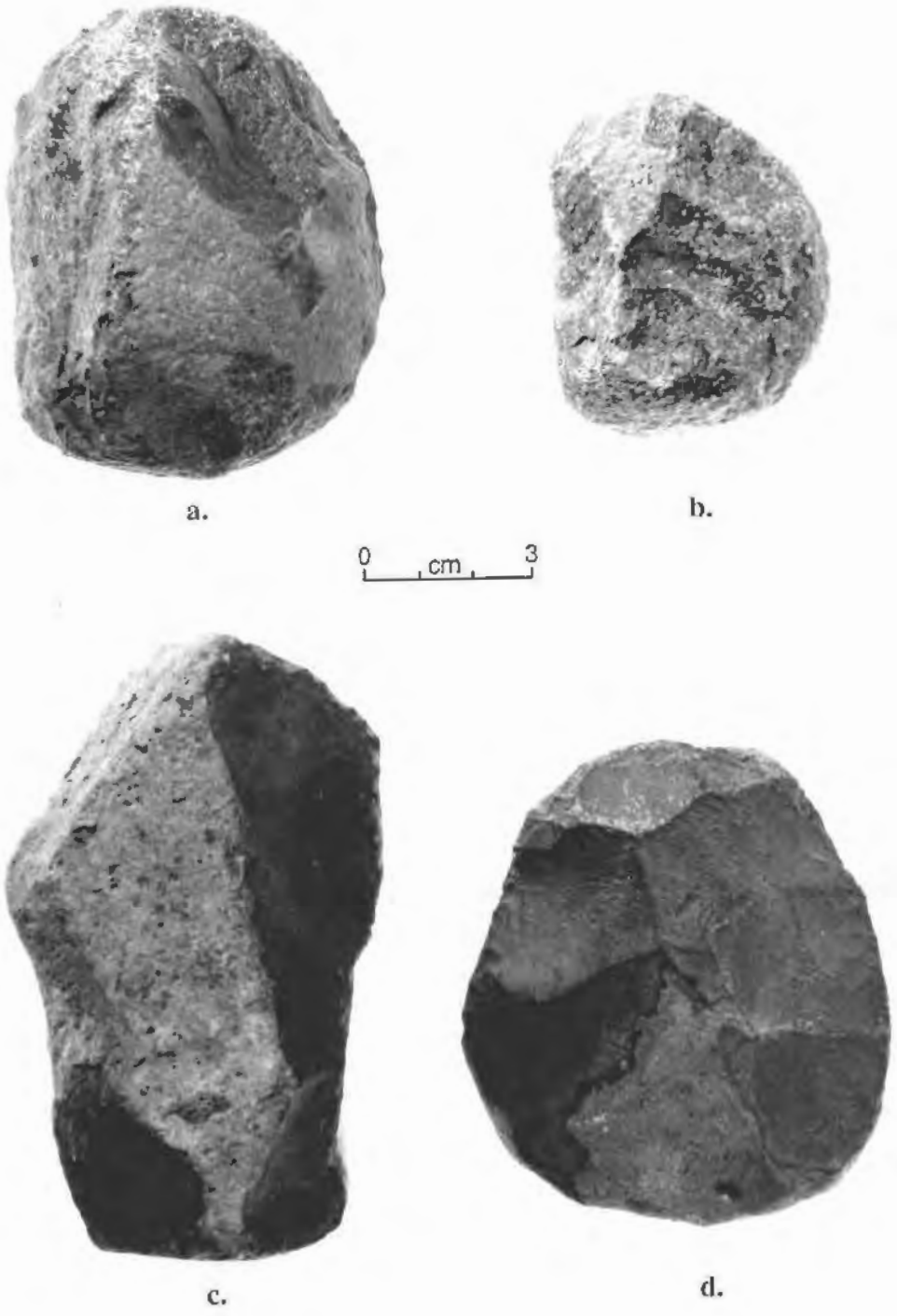


Figure 79. Selected hammerstones.

Table 98. Percussion, Processing, and Digging Tools by Site.

Site* (Locality)	Hammerstones	Scratched Stones	Choppers	Hammer-Choppers	Shovels	Scraper Planes	Totals
3032 (19)	2	-	-	-	-	-	2
3032 (23)	2	-	-	-	-	-	2
3032 (25)	4	-	1	-	-	-	5
3032 (98)	1	-	-	-	-	-	1
3084	4	-	-	-	1	-	5
3085**	1	-	1	-	-	-	2
3092	17	-	5	-	-	-	22
3093**	-	-	1	-	-	-	1
3095	10	1	2	-	-	-	13
3096**	2	-	1	-	-	-	3
3099**	1	-	1	-	-	-	2
3101**	-	-	1	-	-	-	1
3104**	1	-	1	-	-	-	2
3106**	1	1	-	-	-	-	2
3107**	-	-	1	-	-	-	1
3114**	-	1	-	-	-	-	1
3149**	-	-	1	-	-	-	1
3160	6	1	1	-	1	3	12
3170	2	-	1	-	-	1	4
3171	2	1	-	-	-	-	3
3177**	1	-	-	-	-	-	1
3184	3	-	1	-	-	-	4
3185**	2	1	-	-	-	-	3
3192	4	2	-	-	-	-	6
3193**	-	1	-	-	-	-	1
3195	6	-	-	-	-	-	6
3196**	8	-	-	-	-	-	8
3197**	6	-	-	-	-	-	6
3198	2	-	-	-	-	-	2
3200	1	-	-	-	1	-	2
3201**	4	1	-	-	-	-	5
3204	8	1	-	-		-	9
3208	4	1	-	1	-	-	6
3237	4	-	3	-	-	-	7
3238**	1	-	-	-	-	-	1
3239**	2	-	3	-	-	-	5
3251	1	-	2	-	-	-	3
3271**	7	2	9	-	-	-	18
Totals	120	14	36	1	3	4	178

* 26Ek prefix omitted
** Materials recovered from tested sites (cf. Schmitt 1989a)

From Whining Rock Shelter (26Ek3204, in the Eastern Periphery), a unique, small rounded hammerstone (Figure 80) shaped by pecking and abrasion was recovered. It possesses a number of striations, probably resulting from employment in edge preparation (i.e., repeatedly dragging its surface across biface edges to improve edge angles or strengthen platforms). Five additional hammerstones display braided scratches on one or more surfaces from use in similar tasks.

Like the metate assemblage (cf. Chapter 12), hammerstones reflect exploitation of the immediate environment for raw material (cf. Schmitt 1989a). For example, most (61%) hammerstones collected from sites in the Eastern Periphery are quartzite cobbles (Figure 81); aside from opalite, informal survey of Undine Gorge and portions of Little Antelope Creek during field operations found quartzite cobbles to be common. Similarly, basalt hammerstones are most abundant at sites in the Western Periphery (Figure 81), where basalt is a common, often dominant rock type in the Bitterroot Ridge area and adjacent Basalt Canyon.

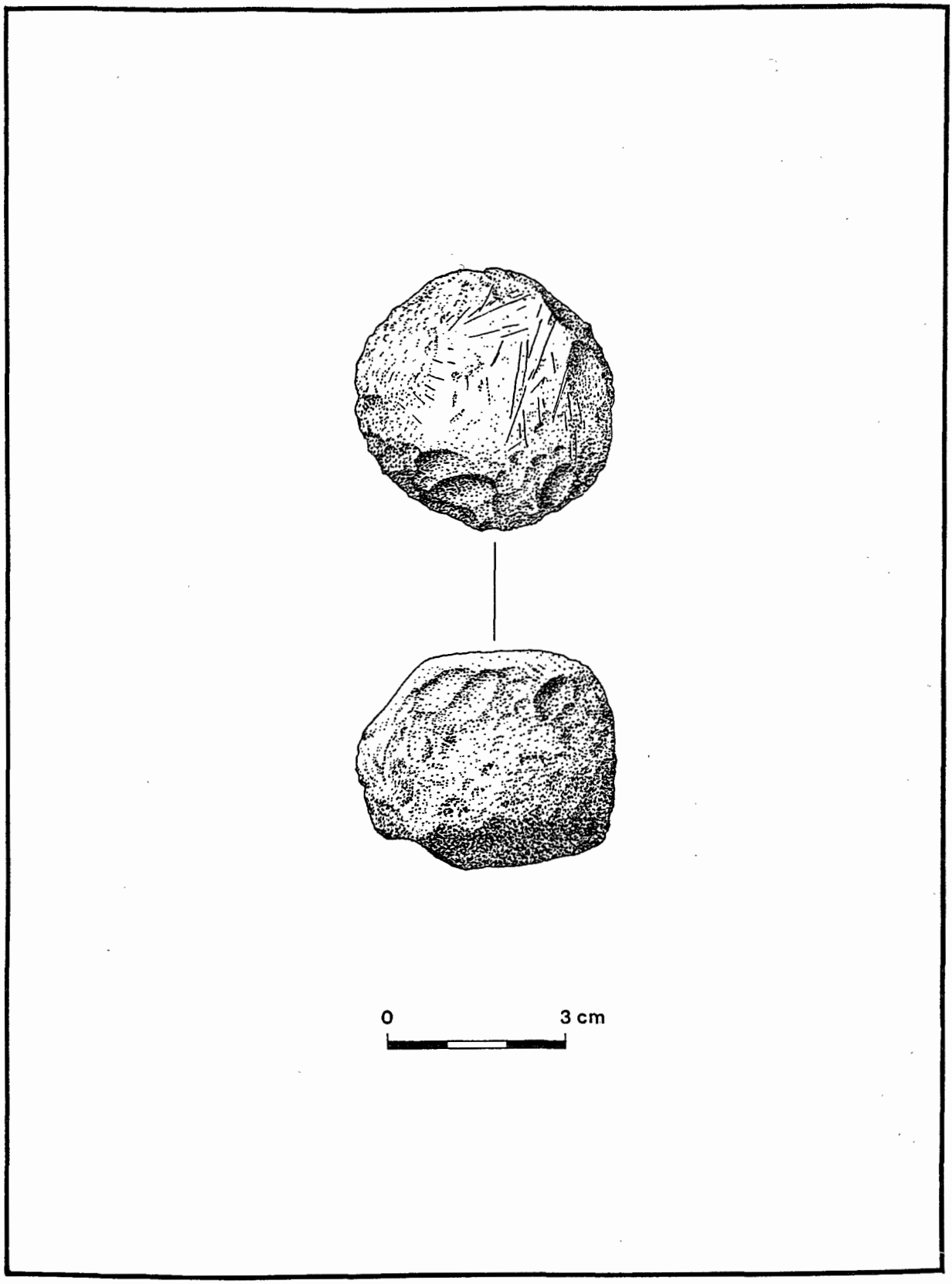


Figure 80. Shaped basalt hammerstone.

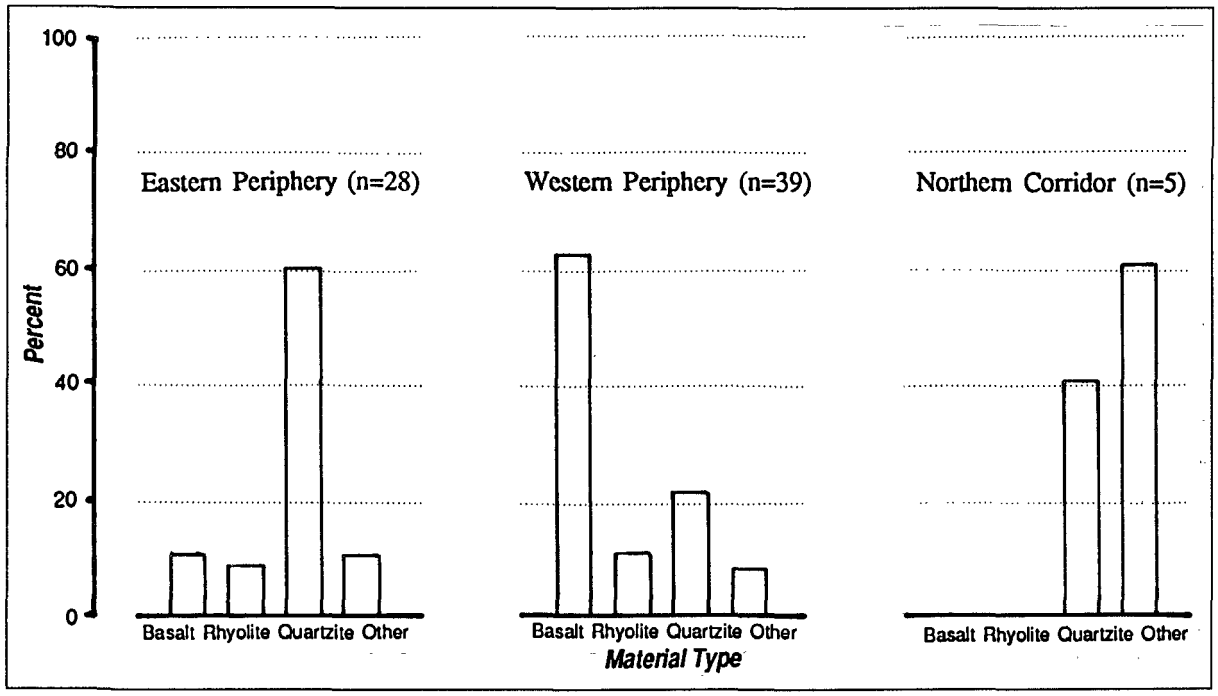


Figure 81. Percentage of hammerstone raw material type by area.

Most hammerstones on "imported" raw materials exhibit inordinate battering when compared to those manufactured on locally available materials. For example, five (63%) of the quartzite hammerstones recovered from the Western Periphery are small, easily portable (probably curated) cobbles displaying pronounced use wear as a result of multiple and extensive use episodes. Although few, those collected from sites in the Northern Corridor reflect the use of "imported" raw materials (including opalite and quartzite cobbles), most of which exhibit pronounced battering and spalling (e.g., Figure 82), also suggesting use histories perpetuated by curation.

While the inferred function of these artifacts is the reduction of toolstone, some may have been used in other percussion tasks, such as the sharpening of exhausted grinding surfaces and the processing of resistant organics (e.g., bone, plant fiber). Two hammerstones apparently were used to process pigment; both are stained with ochre. Specimen 500-331, recovered from the surface of 26Ek3237, has a pitted, crushed area central to a slightly convex surface (cf. Schmitt 1989a:Figure 19a), possibly from use as a percussor during bipolar core reduction (cf. Ahler 1986:60-63; Elston 1986b:106-109). Finally, three specimens are fire-blackened and/or cracked from use as hearth rocks.

Scratched Stone

A collection of seven scratched stones (cf. Table 98) comprises one of the more interesting artifact classes. Much like scratched hammerstones, these distinctive artifacts possess numerous, often deep, striations (cf. Figure 80) indicative of use in biface edge preparation, but they display no evidence of use in percussion tasks (e.g., battered margins).

During field operations and in the laboratory, we produced virtually identical damage on rhyolite and tabular basalt pieces by dragging surfaces across biface margins to prepare

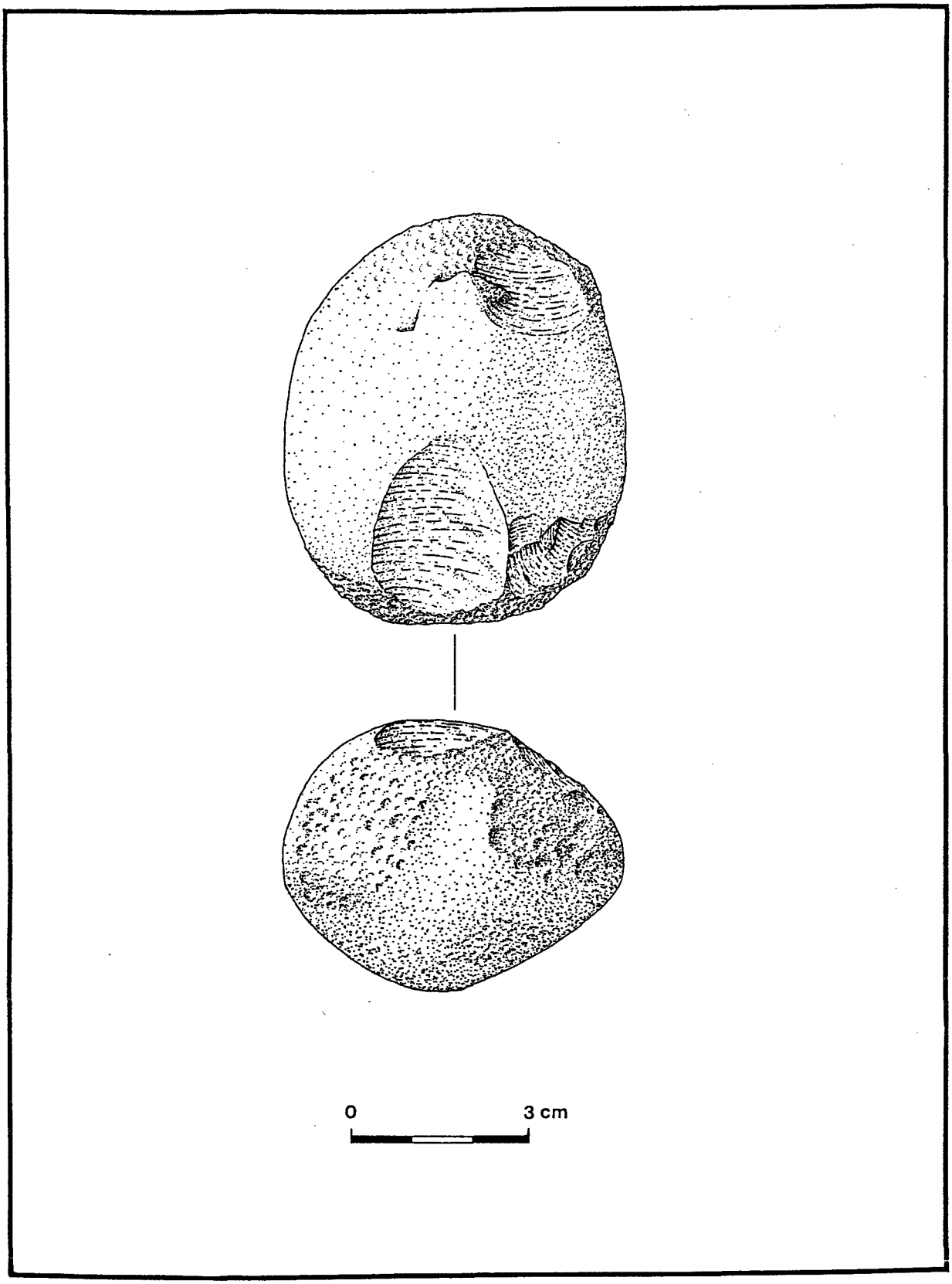


Figure 82. Quartzite hammerstone.

edge angles and platforms prior to subsequent flake removal. Initial damage consists of a series of linear striations; subsequent use produces polished facets that obscure most of the striations. These polished, faintly striated surfaces are very similar to use wear on what others have referred to as small grinding stones or palettes (e.g., Thomas and Bierwirth 1983), but further scrutiny of our specimens disclosed scratches within low (i.e., unpolished) areas of the working surface indicative of contact with a sharp, undulating surface or edge.

Three Tosawihi specimens manufactured on welded tuff unequivocally were utilized in biface edge abrasion, not for subsequent controlled flake removal due to their friability. Two rhyolitic scratched stones and one of basalt may have been employed in expedient percussion, but evidence of battering on each is disjunct and superficial, suggesting that they, also, served only in the abrasion of biface margins.

The seventh stone is a large (847.7 gm) piece of hematite possessing numerous, often pronounced scratches within a slightly concave facet. Although it may have been used as an abrader to strengthen biface margins, it probably served as a portable source of pigment.

Choppers

Excavations at eight sites yielded 16 choppers (cf. Table 98; Appendix J). The assemblage contains a variety of shapes, sizes, and raw material types (including opalite, basalt, and rhyolite), but most were manufactured on cobbles or tabular slabs easily manipulated with one hand (Figure 83). Although choppers may have been used in an array of processing tasks (including toolstone reduction), they probably were employed most frequently in processing organic materials (e.g., wood, fiber, and dried meat; cf. Elston 1986b).

Manufacturing techniques involved removal of three or more flakes (commonly unifacial) by percussion to achieve a sharp, roughly linear working edge; working edge angles vary between 48° and 68°, with a mean of 56°. Differences in working edge angles may represent purposeful modification for a specific task, or they simply may be functions of raw material type (i.e., hardness and initial morphology). Similarly, a few "shaped" specimens may be products of edge damage (i.e., spalling rather than purposeful shaping) of the naturally sharp edges of tabular pieces (Figure 84c); likewise, some may represent reuse of spalled hammerstones for expedient chopping tasks. All these implements display some degree of use wear, but attrition is most apparent on opalite choppers where extensive step fracturing is common.

Hammer-Chopper

Investigation of a quarry pit at 26Ek3208 returned a single hammer-chopper (specimen 501-1). Manufactured on a flake detached from a large basalt cobble (i.e., cortex is still present on 50% of its dorsal surface), the distal end and lateral margins have been flaked bifacially (edge angles range between 28 and 40°) to achieve an oval/spatulate outline for employment in chopping and/or digging tasks, probably to excavate soft tuff layers between lenses of opalite to isolate toolstone. Its proximal end is blunt and extensively battered indicating that it served as a hammer as well.

Shovels

The morphology of three unifacially flaked tabular pieces suggests that they served as shovels; two were collected in association with quarry pits and one from a reduction/ residential locus on Bitterroot Ridge. The context of the former specimens suggests they were employed in quarrying; their uses probably included excavation and removal of tuff and other non-siliceous

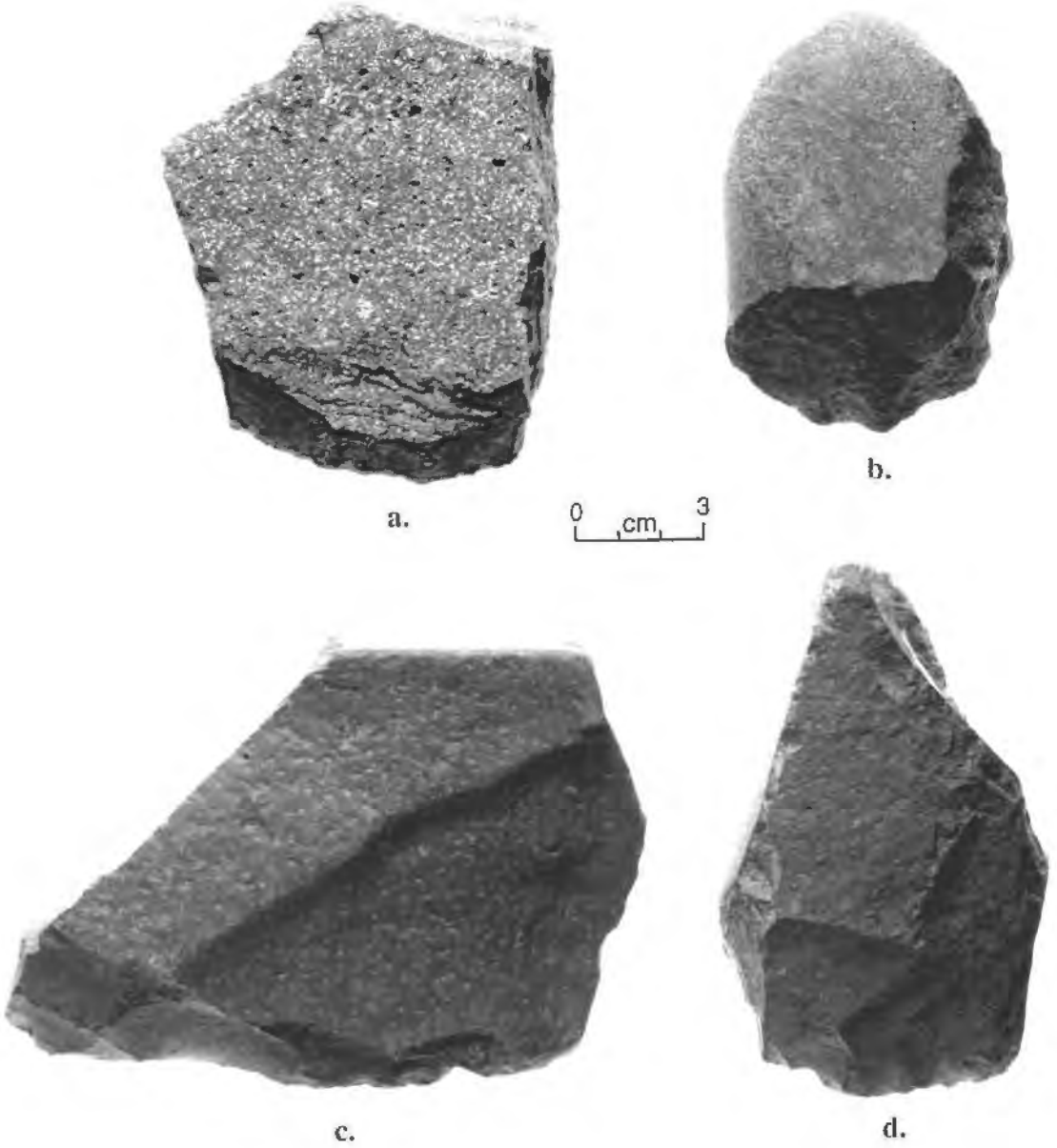


Figure 83. Selected choppers.

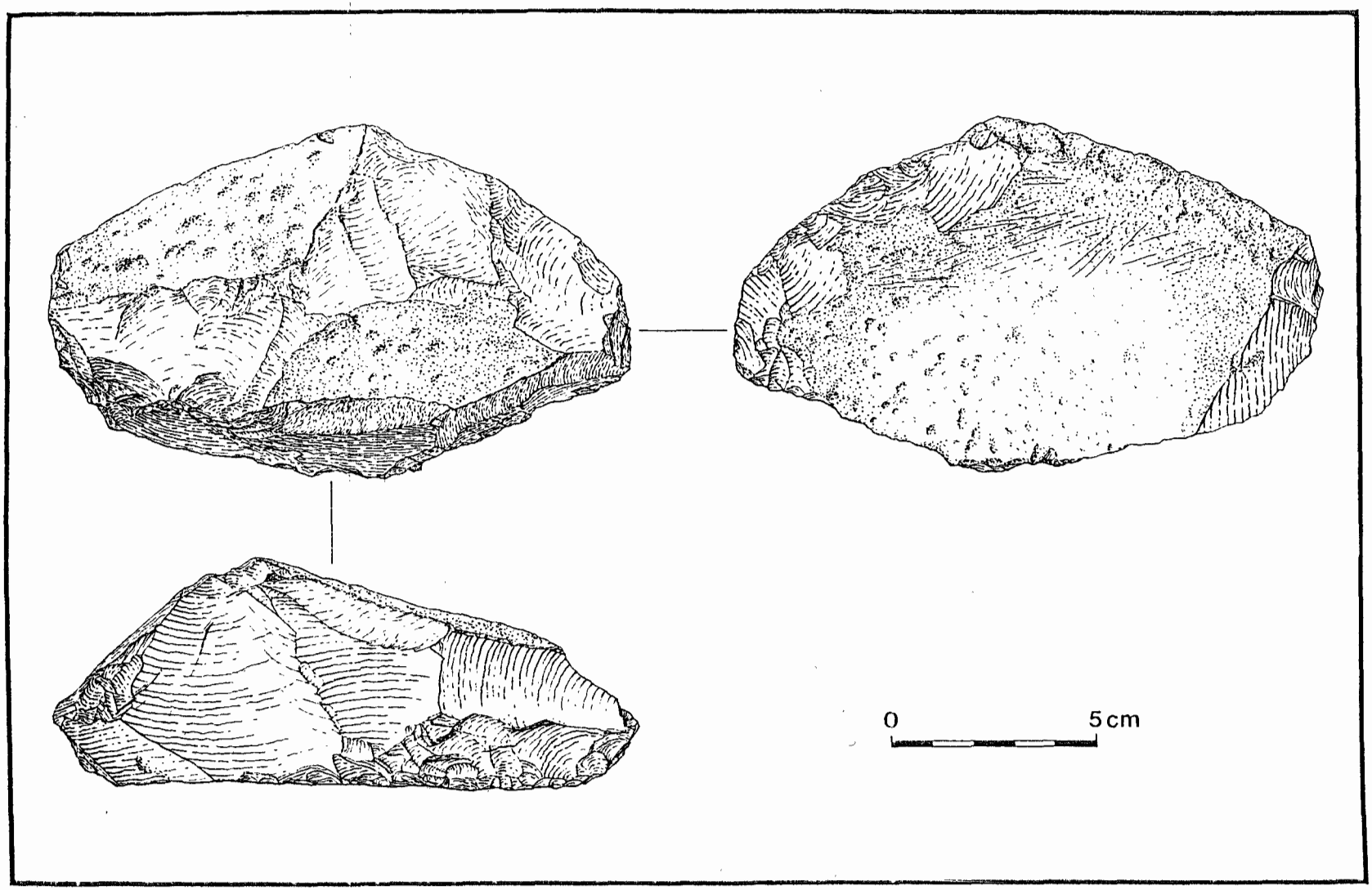


Figure 84. Basalt scraper plane.

debris, and served as "dust pans" in removal of hash and waste flakes. Although they might also have been utilized in the extraction of toolstone, minimal edge damage suggests less rigorous tasks.

One specimen is a large tabular piece of basalt exhibiting manufacture and light edge damage along 30 cm of one margin. The artifact may have served as a quarrying tool, but its provenience, large size, and overall morphology suggest it functioned as a digging tool for non-quarrying activities (e.g., soil excavation).

Scraper Planes

Three nearly identical specimens collected from 26Ek3160 (cf. Appendix J) and a larger, dome shaped specimen collected from the surface of 26Ek3170 share sufficient morphological characteristics that they constitute a separate artifact class. Each of the 26Ek3160 specimens is triangular in cross section and exhibits purposeful decortication on two or more surfaces to create sharp edges (cf. Figure 84). Further flake removal along these edges is reflected by small flake scars and step fractures that resulted from scraping and/or battering tasks. Two specimens display large polished and striated areas on their flat ("bottom") surfaces and adjacent flaked margins (cf. Figure 84); lateral edge damage and polished lower surfaces suggest these artifacts were pushed across another surface (after Thomas and Bierwirth 1983:229).

Although functionally ambiguous, these artifacts may have been used in a number of tasks, including the processing of dried meat and vegetal materials, and the sharpening of exhausted grinding surfaces (cf. Kowta 1969 and references therein). Scraper planes are often abundant in certain southern California sites where they were utilized in the processing of agave and yucca (e.g., Kowta 1969; Salls 1985). Based on the context of the Tosawihi specimens (most are from Bitterroot Ridge), these artifacts may have been utilized in the processing of bitterroot or other tubers; their polished surfaces resulted from abrasion against a hard grinding surface. In the Great Basin, Thomas and Bierwirth (1983:226-229) report similar artifacts at Gatecliff Shelter.

Discussion

Whether associated with single-episode reduction stations, extensive quarry pit complexes, or residential loci, percussion and processing cobble tools were encountered throughout the Tosawihi Quarries vicinity; their abundance is predictable in and near the quarries. While hammerstone frequencies at some quarry pit localities are seemingly low (e.g., site 26Ek3200), this may be a product of data recovery strategies; most such sites were investigated by backhoe trench excavations and subsequent stratigraphic documentation rather than by large scale systematic collection; a number of hammerstones (including "throw-stones"), however, were observed in quarry pit stratigraphic profiles. Conversely, some reduction and/or residential loci returned numerous hammerstones, due probably, in part, to extensive horizontal and vertical excavations (cf. especially site 26Ek3092; Table 98; Chapter 16).

The assemblages also contain choppers and scraper planes used in the processing of resistant organics, and additional toolstone processing and extraction tools, including shovels, a multifunctional hammer-chopper, and scratched stones used to abrade biface margins. A number of hammerstones possess striated surfaces from use in similar tasks, but their battered margins indicate they remained in the knapper's grip for subsequent flake detachment.

Although a few of the hammerstones display evidence of purposeful shaping, most are ovate cobbles that can be held comfortably and controlled with one hand. Variations in overall

morphology and use wear suggest some were collected on or near- site for use in an expedient task, but acquisition of most, especially the quartzite specimens (cf. Figure 82), probably involved extended search time for cobbles possessing the desirable shape, size, and weight. The wealth of simple percussion cobble tools in the quarries, and the multitude of elegant opalitic bifaces and tools they produced, dramatically reflects the persistence and functional utility of the class.

Chapter 12

GROUND STONE

Dave N. Schmitt

Archaeological excavations in and adjacent the Tosawihi Quarries returned 127 ground stone artifacts (Table 99). Although some specimens appear to have been employed in two or more tasks and the function of a few others remains ambiguous, assemblage components can be segregated into seven analytic categories: manos, metates, mortars, pestles, abraders, shaft abraders/smoothers, and other modified stone (e.g., beads and pipes). Combining materials collected from initial testing and subsequent excavations, this chapter focuses only on the 108 ground stone artifacts recovered from sites subject to data recovery (cf. Table 99); attributes of ground stone from all Tosawihi sites are presented in Appendix K, but discussions of specimens recovered from sites subject only to testing are presented elsewhere (Schmitt 1989a).

Table 99. Ground Stone Artifacts by Site.

Site* (Locality)	Manos	Metates	Mortars	Pestles	Abraders	Shaft Abraders	Beads	Misc. Ornaments	Pipes	Total
3032 (19)	-	1	-	-	-	-	-	-	-	1
3032 (93)	-	1	-	-	-	-	-	-	-	1
3092	-	7	1	-	1	-	-	-	-	9
3095	1	11	-	1	1	2	13	-	1	30
3096**	1	-	-	-	-	-	-	-	-	1
3106**	-	1	-	-	-	-	-	-	-	1
3149**	1	1	-	-	-	-	-	-	-	2
3160	3	9	4	2	-	1	-	1	-	20
3165	-	4	-	-	-	-	-	-	-	4
3170	1	1	-	-	-	-	-	-	-	2
3171	1	-	-	-	-	-	-	-	-	1
3181**	1	-	-	-	-	-	-	-	-	1
3184	1	-	-	-	-	1	-	-	1	3
3185**	1	-	-	-	-	-	-	-	-	1
3190**	-	1	-	-	1	-	-	-	-	2
3192	2	5	-	-	-	-	-	-	1	8
3196**	-	1	-	-	-	-	-	-	-	1
3198	-	-	-	-	-	1	-	-	-	1
3201**	1	1	-	-	-	-	-	-	-	2
3204	1	-	-	-	-	-	-	-	-	1
3228**	-	1	-	-	-	-	-	-	-	1
3237	-	8	-	-	-	-	-	1	-	9
3238**	-	1	-	-	-	-	-	-	-	1
3251	6	11	-	-	1	-	-	-	-	18
3271**	2	2	1	1	-	-	-	-	-	6
Total	23	67	6	4	4	5	13	2	3	127

* 26Ek prefix omitted
** Materials recovered from tested sites (cf. Schmitt 1989a)

Each specimen was assigned to an analytic category on the basis of gross morphology, ethnographic observations, and comparison with other Great Basin archaeological assemblages. Documentation of each artifact included provenience, raw material type, degree of use wear, dimensions, and completeness; these and additional attributes are presented in Appendix K. When possible, fragmented artifacts were reconstructed.

Manos

A total of 16 manos was recovered from data recovery at eight sites (cf. Table 99; Appendix K). Eight are unifacial, four are shaped and bifacial, and four are unshaped handstones reflecting the expedient use of small cobbles (e.g., Figure 85a). Shaped manos (12-1b-d) are commonly ovoid to sub-rectangular (i.e., "breadloaf;" Kramer and Thomas 1983b:234-235), possess slightly convex working surfaces, and have a mean thickness of 4.2 cm. Most of the shaped manos (n=8, 67%) exhibit light use wear, but some display rather extensive surface fatigue.

Additional to the commonly inferred function of manos (processing/milling of seeds and nuts), some handstones may have been used to process animal hides or wood (cf. Adams 1989). While Tosawihi manos may have been so employed, the only clear evidence of such use is revealed by battering, staining, and fire alteration. Three manos have battered ends and/or margins suggesting percussive use; damage probably accrued while resharpening other grinding surfaces (e.g., pecking a metate), pounding roots, bone and/or dried meat, or from use as hammerstones in lithic reduction.

One mano, shaped and unifacially utilized, bears ochre staining on its working surface and along one margin, suggesting pigment processing or manufacture (cf. Drews 1986; Juell 1990; Kramer and Thomas 1983). Finally, four manos are fire-blackened and cracked, suggesting re-use for lining roasting pits and/or hearths.

Metates

Represented largely by specimens displaying unifacial use wear (n=47, 84%), 58 metates were recovered (cf. Table 99; Appendix K). While most are fragmentary (n=51) and a few may represent palettes (e.g., Juell 1987a:68-72; Kramer and Thomas 1983b:238), all are classified here as metates.

The assemblage contains both thin, "portable" tabular specimens (often exhibiting pronounced surface fatigue; cf. Figure 86), and thick, heavy boulder types (compare, for example, attributes of specimens 26Ek3095-1002-7 and Locality 93-01-1 in Appendix K, respectively). Fourteen specimens were shaped by percussion, mostly (n=9) to achieve an oval outline (cf. Steward 1941:325). Not surprisingly, most shaped metates (n=10, 71%) are portable (curated?) tabular types (thickness range = 1.2 - 3.3 mm, mean = 2.5 mm) recovered from sites containing residential toolkits.

Although raw material types vary, stone utilized as metates reflects locally available rocks (cf. Schmitt 1989a). In the Western Periphery, for example, especially along Bitterroot Ridge and its vicinity, exposures of exfoliated tabular basalt are abundant. Although basalt metates were found elsewhere, this rock type was favored in the Western Periphery (Figure 87). Similarly, rhyolite outcrops are common in the Northern Corridor (especially in and adjacent Perron Canyon), and metates in this region reflect local raw material (Figure 87).

Six metates displaying multiple, parallel use wear striations were recovered from three sites. While linear striae probably were produced during seed grinding (i.e., stone-against-stone abrasion), deep striae truncating superficial use wear on two specimens suggest use as cutting slabs as well (cf. Juell 1990).

Ochre-stained, fragmented, and fire-blackened specimens evidence use other than food processing (cf. Schmitt 1989a for additional examples at Tosawihi). One item bears red ochre residues suggesting pigment manufacture, probably in addition to food processing. At 26Ek3095,

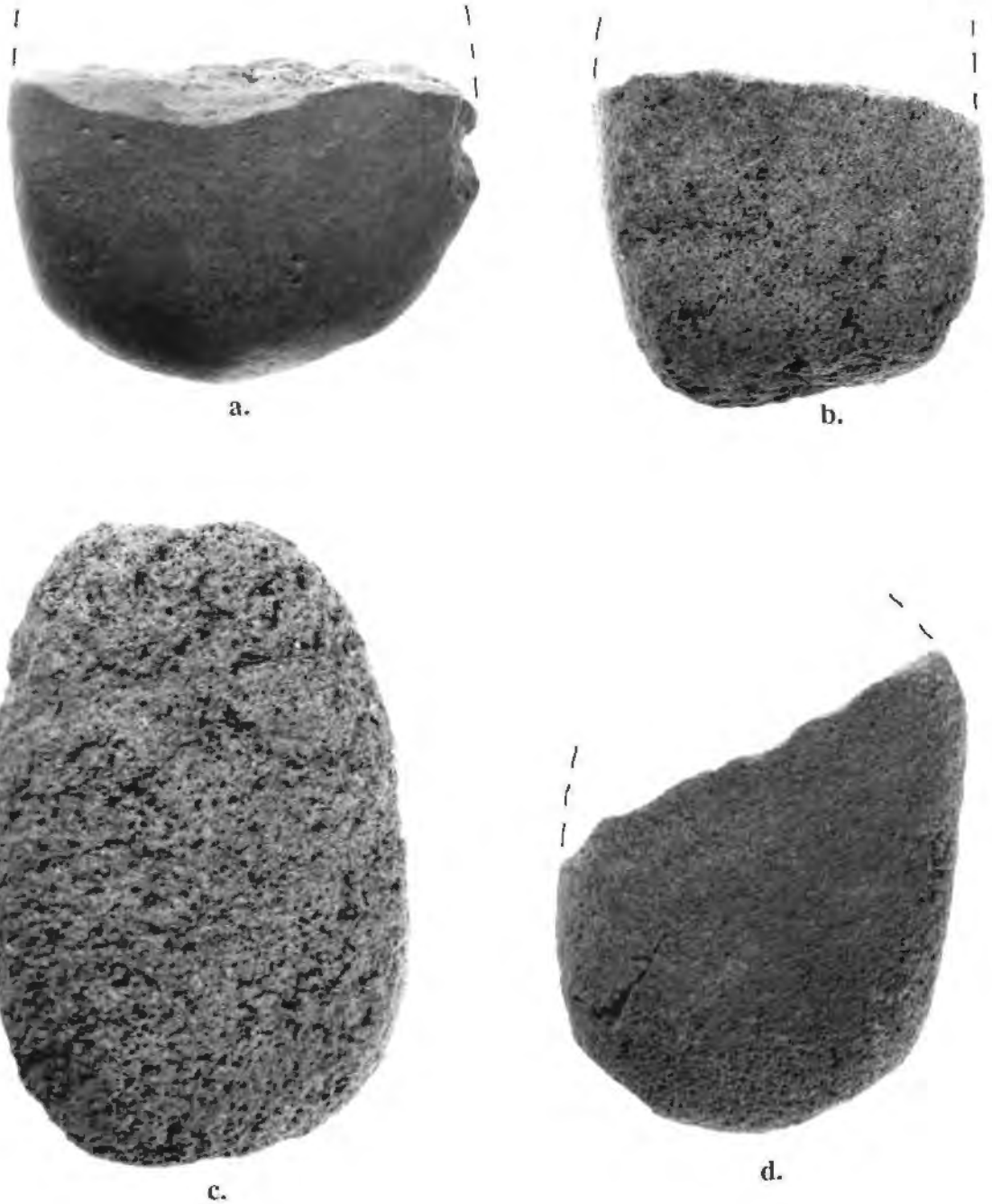


Figure 85. Selected manos.



Figure 86. Tabular shaped, resharpened metate.

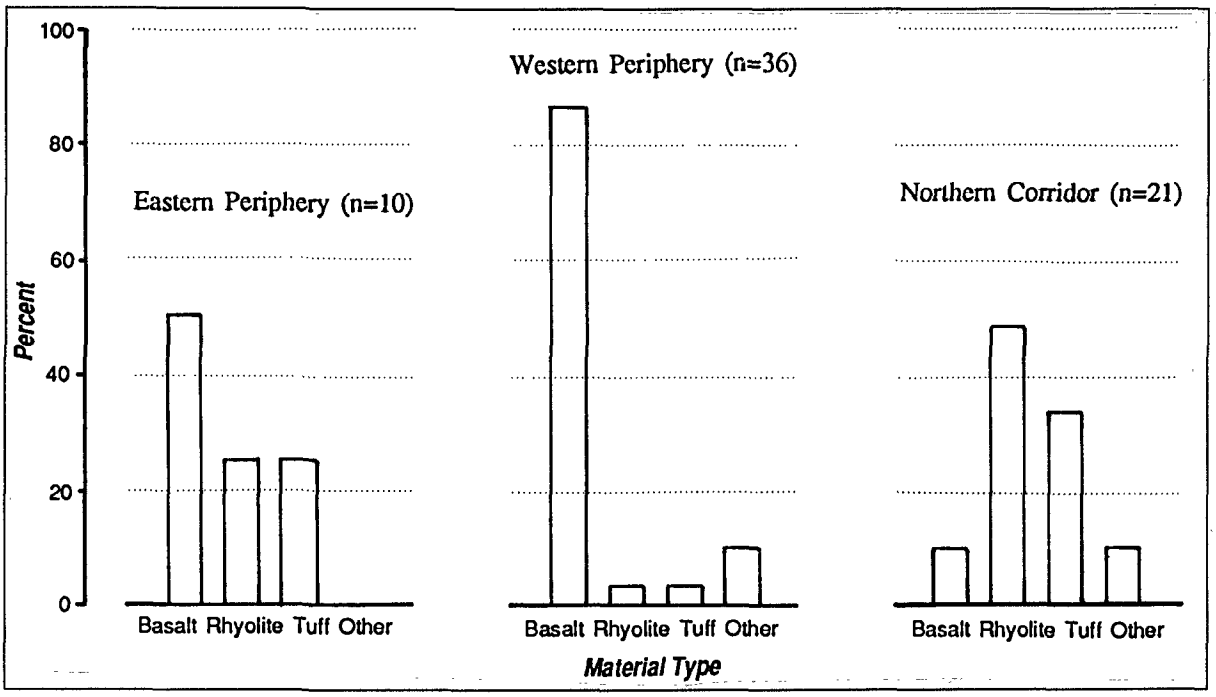


Figure 87. Metate raw material types by area at Tosawihi.

fragments of a single brecciated ignimbrite metate (comprised of macroscopic crystals of quartz, feldspar, and biotite in a glassy matrix [cf. Prinz et al. 1977:349]) were recovered from Features 15 and 19, ca. 25 m apart. Context suggests that fragments of a broken metate were scavenged from Feature 15 for use as boiling stones/hearth rocks by the later inhabitants of Feature 19, where numerous angular fragments were found in association with an ashy hearth-like feature (Budy 1989:231-232). The ignimbrite rock of which this artifact is made is highly distinctive; its source has been identified as an outcrop approximately 3 km east of the site (Mark Bartlett, personal communication).

Finally, also at 26Ek3095, neighboring Features 24 and 25 each yielded single conjoining fragments of a basalt metate; these features are only 5 m apart, suggesting transport via natural processes (e.g., slope wash) rather than human intervention.

Mortars

Five incipient basalt mortars were found at two sites in the western periphery (cf. Table 99; Appendix K). Two complete mortars and two mortar fragments were collected at 26Ek3160, two as extra-feature surface isolates and one each from Features 19 and 23. Specimen 26Ek3160-519-8 is manufactured on a large (6.4 kg) basalt cobble. The artifact exhibits a circular, blackened, slightly polished facet (diameter = 6.5 cm) central to its planar surface. Although fragmented, specimen 26Ek3160-523-14 displays a similar, centrally worn area (diameter ca. 6.0 cm) on a slightly concave surface. The two remaining specimens exhibit similar use wear zones, each approximately 6.5 cm in diameter, centered on a slightly concave surface. Non-feature excavations in Unit 12, 26Ek3092 also yielded a large (13.6 kg) incipient mortar. Similar to specimens at 26Ek3160, the artifact exhibits a polished, circular facet, ca. 6.5 cm in diameter, central to a slightly concave surface, partially truncated by battering.

Although these artifacts probably were used in conjunction with pestles (and possibly hopper baskets) to process plant foods including bitterroot and other tubers, each also may have functioned as metate and/or anvil. Steward (1941:235) notes that "a few small mortars, adopted by the (Snake River) Shoshone from the Plateau or Northwest, were used only by toothless old people to grind their food."

Pestles

Three pestles were recovered on Bitterroot Ridge in the Western Periphery. One (Figure 88a) consists of two refitted pieces encountered ca. 20 meters apart. It is oval in cross section, battered (spalled) and lightly polished on each end, and exhibits overall polish and striations perpendicular to its long axis; these latter modifications appear to be the result of manufacturing techniques (e.g., shaping by transverse abrasion) rather than of use wear. Specimen 26Ek3160-01-208 (Figure 88b) is a complete pestle (subrectangular in cross section) with a slightly polished and battered distal (working) end, suggesting use with a stone mortar. The artifact shows no distinct evidence of shaping and may represent the expedient use of an elongated basalt cobble.

The remaining pestle is an end fragment (oval in cross section and subrectangular in plan outline) displaying superficial polish and spalling from use.

Abraders

Three artifacts were classified as abraders (cf. Appendix K). One has been modified extensively to a rectangular shape, and exhibits further modification in overall polish and faint striations from use wear; it probably was employed in the finishing stages of bone or wood tool manufacture (e.g., awls, needles). Similarly, specimen 26Ek3095-6381-4 is shaped overall and exhibits use wear polish and striations along one edge and on one surface; it, too, possesses a lightly polished trough on one end (1.3 cm in width) which may have been used to finish/resharpen pointed organic artifacts (e.g., bone awls). Both artifacts are small and can be employed easily using thumb and two or three fingers.

Surface collections at Feature 6, 26Ek3251 returned a rhyolitic cobble with a single abraded edge. The facet displays rather extensive polish and multiple, parallel striations, probably from working wood and/or bone, or processing animal hides (cf. Adams 1989). Kuffner (1982) reports similar artifacts collected from Rossi Mine sites.

Shaft Abraders/Smoothers

Five shaft abraders/smoothers were recovered from four sites (cf. Table 99; Appendix K). Four are manufactured on sandstone and one on a piece of coarse-grained welded tuff. Groove width/diameters are similar, ranging between 7.1 mm and 8.0 mm (mean = 7.6 mm). These artifacts probably were employed to smooth arrow mainshafts, but may have been used in the manufacture of bone awls.

At 26Ek3095, two shaft abraders were recovered from Features 15 and 19; each is manufactured on sandstone and possesses one linear trough. The specimen from Feature 15 is interesting in that it retains manufacture marks (i.e., pecking) in the groove, suggesting

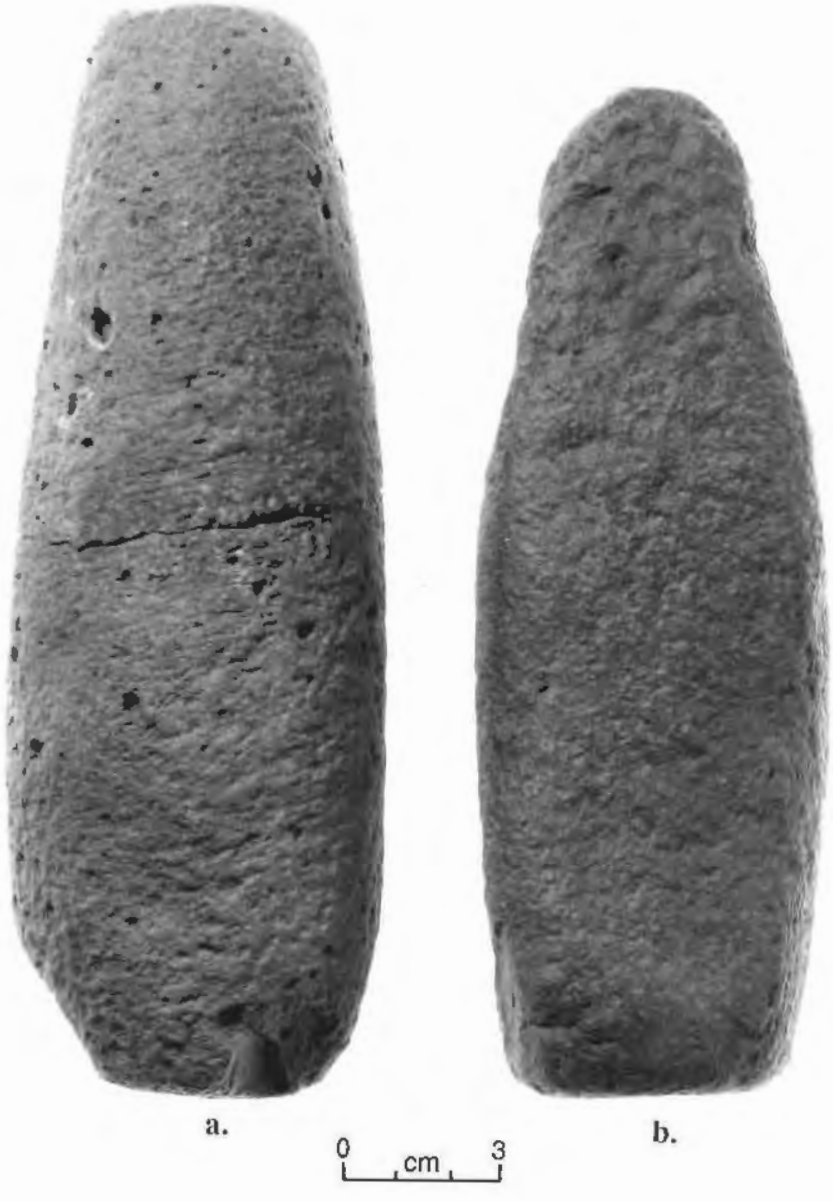


Figure 88. Selected pestles.

minimal use (Figure 89a). While the other four specimens represent single artifacts, this groove, manufactured on a flat surface, may represent half of a paired abrader (cf. Flenniken and Ozbun 1988). Specimen 1002-7 (Feature 19) was found in association with two Desert Side-notched projectile points, suggesting post A.D. 1300 manufacture/use.

Surface collections at Feature 3, 26Ek3184, recovered a sandstone shaft abrader associated with a Cottonwood projectile point. The abrader possesses three linear troughs on one surface, two of which intersect near the middle of the working surface to form an "X", with the third offset to one side. Specimen 26Ek3198-1003-1 is a small rectangular piece of sandstone with shallow, linear troughs truncating each of its four flat surfaces (Figure 89b); associated diagnostic projectile points include four Desert Series specimens. Finally, specimen 26Ek3160-515-1, an ovate shaft abrader/smoother exhibiting one groove (Figure 89c), is similar to one recovered from Horizon 3 (A.D. 700 - ca. A.D. 1300) at Gatecliff Shelter (cf. Kramer and Thomas 1983:Figure 105; Thomas 1983b:491-492).

Most of the Tosawihi shaft abraders are associated with Desert Series points. Although they appear to have been used prior to the introduction of the bow and arrow (i.e., pre-A.D. 500; see, for example, Aikens 1970:28-29, 67-69), stratigraphically provenienced specimens from selected northern and central Great Basin sites suggest that they flourished after ca. A.D. 500 (Figure 90).

Other Modified Stone

The remainder of the ground stone assemblage consists of extensively shaped, "exotic" specimens, including 13 tuff beads, two ornamental (?) objects, and three cylindrical stone fragments representing various stages of pipe manufacture.

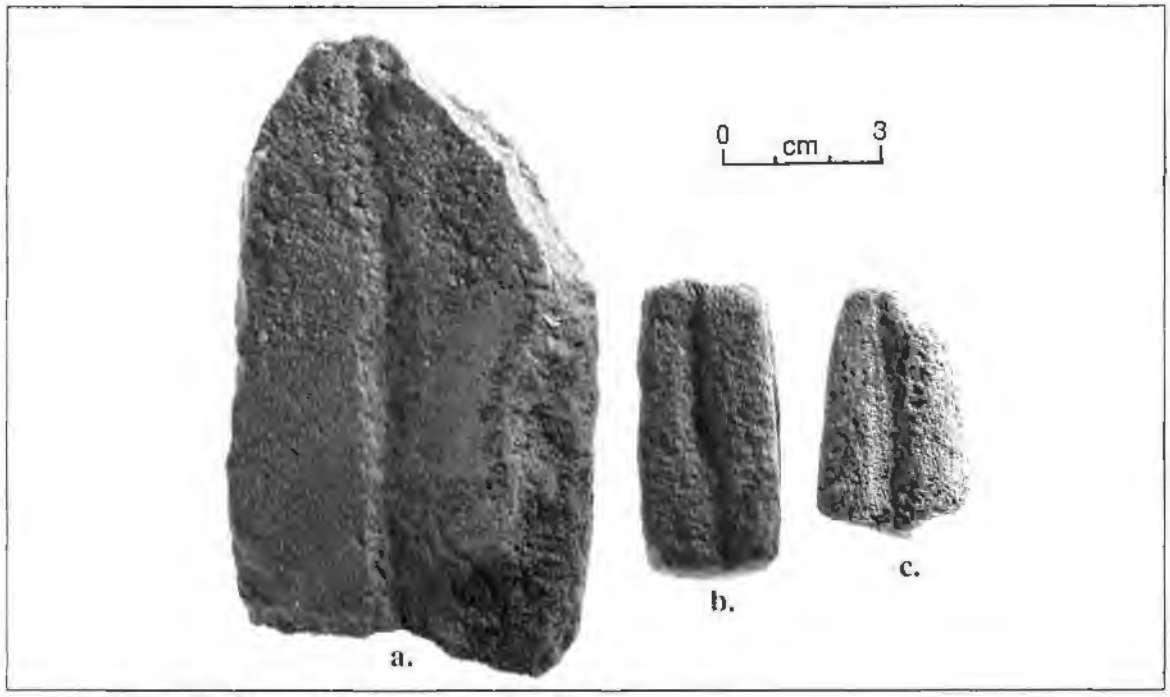


Figure 89. Selected shaft abraders/smoothers.

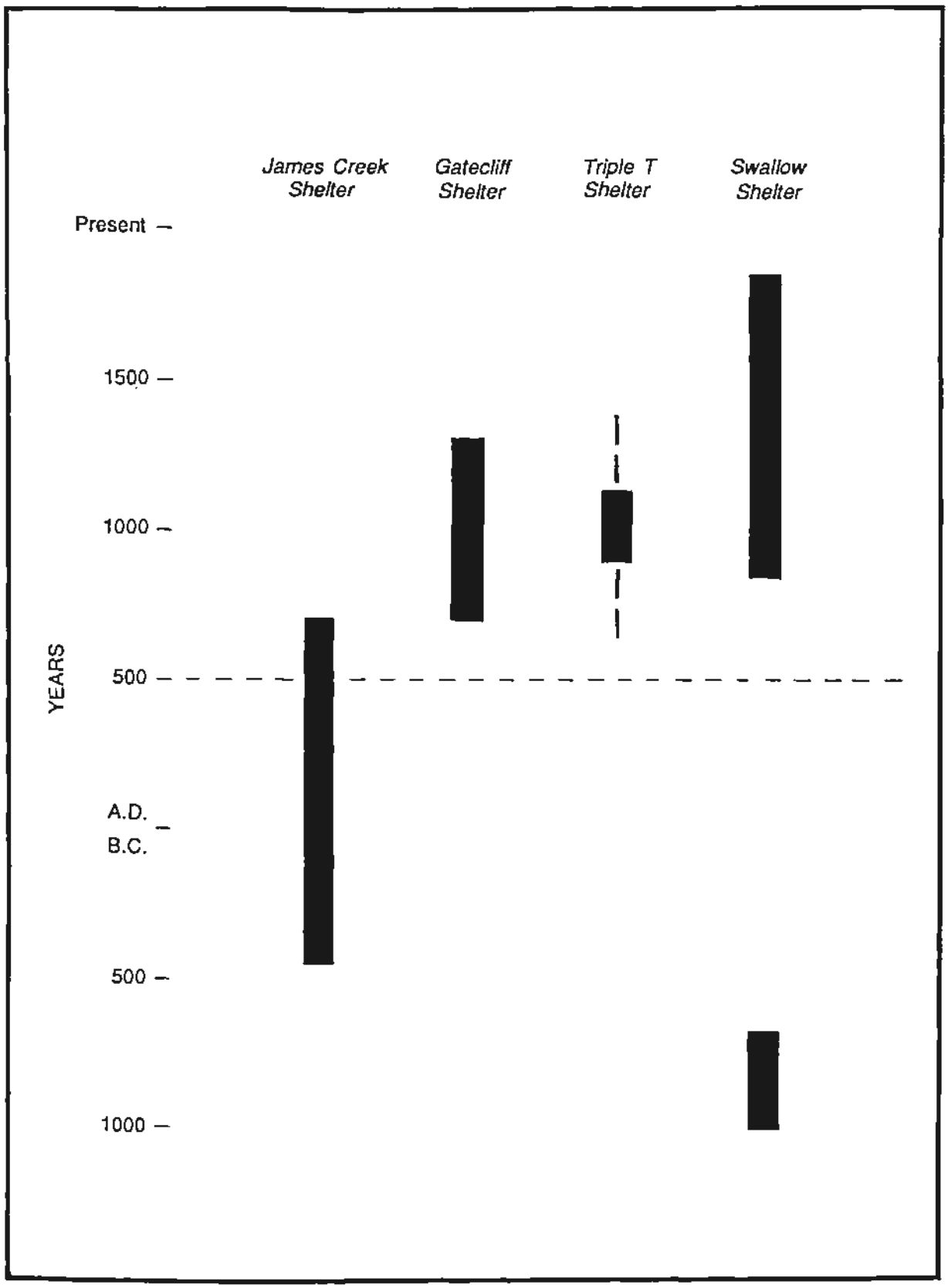


Figure 90. Chronological distribution of shaft abraders/smoothers at selected Great Basin sites (compiled from Elston and Budy 1990; Thomas 1983; Thomas and Kelly 1988; Dalley 1976).

Beads

Excavations at Features 19 and 22, 26Ek3095, yielded eight tuff beads and five bead preforms (Table 100; Figure 91). The raw material of their manufacture is a weathering, friable tuff (much like blackboard chalk), commonly possessing an off-white interior with a weathered pink outer surface. Both the complete beads and preforms display multiple (often random) striations from limation against a slightly abrasive surface, and each of the finished (i.e., perforated) specimens bears evidence of biconical drilling. The recovery of these unique beads and preforms suggests contemporaneous occupation of the neighboring features sometime after A.D. 1300, a date signaled by a Desert Side-notched point at Feature 19.

Table 100. Provenience and Attributes of Tuff Beads and Bead Preforms, 26Ek3095.

Spec. No.	Fea.	Unit	mm Length	Width	Thick.	Figure	Type
6381-5	19	24	11.7	10.6	1.4	12.7g	Complete
6381-6	19	24	13.7	9.0	1.9	-	Fragment
6381-7	19	24	12.9	8.5	2.2	12.7e	Fragment
9381-4	19	24	5.1	6.6	1.4	-	Fragment
6221-1-1	22	16	11.6	8.8	5.9	12.7a	Preform
6221-1-2	22	16	15.4	11.1	9.5	-	Preform
6221-1-3	22	16	10.5	6.3	1.8	-	Fragment
6241-7	22	17	11.8	9.9	2.0	12.7h	Complete
6241-8	22	17	10.7	10.3	1.8	12.7c	Preform
6281-4-1	22	19	8.8	11.3	1.9	12.7f	Fragment
6281-4-2	22	19	10.3	7.5	3.0	-	Fragment
6301-1	22	20	13.2	12.6	2.5	12.7b	Preform
6302-1	22	20	9.6	9.1	2.5	12.7d	Preform

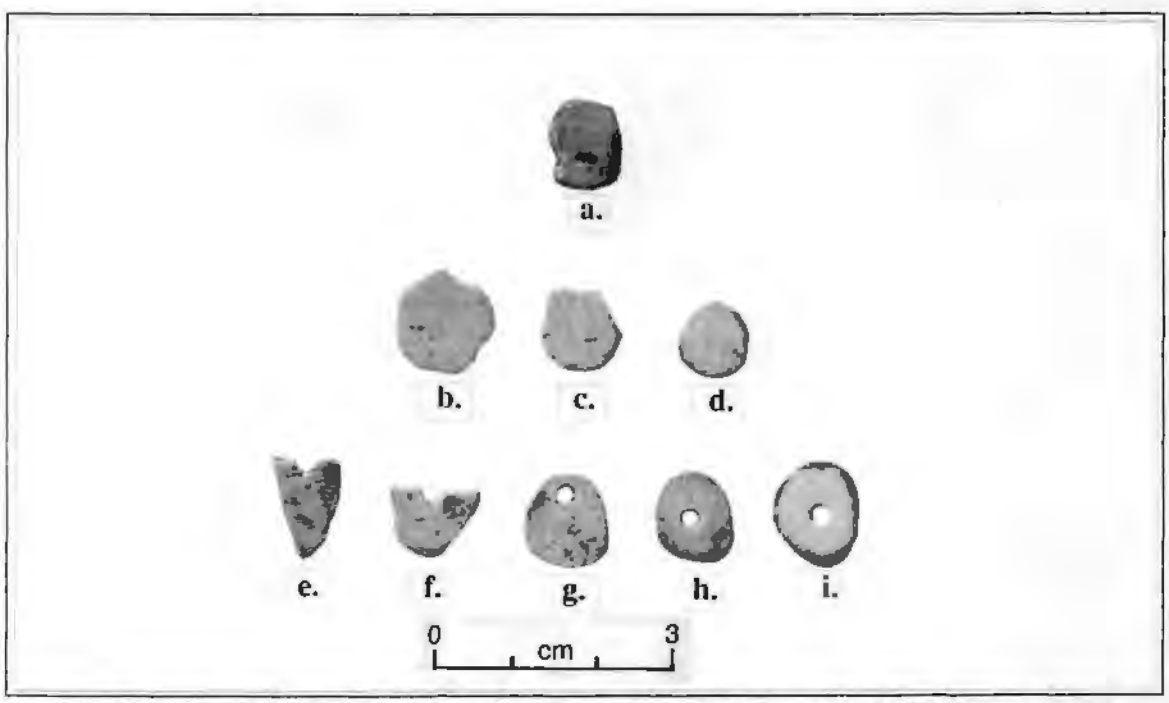


Figure 91. Selected tuff beads and preforms, 26Ek3095 (cf. Table 100). Specimen *i* was manufactured on-site by the author.

Additionally, numerous small, pink tuff nodules were retrieved from Feature 22. In an attempt to replicate the recovered ornaments, I manufactured a bead from one of these nodules by bifacially reducing (i.e., thinning) its surfaces with abrasion against a small basalt slab. I perforated the uniformly thinned disc biconically with a thin, elongated opalite flake (total manufacture time ca. four minutes); the result was a bead very similar to those recovered from the archaeological deposits (cf. Figure 91). Clearly, the archaeological recovery of unfinished beads and bead preforms suggests that such beads were manufactured on-site.

Ornaments

Non-feature surface collections at 26Ek3160 yielded a fragment of an incised tuff disc (Figure 92a). The artifact bears evidence of numerous attempts to perforate its center biconically (i.e., three drilled pits truncate one surface and four the other), one of which succeeded in creating an aperture 6.5 mm in diameter. Numerous decorative linear striae are present on one surface, creating a "sunburst" pattern radiating from the perforation. The artifact is 17 mm thick, weighs 18.7 gms, and its estimated (complete) outer diameter is ca. 80 mm.

Similar artifacts, manufactured on a variety of material (including stone, baked clay, and pitch), have been found in numerous Great Basin sites, particularly along the western and eastern margins (e.g., Drews and Schmitt 1986; Hattori 1982; Heizer 1974; Hull and White 1980; Pendleton 1985b). These artifacts are functionally enigmatic, but may have been used as pendants, charms, transits, and/or spindle whorls employed in the manufacture of cordage (cf. Tuohy 1986a). In the eastern Great Basin, stone and ceramic discs have been found in Fremont contexts dating from about A.D. 500 - 1300 (Tuohy 1986a:237).

Specimen 2142-1 was retrieved from subsurface deposits immediately adjacent a hearth at 26Ek3237. The artifact possesses a scored neck near one end (neck diameter = 12.7 mm) truncating an otherwise unmodified chalcedony nodule (Figure 92b). This puzzling artifact probably served as an ornament/effigy, but might have been utilized in fishing (e.g., a net sinker or lure weight). It weighs 11.2 gm and has a maximum diameter of 21.8 mm.

Pipes

Two fragmented smoking pipes and an unfinished pipe were collected. Excavations at Feature 19, 26Ek3095, retrieved a shaped tuff cylinder with a small pit in one end (maximum diameter = 8.4 mm; Figure 92c); the opposite end is truncated. This fragment probably represents a pipe preform that broke early in manufacture; two apparently associated Desert Side-notched points suggest that the event occurred after A.D 1300.

Specimen 26Ek3195-502-10 is a schist pipe in several fragments (outer diameter = 22 mm; reconstructed in Figure 92d) exhibiting multiple, longitudinal manufacture striations within its aperture. The external surface is decorated; deep, isolated striations circumscribe its short axis. The aperture is flared at one end, tapering gradually to a smaller opening at the other, a trait characteristic of ethnographic Shoshone pipes illustrated by Steward (1941: Figure 4 c-d).

A small pipe (stem?) fragment was recovered from excavations at Feature 2, 26Ek3184 (Figure 92e). Manufactured on a piece of welded tuff, the artifact possesses a small ridge adjacent to its aperture on one end, indicating that it had been scored around its circumference and then snapped from a larger cylindrical segment, a technique commonly employed in the manufacture of bone beads (cf. Aikens 1970; Schmitt 1990). Its internal surface is blackened from use and its estimated outer diameter is 18 mm.

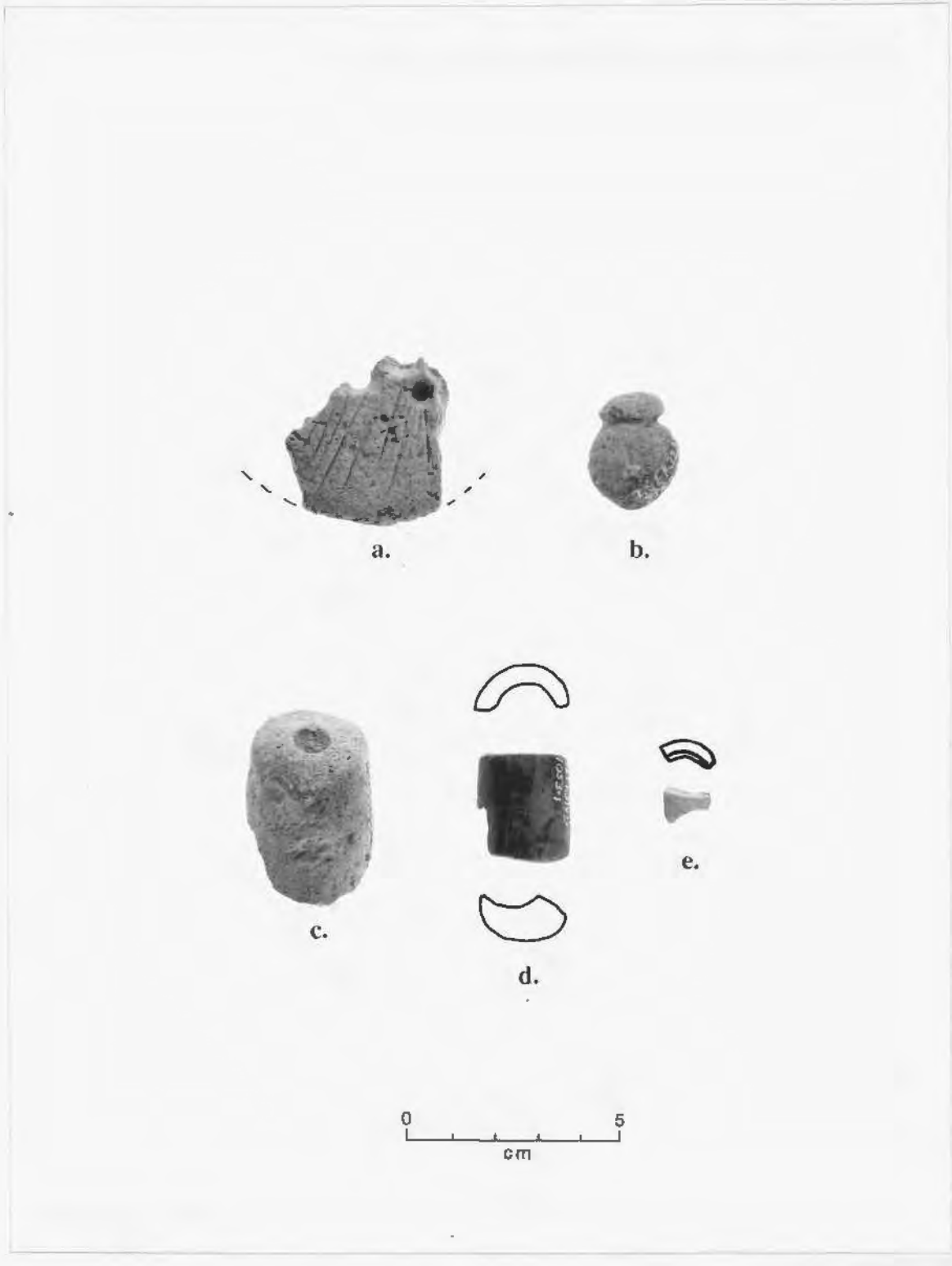


Figure 92. Ornaments (a-b) and pipes (c-e).

Although infrequently, complete pipes, pipe fragments, and pipe preforms have been recovered from archaeological sites throughout the Great Basin, including single specimens retrieved from James Creek Shelter (Horizon II-III; A.D. 700 - 1300; Juell 1990; Budy and Katzer 1990) and Gatecliff Shelter (Horizon 4; 1250 B.C. - A.D. 700; Kramer and Thomas 1983:236; Thomas 1983b). Budy (1987) reports an elaborate stone pipe from Panaca Summit.

Discussion

The presence of metates and other grinding implements at Tosawihi clearly attests the coincidence of subsistence resource processing and toolstone acquisition and reduction. Although ground stone assemblages at most sites are small and commonly display only superficial use wear (cf. Table 99; Appendix K; also cf. Schmitt 1989a), the abundance of ground stone in association with multifunctional toolkits at some of the larger sites supports inferred residential use, especially at 26Ek3095, 26Ek3160, and at 26Ek3251 where differences in morphology and raw material types indicate at least nine different metates are represented.

To quantify the relative role of these assemblages at Tosawihi, Table 101 presents projectile point to milling tool ratios for five selected Great Basin sites and three Tosawihi sites containing abundant ground stone associated with multifunctional toolkits. Although occupational intensity of the former sites was variable through time, each contained ample evidence of campsite use, including the presence of hearths, butchered and burned artiodactyl bone, and/or expedient brush shelters (Aikens 1970; Dalley 1976; Elston and Budy 1990; Rusco et al. 1979; Thomas 1983b). The ratios of "hunting versus gathering" assemblages at these sites and those at Tosawihi are markedly similar, suggesting that the Tosawihi sites sometimes served as campsites and/or short-term base camps.

Table 101. Projectile Point to Mano/Metate Ratios at Selected Great Basin Sites.

Sites	Projectile Points	Manos and Metates	Ratio
Hogup Cave	648	319	2:1
Swallow Shelter	279	21	13:1
James Creek Shelter	194	44	4:1
Maggie Creek (Ek1670)	18	37	.5:1
Gatecliff Shelter	561	158	4:1
26Ek3095	33	12	3:1
26Ek3160	58	12	5:1
26Ek3251	40	17	2:1

At Features 15 and 19, site 26Ek3095, evidence of metate scavenging and reuse by later site occupants is quite clear. Although direct testimony of similar activities at other Tosawihi sites was not identified, most sites contain ample evidence of multiple occupations (often spanning up to four millennia), and one must suspect that the scavenging and use/reuse of toolstone and ground stone was quite common (cf. Simms 1983).

Chapter 13

CERAMICS

Dave N. Schmitt

Fragmentary ceramics occur frequently in some regional Great Basin assemblages. While basic attributes (wall thickness, color, morphology, composition) usually suffice to classify sherds to the level of *type* (e.g., Shoshone Brownware, Fremont Grayware), *varietal* classification often is beyond reach. This is the case with our modest Tosawihi assemblage. The present chapter, then, while it offers some typological classifications and chronological inferences, focuses more on provenience, raw material identification, and production techniques (cf. Griset 1986:122).

We collected 242 ceramic sherds from nine Tosawihi sites. In the Western Periphery, 26Ek3092 and 26Ek3160 yielded 60 and 61 sherds, respectively, and 26Ek3239 and 26Ek3251 in the Northern Corridor each returned two specimens. From five sites in the Eastern Periphery we recovered 117 sherds, most (102) collected from Features 1 and 2 at 26Ek3192. Fremont Grayware and Shoshone Brownware overwhelmingly dominate all Tosawihi assemblages; only six sherds defy classification.

Analytic Methods

Sherds were sorted by vessel on the basis of thickness, color, and provenience, supplemented, where possible, by refitting to confirm single vessels of origin. Ceramics were described and classified by color, decorative technique and style, manufacture technique, and wall thickness (cf. Juell 1987b). Temper initially was identified by examining freshly broken edges under 25-30x magnification. Provenience, color, thickness, and preliminary observation of temper constituents contributed to the selection of 10 sherds for petrographic analysis (Table 102); in some instances, results of thin-section analysis assisted typological classification and the assignment of fragments to individual vessels.

Table 102. Results of Petrographic Thin-section Analysis of Selected Sherds.

Site No.	Ref. No.	Unit	Level	Fea.	RAW MATERIALS A	Q	B	S	T	C	PASTE % Clay	TEMPER COMPOSITION (%) F	Q	P	A	T	M	Type
26Ek3092	6041	6	1	-	+	-	-	-	-	-	40	20	5	10	15	-	-	B
	6243	16	3	-	-	+	-	-	-	-	80	~8	~10	-	-	-	-	(G)
	6285	18	2	-	+	+	-	-	-	-	50	16	12	5	5	-	-	B
	8285	18	2	21	-	+	-	+	-	-	70	5	>20	1	1	-	-	(G)
	6582	33	2	-	+	+	+	-	-	-	45	30	~25	<1	<1	-	-	B
26Ek3160	1013	13	S	1	+	-	-	-	+	-	50	15	5	12	10	-	-	B
26Ek3192	6201	26	1	2	-	+	+	-	+	-	60	>20	5	5	5	-	-	B
	6600	46	S	1	-	+	+	-	+	-	60	20	5	5	5	-	-	B
26Ek3198	509	-	S	9	+	-	-	-	-	-	45	25	10	10	10	~1	<1	?
26Ek3251	3006	-	S	6	+	-	-	-	+	+	40	25	7	12	5	-	<1	B

Key:

Level
S = Surface
1 = S-10 cm
2 = 10-20 cm
3 = 20-30 cm

RAW MATERIALS (clay and temper)
A = Andesite
Q = Quartzite
B = Basalt
S = Schist
T = Welded Tuff
C = Chert

TEMPER
F = Feldspars
Q = Quartz
P = Pyroxene
A = Amphibole
T = Magnetite
M = Mica

Type
B = Brownware
G = Grayware
? = Indeterminate
( )= Corrugated

Following definitions advanced by R. Madsen (1977), Fremont Graywares were identified by temper and mineral inclusions added to the paste, as well as color, wall thickness, and overall morphology; tentative identification of graywares as the Great Salt Lake Gray Fremont variant is based largely on the proximity of the Tosawihi Quarries to this Fremont core area (cf. D. Madsen 1986:Figure 4; Marwitt 1970:Figure 84). Shoshone Brownwares were classified on the basis of surface color, wall thickness, surface manipulation, and temper (cf. D. Madsen 1986; Tuohy 1986b).

Brownware

Surface collections and excavations at six sites returned Shoshone Brownware (or "Shoshone ware;" cf. Thomas 1988:225 and references therein) sherds representing at least eight fragmentary vessels (Table 103). Two vessels were identified in the "boulder" activity area of 26Ek3092, one north of the boulder in Units 33 and 36, and one in Unit 18 (cf. Table 103 and Chapter 16). The northernmost sherds (n=7) are composed of fine to very coarse (ca. 7 mm) andesitic/basaltic and quartzite clay and temper; large shrinkage cracks surround the coarse temper particles, probably resulting from differences in thermal expansion rates of quartzite and andesites/basalts. The temper particles are parallel to the well laminated clays, suggesting that the vessels were shaped by coiling. All sherds lay immediately above a fire hearth (Feature 9) which returned radiocarbon dates of 650 ± 50 B.P. and 750 ± 70 B.P. (ca. A.D. 1250).

Excavations south of the boulder at 26Ek3092 recovered two Brownware sherds in Unit 18 (Table 103; cf. Figure 112); they are composed of andesite and quartzite particles, both water worn. The andesite clays and temper were ground prior to vessel formation; most of the quartzite appears unground. Although there is no detectable lamination of the clay to suggest coiling, both fragments are very small, precluding reliable inferences of manufacturing technique.

Table 103. Provenience and Attributes of Tosawihi Vessels by Site.
All measurements are in millimeters.

Site No.	Unit(s)	Depth (cm B.S.)	Fea.	No. Sherds	WALL THICKNESS Range	Mean	Coiled	Type*
26Ek3092	6,7,9	0-10	-	5	4.2 - 6.0	5.4	+	B
26Ek3092	18	10-20	-	2	5.9 - 6.7	6.3	-	B
26Ek3092[a]	3, 16-19, 23, 28, 37	10-60	[b]	46	3.2 - 5.5	4.2	+	(G)
26Ek3092	33, 36	10-30	-	7	5.0 - 6.0	5.4	+	B
26Ek3160	13-17, 27, 42	0-2	1	61	5.3 - 7.5	6.5	+	B
26Ek3171	--	Surface	-	8	6.2 - 6.7	6.4	?	G
26Ek3174	--	Surface	2	1	-	9.4	?	B
26Ek3181	10, 11	0-2	1	2	6.5 - 6.6	6.6	+	B
26Ek3192	[c]	0-20	1,2	102	4.5 - 9.1	7.0	?	B
26Ek3198	2	0-2	9	4	6.3 - 6.7	6.4	+	?
26Ek3239	1	0-10	1	2	5.8 - 5.9	5.9	?	?
26Ek3251	--	Surface	6	2	6.1 - 6.9	6.5	+	B

* See Table 102 key
[a] May represent two fragmentary pots
[b] Sherds were found throughout Features 7, 14, 20, 21, and 23, and associated non-feature unit/levels
[c] Sherds were found throughout Units 5-7, 14-16, 22-25, 42, 43, 46, and 47 in Feature 1, and in Units 26, 29, 39, and 40 in Feature 2

Fragments of a third vessel were recovered from the middle terrace of 26Ek3092 (Units 6, 7, and 9; cf. Table 103 and Figure 114). Forty percent of these sherds consist of grainy andesitic clays (cf. Table 102) derived directly from the decomposition of materials used as temper. Both clay and temper appear to have been ground prior to vessel construction, but the range of particle size does not suggest winnowing of raw materials. Each sherd is uniform light brown throughout, suggesting firing under uniform conditions.

One hundred two Brownware sherds were collected at 26Ek3192; 89 were recovered from block excavations in Feature 1 and 13 from random excavations at Feature 2 (cf. Table 103; Chapter 17). Although provenience suggests two vessels of origin (i.e., the features are ca. 15 m apart, and no sherds were found intervening), petrographic compositions of sherds from each are virtually identical (cf. Table 102). Similarly, each feature returned sherds with isomorphic "fingernail" decorations (Figure 93d; also cf. Tuohy 1986b:Figure 6) and are a similar red/brown, indicative of a poorly controlled firing atmosphere.

The paste is composed of rock and mineral fragments, including basalt, welded tuff, and quartzite. There is no apparent lamination of the clay, but petrographic analysis observed numerous parallel shrinkage cracks, indicating that the vessel may have been shaped by coiling. Most surfaces are deeply striated from brushing/smoothing (Figure 93a); interior striae are commonly random while exterior brush-marks tend to run parallel. Many sherds have a thin, dark, noncarbonaceous rind on their interior surfaces.

Excavations in Feature 1 at 26Ek3160 yielded 61 ceramic fragments; based on provenience, morphological similarities, and refitting, they probably represent a single pot (cf. Chapter 16). Temper consists largely of water worn andesite and tuff particles with sparse rounded quartzite grains. Similar to specimens collected at 26Ek3192, most surfaces are striated (often deeply) from scraping prior to firing. One specimen possesses a biconically drilled hole (Figure 93c), probably employed to repair a crack (cf. Tuohy 1986b:Figure 5); it may, however, represent an opening to facilitate hanging and/or carrying (cf. Heizer, Baumhoff, and Clewlow 1968; also cf. Butler 1979:Figure 4). Laminations in the clay, although faint, indicate that the

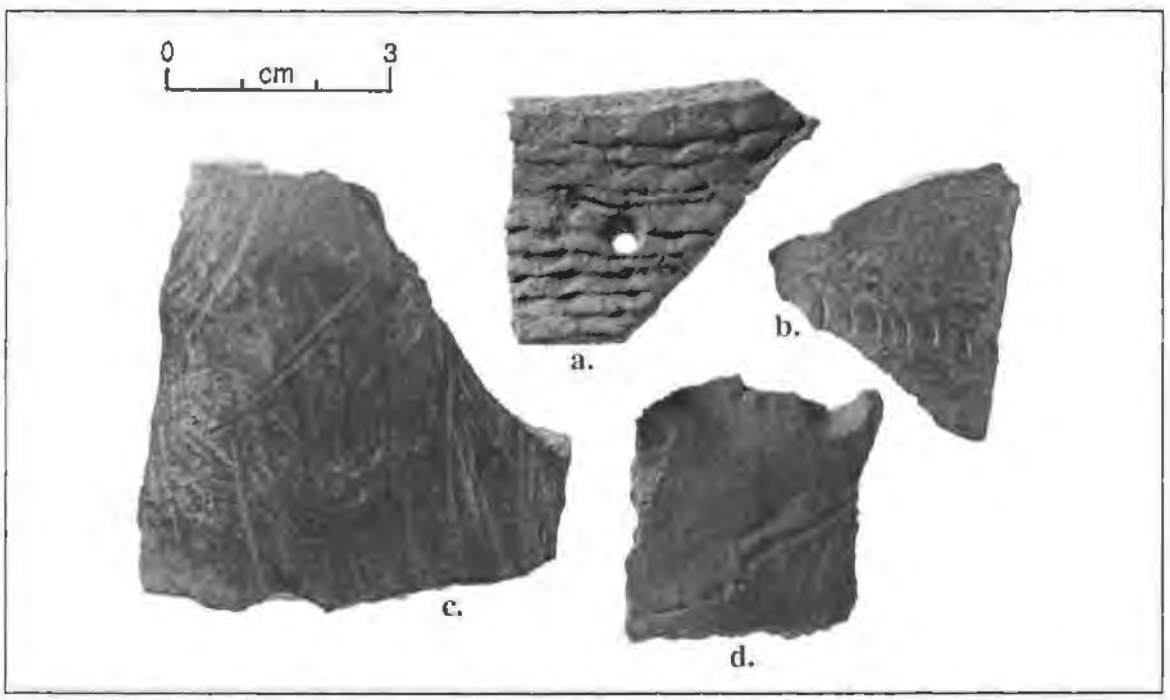


Figure 93. Selected Brownware (a, c-d) and Grayware (b) sherds.

vessel probably was shaped by coiling. Associated artifacts include flake tools, preforms, ground stone, and a projectile point assemblage dominated by Desert Series types (cf. Chapter 16).

A single, thick (9.4mm) Shoshone Brownware sherd was collected from the surface of Feature 2 at 26Ek3174 (cf. Table 103). A biconically drilled hole (diameter = 6.2mm) occurs along one margin, probably to facilitate vessel repair. The sherd has a very slight lateral and longitudinal curvature and may represent a basal fragment of a flat-bottomed jar. Its interior surface is deeply striated from manufacture and is covered with a black noncarbonaceous residue.

Two small brownware fragments were recovered from the surface of Feature 1 at 26Ek3181 (cf. Chapter 17). They are composed largely of feldspars and quartzite, and have uniform brown interior surfaces and a reddish brown rind on outer surfaces indicative of firing in an uncontrolled oxidizing atmosphere. Provenience, overall morphology, and similarity in temper and color suggest they pertain to the same vessel.

Also representing fragments of a single vessel, two sherds were collected from the surface of Feature 6 at 26Ek3251 (cf. Table 103); they lay approximately 2m apart in association with several bifaces, flake tools, preforms, and ground stone fragments (cf. Chapter 18). The sherds are composed of a mixture of decomposed andesite, welded tuff, and chert; the presence of tuff and "chert" may signal local manufacture, but the particles are too small to compare with Tosawihi tuffs and opalites. Very crude laminations in the clay and slight orientation of the rock fragments to these laminations indicate that the vessel was shaped by coiling. Petrographic analysis identified extensive shrinkage cracks, probably the result of different thermal expansion rates between the temper and clay.

Although the highly fragmented condition of brownwares at Tosawihi often precludes inferences of vessel type, rim sherds recovered from 26Ek3160 and 26Ek3192 (exhibiting straight-to-slightly curved profiles; Figure 94) suggest that these specimens are fragments of large, wide-mouthed, flat-bottomed jars (cf. D. Madsen 1986:214; Thomas 1988:224-227), or wide-mouthed conical pots (cf. Tuohy 1986b:Figures 2-4).

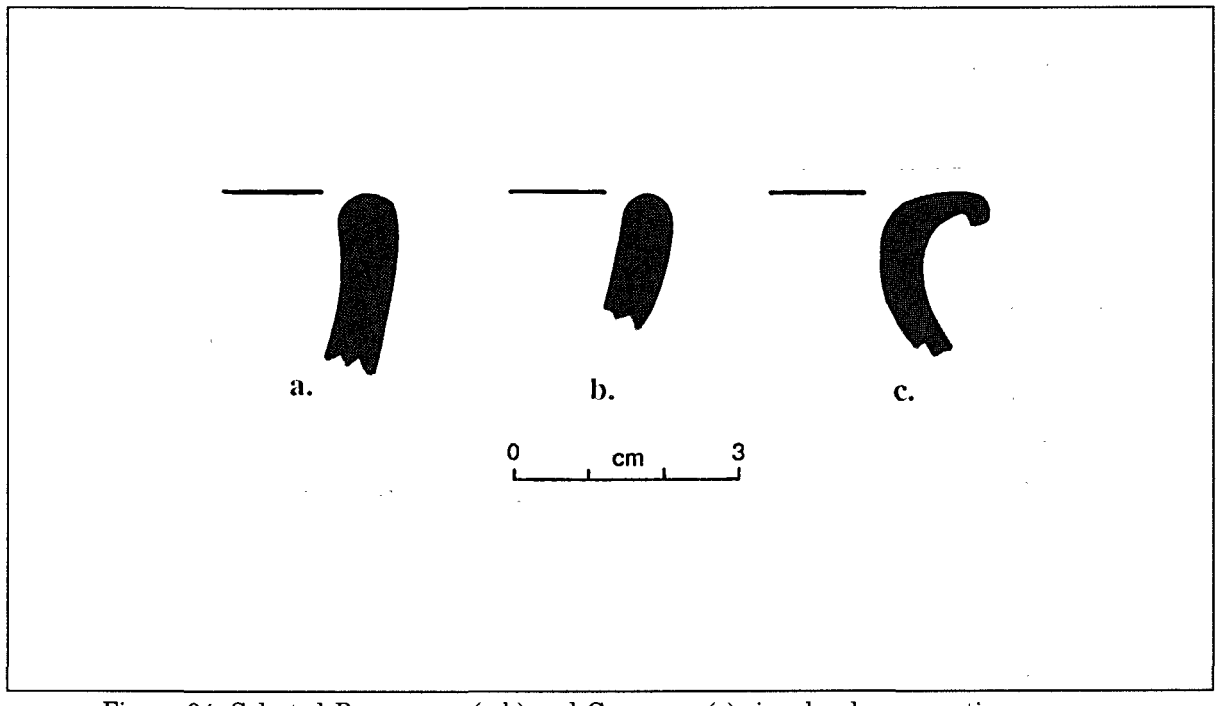


Figure 94. Selected Brownware (a-b) and Grayware (c) rim sherd cross-sections.

Brownware sherds have been recovered from numerous sites in the central and eastern Great Basin (e.g., Dalley 1976; Dean 1983; Jennings 1957; Magee 1964; Spencer et al. 1987; Thomas 1988; cf. especially Fowler 1968). Although Shoshone Brownware remains poorly dated, it probably postdates A.D. 1300 in the region (cf. D. Madsen 1986:214).

Grayware

Great Salt Lake Gray, the Salt Lake variant of Fremont ceramics (D. Madsen 1986), was recovered from two sites peripheral to the Tosawihi Quarries (cf. Table 103). At 26Ek3171, eight sherds were collected just south of Feature 3. Temper constituents include rounded and subangular quartz grains, feldspar, and mica. Exterior surface colors range from light to dark gray with dark gray-to-black interiors; some interior surfaces exhibit a thin, blackened, organic residue.

Excavations at 26Ek3092 returned 46 corrugated grayware sherds; provenience and overall morphology suggest a single vessel of origin, but differences in clay and temper observed in thin-section analysis may signal two pots (cf. Tables 102 and 103). The clay and temper are composed of quartzite and potassium feldspar particles which have been ground prior to manufacture. A number of sherds exhibit well-laminated, overlapping coils and distinctive dark brown rinds on interior surfaces, possibly the result of a thin slip applied to diminish porosity. Steward (1941:294) notes that several ethnohistoric groups in Nevada added vegetal material to the clay or applied it to vessel surfaces, but the residues on specimens from 26Ek3092 do not appear carbonaceous. One (neck?) fragment is drilled biconically, either for vessel hanging or repair (cf. Figure 93b), and two outcurving ("everted") rim sherds (cf. Figure 94c) suggest a wide-mouthed, short-necked jar or cooking pot (cf. Dalley 1976:54-57; Juell 1987b:110-113; also cf. D. Madsen 1986:208).

Great Salt Lake Gray has the widest temporal range of all Fremont ceramics, dating between A.D. 500 and A.D. 1300 (Marwitt 1970; D. Madsen 1986). Elsewhere in the region, Zeier and Zeanah (1987) report a Great Salt Lake Gray sherd collected in Toano Draw, and from James Creek Shelter D. Madsen (1990) reports a single sherd stratigraphically bracketed by hearths dated to 930 B.P. and 1240 B.P. (see also James 1986:108-111 and references therein for additional occurrences). Fremont graywares also have been recovered from sites along the Snake River in southern Idaho (Butler 1979) and at South Fork Shelter on the Humboldt (Heizer, Baumhoff, and Clewlow 1968).

Unidentified Types

Excavations at two additional Tosawihi sites yielded six small, typologically ambiguous sherds (cf. Table 103); four were recovered from Feature 9 at 26Ek3198, and one was petrographically analyzed (cf. Table 102). All are grayish brown, with interior and exterior surfaces exhibiting rinds slightly darker than their cores; the rinds may constitute organic residues. Temper is comprised largely of andesite, and all materials appear to have been ground prior to vessel formation. It is unclear whether the vessel was shaped by coiling, as no detectable laminations are present.

At 26Ek3239, excavations at Feature 1 yielded two small sherds. Similar to those from 26Ek3198, they are grayish brown and are composed largely of andesitic clay and temper; their small size precludes inferences on manufacture techniques. Although their cultural affinity remains unknown, they probably were manufactured and subsequently deposited sometime after A.D. 500 (i.e., the earliest known occurrence of pottery in the region; D. Madsen 1986:211-214).

Summary

Save for the prominence of welded tuff, the raw materials of Tosawihi pottery are similar to those from other sites in northern Nevada, western Utah, and at least one site in southern Idaho (the Wamuza site, 10Bk26; P. Dean, personal communication 1990). Welded tuff has been identified in sherds from a few sites in the region (e.g., Danger Cave), but generally is scarce. Consequently, the abundance of tuff across the Tosawihi landscape (cf. Chapter 2; Chapter 5) and its presence in brownwares recovered here may signal local ("on-site") manufacture of ceramic vessels.

To explore this possibility, we had a piece of welded tuff from a quarrying locality on Red Hill petrographically analyzed. Some tuff particles in the sectioned Tosawihi sherds appear vastly different from the raw material sample, suggesting manufacture elsewhere, but the specimens from 26Ek3192 contain grains identical in crystalline structure to the Red Hill tuff; the possibility of local manufacture cannot be rejected. Conversely, because local tuffs probably were produced by a pyroclastic event and not by flow, their distribution may be widespread and their inclusion in our sherds fortuitous.

Perhaps the most significant aspect of the vessels recovered at Tosawihi is the function they once served. Most resources are seasonal in the vicinity (cf. Chapter 2), and, even at their peak, many are scanty at best. Some of the pots appear to have been brought to the quarries and it is probable that they served a number of tasks, including food transport (doubtless supplemented with baskets and pouches) to support subsistence in the Tosawihi countryside, and as water and food storage containers during quarrying episodes. If vessels were manufactured at the quarries, we must suspect that they served similar functions, less, of course, the transport of goods. Although interior rinds on most Tosawihi sherds appear to be products of vessel firing, and slips on some interior surfaces are noncarbonaceous, a few sherds possess blackened, seemingly carbonaceous interior residues, probably relics of prehistoric storage or preparation of food.

Chapter 14

FAUNAL REMAINS

Dave N. Schmitt

The analysis of archaeological faunal assemblages can be difficult and often frustrating. Quantitative, ethnoarchaeological, and taphonomic faunal studies conducted in the past two decades have helped redefine the approaches, goals, and reliability of analysis (e.g., Binford 1978b, 1981a; Gifford 1981; Grayson 1984; Lyman 1982, 1985; Lyon 1970; Thomas and Mayer 1983; Yellen 1977b), but many questions remain unanswerable owing to the plethora of taphonomic mechanisms that deposit and modify bony remains. Even when a particular taphonomic agent can be identified, functional interpretations may remain ambiguous (e.g., Lyman 1987).

Archaeofaunas recovered from excavations in and adjacent the Tosawihi Quarries prove no exception. The assemblages contain a host of mammalian species displaying various degrees of skeletal attrition, often within the same taxa or animal size class. In order to identify the subsistence practices and taphonomic agents responsible for assemblage compositions, analysis of the Tosawihi archaeofaunas focused largely on the segregation of human from non-human accumulations through the detailed examination of bone damage. While the precise taphonomic history of the Tosawihi fossils remains unknown, many aspects are revealed by butcher marks, evidence of partial digestion (i.e., scat bones), or the presence of complete, unmodified elements, often in aggregates representing whole individuals, indicative of on-site or near-site natural death.

Analytic Methods

Faunal remains were identified by comparison with Nevada State Museum osteological collections and with specimens of known identity held by the author. Fragmented, non-diagnostic elements and post-cranial rodent remains were sorted into animal size classes (Table 104) on the basis of size and overall morphology. The number of identified specimens per taxon was quantified (Grayson 1984).

Table 104. Bone/Animal Size Classes (after Thomas 1969).

Class I	-	Mice, Voles
Class II	-	Ground Squirrels, Wood Rats
Class III	-	Rabbits, Hares, Marmot
Class IV	-	Coyote, Badger
Class V	-	Deer, Pronghorn, Sheep
Class VI	-	Bison, Wapiti, Cow
Class 0	-	Indeterminate

Attritional data were recorded during identification and sorting to allow inferences on depositional processes and human subsistence. These data included documentation of butcher marks, rodent and carnivore gnawing, weathering, and burning. Recently, I documented the

faunal contents of 40 Great Basin coyote scats, (Schmitt 1988a; Schmitt and Juell 1989; cf. Schmitt 1986), and found pitting (especially of long bone metaphyses), staining, overall polish, and/or rounding of fractured surfaces to be characteristic of partially digested bone. Identification of two or more of these attritional characteristics served to isolate numerous scat bones in the Tosawihi assemblages.

Artifactual bones were identified to species (when possible) and were described, measured, weighed, and compared with ethnographic and archaeological specimens in order to infer function.

Descriptive Summary

Archaeological excavations at Tosawihi retrieved 2,339 animal bones representing four vertebrate classes. Mammalian remains of at least 20 taxa dominate the faunal assemblage. A descriptive summary by site of the species identified and the anatomical portions recovered follows below, together with observations on modern and prehistoric mammalian distributions in the northern Great Basin and remarks on the methods employed in taxonomic identification.

Class Mammalia - Mammals

Order Lagomorpha - Rabbits, Hares, and Pikas

Family Leporidae - Rabbits and Hares

Sylvilagus sp. - Rabbits

MATERIAL:

26Ek3092: 1 radius shaft fragment, 1 metapodial fragment: 2 specimens.

26Ek3204: 1 skull fragment, 2 mandible fragments, 2 isolated tooth fragments, 1 distal humerus, 1 radius shaft fragment, 1 proximal metapodial fragment: 8 specimens.

Sylvilagus idahoensis - Pygmy Rabbit

MATERIAL:

26Ek3204: 1 mandible fragment, 1 distal humerus, 1 proximal radius, 1 proximal femur: 4 specimens.

Sylvilagus cf. *nuttallii* - Nuttall's Cottontail

MATERIAL:

26Ek3092: 2 isolated teeth, 1 femur, 1 proximal tibia: 4 specimens.

26Ek3204: 3 mandible fragments, 2 isolated teeth, 1 innominate fragment, 1 astragalus, 1 calcaneum, 1 calcaneum fragment: 9 specimens.

26Ek3251: 1 distal humerus, 1 radius, 1 proximal metapodial: 3 specimens.

Sylvilagus nuttallii - Nuttall's Cottontail

MATERIAL:

26Ek3092: 3 mandible fragments, 1 isolated tooth: 4 specimens.

26Ek3204: 1 mandible fragment: 1 specimen.

REMARKS: The pygmy rabbit and Nuttall's cottontail are the only rabbits found currently in the Tosawihi vicinity (Hall 1946). Although Audubon's cottontail (*Sylvilagus audubonii*) is not represented in Tosawihi archaeofaunas and presently is unknown in northeast Nevada, *S. audubonii* occurs in western Utah (Hall 1981; Zeveloff 1988) and once may have been present in the Tosawihi area. Accordingly, many fragmented large rabbit remains are identified only tentatively (cf. Grayson 1990).

Pygmy rabbits were abundant during field operations in the quarries, especially in dense stands of big sagebrush along Undine Gorge and in Velvet Canyon. Grayson (1990) reports a wealth of pygmy rabbit remains throughout the deposits of James Creek Shelter.

Lepus sp. - Hares

MATERIAL:

26Ek3092: 1 skull fragment, 1 mandible fragment, 1 distal scapula, 2 proximal ulnae, 1 patella, 1 metapodial: 7 specimens.

26Ek3095: 1 skull fragment, 1 mandible fragment: 2 specimens.

26Ek3170: 1 proximal ulna, 1 distal humerus: 2 specimens.

26Ek3192: 1 radius shaft fragment: 1 specimen.

26Ek3204: 4 skull fragments, 4 mandible fragments, 3 isolated teeth, 1 distal scapula, 1 proximal ulna, 3 innominate fragments, 1 vertebra, 2 proximal femora, 1 femur shaft fragment, 1 patella, 1 proximal tibia, 1 distal tibia, 2 calcanea, 1 proximal metapodial: 26 specimens.

26Ek3251: 1 mandible fragment: 1 specimen.

REMARKS: Two species of *Lepus*, the black-tailed jackrabbit (*L. californicus*) and white-tailed jackrabbit (*L. townsendii*), currently are found in Elko County (Hall 1946). Although *L. townsendii* tends to be larger than *L. californicus* (cf. Grayson 1977, 1983:106-108), identification of the small, fragmented Tosawihi jackrabbit assemblage was not carried past the genus level. I observed numerous jackrabbits (especially *L. townsendii*) throughout the project area during 1987-1989 field investigations.

Order Rodentia - Rodents

Family Sciuridae - Squirrels and Relatives

cf. *Marmota flaviventris* - Yellow-bellied Marmot

MATERIAL:

26Ek3092: 1 vertebra: 1 specimen.

26Ek3095: 1 distal humerus: 1 specimen.

26Ek3184: 1 innominate fragment: 1 specimen.

26Ek3192: 1 skull fragment, 2 mandible fragments, 1 vertebra: 4 specimens.

26Ek3251: 1 distal femur: 1 specimen.

Marmota flaviventris - Yellow-bellied Marmot

MATERIAL:

26Ek3092: 2 skull fragments, 1 mandible, 4 mandible fragments, 4 isolated teeth, 2 proximal humeri, 1 distal humerus, 2 proximal ulnae, 2 innominate fragments, 1 femur: 19 specimens.

26Ek3095: 1 isolated tooth, 2 distal humeri, 1 radius, 1 proximal femur, 1 tibia, 1 fibula, 2 astragalus fragments: 9 specimens.

26Ek3160: 1 proximal femur: 1 specimen.

26Ek3184: 1 distal humerus, 1 radius, 1 proximal ulna: 3 specimens.

26Ek3192: 12 skull fragments, 2 mandibles, 8 mandible fragments, 2 isolated teeth, 1 proximal humerus, 1 humerus shaft fragment, 2 distal humeri, 1 distal radius, 2 proximal ulnae, 2 femora: 33 specimens.

26Ek3204: 2 isolated teeth: 2 specimens.

26Ek3251: 1 skull fragment, 1 isolated tooth, 1 ulna: 3 specimens.

REMARKS: The yellow-bellied marmot occupies rock piles, boulders, and outcrops throughout northern Nevada (e.g., Hall 1946). Marmots were observed throughout the project area, particularly in late afternoon near the craggy terrain west of Buttercup Spring (elevation 5807 ft. [1770 m]).

Spermophilus sp. - Ground Squirrels

MATERIAL:

26Ek3092: 52 Skull fragments, 22 mandible fragments, 7 isolated teeth: 81 specimens.

26Ek3095: 1 skull fragment, 2 mandible fragments: 3 specimens.

26Ek3160: 1 skull fragment, 2 isolated teeth: 3 specimens.

26Ek3170: 1 mandible fragment: 1 specimen.

26Ek3184: 1 skull fragment: 1 specimen.

26Ek3192: 1 skull fragment, 1 mandible fragment: 2 specimens.

26Ek3204: 4 skull fragments, 1 mandible fragment, 2 isolated teeth: 7 specimens.

26Ek3237: 3 skull fragments, 4 mandible fragments, 7 specimens.

26Ek3251: 1 skull fragment, 2 mandible fragments: 3 specimens.

Spermophilus cf. *townsendii* - Townsend's Ground Squirrel

MATERIAL:

26Ek3204: 1 mandible fragment: 1 specimen.

26Ek3237: 2 mandible fragments: 2 specimens.

Spermophilus townsendii - Townsend's Ground Squirrel

MATERIAL:

26Ek3092: 2 mandibles: 2 specimens

26Ek3095: 1 mandible: 1 specimen.

Spermophilus cf. *lateralis* - Golden-mantled Ground Squirrel

MATERIAL:

26Ek3092: 3 mandible fragments: 3 specimens.

Spermophilus beldingi and/or *elegans* - Belding's or Wyoming Ground Squirrel

MATERIAL:

26Ek3092: 31 skull fragments, 9 mandibles, 28 mandible fragments: 68 specimens.

26Ek3095: 1 skull fragment: 1 specimen.

26Ek3184: 1 skull fragment, 3 mandible fragments: 4 specimens.

26Ek3204: 3 skull fragments, 1 mandible fragment: 4 specimens.

26Ek3237: 2 skull fragments, 4 mandible fragments: 6 specimens.

26Ek3251: 3 skull fragments, 3 mandible fragments: 6 specimens.

REMARKS: All of the squirrels recovered at Tosawihi are ubiquitous in the project area (Hall 1946). Because I did not have access to comparative skulls and mandibles of *Spermophilus elegans* (*richardsoni*), no attempt was made to distinguish the remains of this large squirrel from those of *S. beldingi* (cf. Grayson 1990). Interestingly, numerous least chipmunks (*Tamias minimus*) were observed during field investigations, but chipmunk remains are absent from the collection.

Family Geomyidae - Pocket Gophers

Thomomys sp. - Smooth-toothed Pocket Gophers

MATERIAL:

26Ek3092: 1 skull fragment, 4 mandible fragments: 5 specimens.

26Ek3095: 1 mandible fragment: 1 specimen.

26Ek3204: 1 isolated tooth: 1 specimen.

26Ek3237: 1 skull fragment, 2 mandible fragments: 3 specimens.

Thomomys talpoides - Northern Pocket Gopher

MATERIAL:

26Ek3092: 1 skull fragment, 1 mandible, 3 mandible fragments: 5 specimens.

26Ek3095: 1 skull fragment, 1 mandible fragment: 2 specimens.

26Ek3165: 1 skull fragment: 1 specimen.

26Ek3237: 1 skull fragment: 1 specimen.

REMARKS: Both the northern pocket gopher and Townsend's pocket gopher (*Thomomys townsendii*) occur in Elko county (Hall 1946). Specimens identified as *T. talpoides* retain sufficient cranial and/or dental morphology for specific ascription (cf. Grayson 1983 and references therein). Most recovered *Thomomys* cranial and mandibular fragments are gracile, and probably represent *T. talpoides*.

Family Heteromyidae - Pocket Mice, Kangaroo Mice, and Kangaroo Rats

Perognathus sp. - Pocket Mice

MATERIAL:

26Ek3092: 1 skull fragment: 1 specimen.

26Ek3204: 4 mandible fragments: 4 specimens.

Perognathus parvus - Great Basin Pocket Mouse

MATERIAL:

26Ek3092: 1 skull fragment, 2 mandibles, 2 mandible fragments: 5 specimens.

26Ek3204: 1 skull fragment, 1 mandible, 3 mandible fragments: 5 specimens.

REMARKS: The Great Basin pocket mouse is the only member of the genus currently known to reside in the Tosawihi vicinity (Hall 1946). Although the distribution of the little pocket mouse (*Perognathus longimembris*) extends into western Elko county (Hall 1946:360-361), this species is smaller than both *P. parvus* and the skeletal remains reported here.

Although no elements were identified in the Tosawihi assemblage, an Ord's kangaroo rat (*Dipodomys ordii*) was found trapped in an excavation unit at 26Ek3092 (elevation 5627 ft. [1715 m]).

Family Muridae - Murids

Peromyscus sp. - White-footed Mice

MATERIAL:

26Ek3092: 1 skull fragment, 1 mandible fragment: 2 specimens.

26Ek3237: 1 skull fragment: 1 specimen.

Peromyscus cf. *maniculatus* - Deer Mouse

MATERIAL:

26Ek3204: 1 edentulous mandible: 1 specimen.

REMARKS: Two species of white-footed mouse, the canyon mouse (*Peromyscus crinitus*) and deer mouse (*P. maniculatus*), currently reside in the project area (Hall 1946; Zeveloff 1988). My tentative identification of a mandible from 26Ek3204 as *P. maniculatus* is based on metric comparison (alveolar length [m1-m3] = 3.62mm) with modern *Peromyscus* alveolar lengths (cf. Grayson 1985:147-149).

Neotoma cinerea - Bushy-tailed Wood Rat

MATERIAL:

26Ek3092: 1 skull fragment with M1, isolated M3, isolated m1: 3 specimens.

26Ek3204: 1 edentulous mandible (alveolar length [m1-m3] = 9.5mm), isolated M1, isolated m1, isolated m2: 4 specimens.

REMARKS: Although the occurrence of *Neotoma cinerea* is well documented throughout Elko County, distributional data presented by Hall (1946:529-530) suggest the desert wood rat (*N. lepida*) to be marginal to the Tosawihi Quarries (the nearest record being northeast of Iron Point at 4610 ft. [1405 m amsl), while Zeveloff's (1988:210) distributional map reports the species throughout northern Nevada.

In order to identify isolated *Neotoma* remains, I compared measurements in concert with morphological attributes (cf. Grayson 1990). Metric comparison of the Tosawihi *Neotoma* materials (cf. above and Table 105) with modern data presented by Grayson (1985:Table 31) identified all Tosawihi wood rat elements as *N. cinerea*; the two recovered upper first molar anterior prisms also possess deep reentrant angles, a trait characteristic of the species. In July of 1989, I observed a single N. cinerea in a rock crevice east of site 26Ek3204 (elevation 5,690 ft. [1734 m]).

Table 105. Occlusal Lengths (mm) of Wood Rat Molars Assigned to *Neotoma cinerea*.

	26Ek3092	26Ek3204
M1	3.69	3.48
M2	-	-
M3	2.42	-
m1	3.58	3.62
m2	-	3.09
m3	-	-

Microtus sp. - Meadow Voles

MATERIAL:

26Ek3092: 1 skull fragment, 1 mandible fragment: 2 specimens.

26Ek3204: 5 mandible fragments: 5 specimens.

26Ek3237: 1 skull fragment, 3 mandible fragments: 4 specimens.

26Ek3251: 1 skull fragment: 1 specimen.

Microtus longicaudus - Long-tailed Vole

MATERIAL:

26Ek3092: 1 skull fragment: 1 specimen.

26Ek3237: 1 skull fragment: 1 specimen.

Lagurus curtatus - Sage Vole

MATERIAL:

26Ek3198: 1 skull fragment, 1 mandible: 2 specimens.

26Ek3204: 2 skull fragments, 1 mandible fragment: 3 specimens.

Microtine Rodent - Montane, Long-tailed and/or Sage Vole

MATERIAL:

26Ek3092: 2 mandible fragments: 2 specimens.

26Ek3204: 2 skull fragments, 3 mandible fragments: 5 specimens.

REMARKS: Both the montane vole (*Microtus montanus*) and long-tailed vole (*M. longicaudus*) occur throughout northern Nevada (Hall 1946). Identification of *M. longicaudus* skulls was based on the presence of expanded incisive foramina (Maser and Storm 1970).

Order Carnivora - Carnivores

Family Mustelidae - Weasels, Skunks, and Allies

cf. *Taxidea taxus* - Badger

MATERIAL:

26Ek3251: 1 phalanx: 1 specimen.

Taxidea taxus - Badger

MATERIAL:

26Ek3092: 1 scapula, 1 scapula fragment, 1 proximal ulna, 1 innominate fragment, 1 femur shaft fragment, 1 tibia: 6 specimens.

26Ek3192: 1 skull fragment: 1 specimen.

26Ek3204: 1 proximal ulna: 1 specimen.

REMARKS: Badgers are extant throughout most of western North America, including all of the state of Nevada (Hall 1946; Zeveloff 1988); their burrows are abundant in the project area, and a carcass was noted south of Big Meadows.

Order Artiodactyla - Even-toed Ungulates

Small Artiodactyl - Deer, Pronghorn, Domestic Sheep, and/or Mountain Sheep

MATERIAL:

26Ek3092: 10 tooth fragments, 1 vertebra fragment, 1 radius shaft fragment, 1 distal tibia shaft fragment: 13 specimens.

26Ek3160: 2 tooth fragments: 2 specimens.

26Ek3204: 4 tooth fragments: 4 specimens.

26Ek3251: 4 tooth fragments, 1 radius shaft fragment, 1 distal humerus shaft fragment: 6 specimens.

Large Artiodactyl - Bison, Domestic Cow, and/or Wapiti

MATERIAL:

26Ek3092: 5 tooth fragments, 1 rib fragment: 6 specimens.

26Ek3204: 3 tooth fragments: 3 specimens.

26Ek3208: 1 scapula fragment: 1 specimen.

REMARKS: The 26Ek3208 scapula blade fragment is artifactual, representing either bison (*Bison bison*) or wapiti (*Cervus elaphus*).

Family Cervidae - Cervids

Cervus elaphus - Wapiti (Elk)

MATERIAL:

26Ek3032, Loc. 23: 1 antler fragment: 1 specimen.

REMARKS: This single specimen is artifactual (cf. below) and may have been transported some considerable distance by people. Elsewhere in northern Nevada, Heizer et al. (1968) report *Cervus* at South Fork Shelter and Grayson (1988) reports 9 specimens from

Last Supper Cave; reasonably, he concludes (1988:57), "the growing number of Holocene records for these animals in the more northerly parts of the Great Basin suggests that these animals were once widespread here, though apparently nowhere abundant." Our specimen was recovered from a backhoe trench, and lacks precise provenience.

Odocoileus cf. *hemionus* - Mule Deer

MATERIAL:

26Ek3160: 1 tooth fragment: 1 specimen.

26Ek3251: 2 tooth fragments, 1 distal humerus: 3 specimens.

REMARKS: Mule deer occur throughout the Great Basin and most of western North America (Hall 1981). I observed numerous mule deer browsing in the project area, especially in Big Meadows and Velvet Canyon during early morning and at sunset.

Family Antilocapridae - Pronghorn

Antilocapra americana - Pronghorn

MATERIAL:

26Ek3092: 2 phalanx fragments: 2 specimens.

REMARKS: Pronghorn presently occur throughout northern Nevada (Hall 1946), and their remains have been recovered from numerous Great Basin archaeological sites (e.g., Dansie and Ringkob 1979; Grayson 1985, 1988). In July, 1989, I observed a buck with a harem of six does approximately 4 km south of the quarries. Both specimens from 26Ek3092 exhibit parallel grooves created by rodent gnawing (cf., for example, Lyman 1988:Figure 26).

Family Bovidae - Bovids

Bos sp. - Domestic Cow

MATERIAL:

26Ek3032, Loc. 22: 1 tooth fragment: 1 specimen.

26Ek3160: 17 tooth fragments: 17 specimens.

REMARKS: Much of the Tosawihi vicinity is open rangeland for cattle grazing; the recovery of *Bos* remains from these open sites is not surprising.

Bison bison - Bison

MATERIAL:

26Ek3092: 1 humerus shaft fragment: 1 specimen.

26Ek3200: 1 distal scapula fragment: 1 specimen.

REMARKS: Bison were distributed widely throughout the Great Basin during the Holocene, though nowhere were they abundant (Grayson 1982). Elsewhere in northeast Nevada,

Dansie (1982) reports a bison ulna at 26Ek2304, and Grayson (1990) documents the largest archaeological bison assemblage in the region at James Creek Shelter; Grayson (1988) also reports bison at Danger Cave.

cf. *Ovis canadensis* - Mountain Sheep

MATERIAL:

26Ek3092: 1 tooth fragment, 2 dorsal ribs: 3 specimens.

26Ek3204: 1 tooth fragment: 1 specimen

Ovis canadensis - Mountain Sheep

MATERIAL:

26Ek3092: 3 isolated teeth, 1 mandible fragment, 1 proximal femur: 5 specimens.

REMARKS: Mountain sheep remains are common constituents of Great Basin archaeofaunal assemblages, often representing the most abundant artiodactyl (e.g., Grayson 1982, 1988; Thomas and Mayer 1983).

Class Aves - Birds

MATERIAL:

26Ek3092: 1 phalanx, 1 longbone shaft fragment: 2 specimens.

26Ek3095: 1 skull fragment, 2 proximal humeri, 1 distal humerus, 1 carpometacarpus, 1 distal tarsometatarsus, 1 proximal phalanx: 7 specimens.

26Ek3204: 1 phalanx (talon): 1 specimen.

26Ek3251: 1 innominate fragment, 1 proximal carpometacarpus, 1 tarsometatarsus: 3 specimens.

REMARKS: Although lack of sufficient comparative collections precludes identification of avian remains at this time, differences in size and morphology indicate at least three different species are represented.

Class Osteichthyes - Bony Fishes

MATERIAL:

26Ek3204: 1 facial bone: 1 specimen.

Class Reptilia - Reptiles

Order Squamata - Lizards and Snakes

MATERIAL:

26Ek3204: 1 skull fragment, 1 dentary fragment, 6 vertebra: 8 specimens.

Site Data: Small Faunal Assemblages

Twelve sites yielded small faunal assemblages containing fewer than 70 bones. These are described briefly below, together with pertinent data on taxonomic presences, bone distributions, and taphonomic processes.

26Ek3032; Localities 22 and 23

One weathered *Bos* molariform was recovered from Unit 1 at Locality 22 and a modified wapiti (*Cervus elaphus*) antler from backhoe trench backdirt at neighboring Locality 23. The latter specimen is artifactual, and is discussed below.

26Ek3095

Fifty bones were recovered from 26Ek3095. Most (n=36, 72%) were retrieved from surface collections and excavations at Feature 19; they include the remains of marmot, ground squirrel, and jackrabbit. The remainder were collected from Features 15 (n=2), and 22 (n=11), and a complete, probably intrusive *Thomomys talpoides* mandible from Feature 10. Burned bone was present across the site, and, although few (n=10), some elements (e.g., a marmot distal humerus and astragalus, and a rodent distal tibia) may have been burned via cooking/roasting.

26Ek3160 and 26Ek3165

Excavations at 26Ek3160 returned 7 fragmented bones and 25 teeth. A large portion of the assemblage consists of domestic cow molariform fragments (n=17, 15 recovered from the surface of Feature 1), clearly representative of recent, non-cultural accumulations; an additional five small, weathered tooth fragments identified only as "artiodactyl" may also be cattle remains as well. Other faunal specimens include the remains of ground squirrel (*Spermophilus* sp.) and an isolated marmot proximal femur, neither exhibiting evidence of cultural modification.

26Ek3165 yielded only four rodent bones, all retrieved from non-feature excavation units in Locus A.

26Ek3170 and 26Ek3171

Excavations at 26Ek3170 recovered three rodent bones (including a *Spermophilus* sp. mandible) and a jackrabbit proximal ulna and distal humerus. The latter specimens exhibit extensive rounding of fractured surfaces and overall gloss characteristic of carnivore scat bones (cf. Andrews 1990:Figure 3.28; Schmitt and Juell 1989). One Class II bone fragment was collected from the surface of Feature 1 at 26Ek3171.

26Ek3184 and 26Ek3198

A total of 17 faunal items was recovered from these sites, 14 from 26Ek3184 and 3 from 26Ek3198. The assemblage from 26Ek3184 includes remains of marmot, ground squirrel (*Spermophilus beldingi/elegans*), and large mammal (i.e., Classes IV and V). All marmot remains were clustered on the surface of Feature 20, probably representing recent, unassociated deposition. A burned large mammal long bone fragment and a ground squirrel maxilla may represent human subsistence refuse, but little can be determined of such a small, diffuse assemblage.

Three rodent bones were collected at 26Ek3198; they include a sage vole (*Lagurus curtatus*) skull fragment and mandible and a Class II innominate. With the exception of the fragile, fragmented cranium, these complete and undamaged elements probably were deposited naturally (e.g., on-site mortality).

26Ek3200 and 26Ek3208

The few faunal remains retrieved from these quarry pits are artifactual and are discussed below. The bison scapula scoop/shovel from 26Ek3200 exhibits butcher marks; mark type and location are also presented below (cf. Table 107).

26Ek3237

Sixty-five faunal specimens were collected from excavations at 26Ek3237. Most (n=56, 86%) were retrieved from block excavations adjacent the Feature 3 and 4 hearths (Locus C). Most of the identified taxa consist of complete, unmodified rodent remains (including ground squirrel, white-footed mouse, pocket gopher, vole, and miscellaneous Class II long bones and vertebrae), probably reflecting recent, on-site natural deaths. Fourteen Class V specimens recovered from this area, however, may represent human subsistence refuse; all are fragmented, and 8 (57%) are burned.

Site Data: Large Faunal Assemblages

Large faunal assemblages are defined here as those containing more than 100 items. Four sites yielded large assemblages, ranging from 115 specimens at 25Ek3251 to 955 at Whining Rock Shelter (26Ek3204). The site assemblages are discussed below, together with inferences on human subsistence, faunal distributions, and animal-bone accumulative mechanisms.

26Ek3092

Excavations at 26Ek3092 returned a large and diverse archaeofaunal assemblage; 927 faunal items (including four bone artifacts) representing at least 16 taxa were recovered. Rodent remains (Classes I and II) are most abundant (n=685, 74% of the total assemblage), including

the remains of ground squirrel, pocket gopher, pocket mouse, white-footed mouse, wood rat, and vole (Table 106). Although some isolated, fragmented elements were recovered, Class I and II remains are largely undamaged, and often were encountered as complete skeletons in unit/level aggregates (i.e., burrow deaths). Similarly, excavations revealed abundant active rodent burrows, subsurface nests, and krotovina. Burrow death accumulations often account for increases in unit/level faunal frequencies (compare, for example, small and large mammal bone counts in Levels 5 and 6, Table 106).

Additional non-human accumulations includes 25 scat bones, recovered throughout the site; a small concentration from Level 3 of Unit 1 probably represents of a portion of a single, disaggregated scat. A few burned and broken rodent bones may represent human subsistence refuse (n=16, 2.3%), but this small assemblage easily could have burned naturally (e.g., a brush fire), or could be the product of non-subsistence related human activities (e.g., a hearth constructed over/adjacent a natural rodent accumulation).

Fragmented Class III and large mammal (Classes IV, V, and VI) bones were discovered throughout the deposits at 26Ek3092, including the remains of rabbit, hare, marmot, badger, pronghorn, bison and mountain sheep (Table 106). Although the bones of large mammals were recovered across the site, most (n=175, 12.5 bones per unit) were retrieved from non-feature random 1 x 1 m excavation units placed south of the boulder area, including small concentrations in Units 8 (n=28) and 12 (n=18). Conversely, block excavations adjacent the boulder disclosed a host of activity areas (including numerous reduction and hearth features; cf. Chapter 16), but large mammal remains are scarce (n=40, 1.4 bones per unit). This suggests that the small meadow south of the boulder served as a "toss-zone" (Binford 1983a:153; also cf. Thomas 1988) where large mammal bones were redeposited from the hearth areas.

Based on the number of bones, variety of taxa, and the fragmented, often burned nature of the class III-VI mammal assemblage at 26Ek3092, I suspect most are remnants of carcasses acquired by people for diverse resources (e.g., hides, sinew, meat, and marrow). Subsistence exploitation of large animals is evident in five bones possessing butcher marks (Table 107). Three bones exhibit cut marks, including a mountain sheep (cf. *Ovis canadensis*) rib with multiple striations along its caudal border (Figure 95c) and a marmot ulna and mandible fragment, both recovered from Level 2 of Unit 8. The ulna (Figure 95b) has two parallel cuts on its posterior surface; they are most similar to Binford's (1981a) filleting mark RCp-7, but may have been produced during dismemberment as variation in cut mark location and orientation may be conditioned by prey size (i.e., Binford's locational/functional cut mark data are based on artiodactyls, not marmot-sized carcasses).

Similar to cut marmot mandibles recovered from Last Supper Cave and Hanging Rock Shelter (Grayson 1988:72-73), one marmot mandible fragment displays two striae on the buccal face of the ascending ramus (Figure 95a). These marks probably were produced while severing the masseter muscle during removal of the mandible (Grayson 1988:72), a likely prelude to consumption. Finally, a bison humerus and an undifferentiated artiodactyl tibia shaft (Figure 95d) display distinct impact scars (i.e., "dull dynamic loading;" Lyman 1987:292) produced by percussion to facilitate the extraction of marrow.

In sum, the 26Ek3092 archaeofaunas contains a mixture of culturally and naturally deposited bone. Rodent bones appear to have accumulated via natural (e.g., senile) mortality and non-human predation while those of larger mammals (e.g., marmots, mountain sheep, and bison) have accumulated largely through human subsistence activities as evident by the recovery of highly fragmented and butchered specimens.

Table 106. Numbers of Identified Specimens per Taxon/Animal Size Class by Excavation Level at Site 26Ek3092.

Level (10 cm)	*Sylvilagus* sp.	*Sylvilagus* cf. *nuttallii*	*Sylvilagus nuttallii*	*Lepus* sp.	cf. *Marmota flaviventris*	*Marmota flaviventris*	*Spermophilus* sp.	*Spermophilus townsendii*	*Spermophilus* cf. *lateralis*	*Spermophilus beldingi/elegans*	*Thomomys* sp.	*Thomomys talpoides*	*Perognathus* sp.	*Perognathus parvus*	*Peromyscus* sp.	*Neotoma cinerea*	*Microtus* sp.	*Microtus longicaudus*	Microtine	*Taxidea taxus*	Artiodactyl	*Antilocapra americana*	*Bison bison*	cf. *Ovis canadensis*	*Ovis canadensis*	Aves	I-II	III	IV	V	V-VI	VI	0	Total*
1	-	-	-	2	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	4	1	-	2	3	2	-	18
2	-	-	-	4	1	8	19	-	-	9	-	-	1	1	-	-	-	-	-	1	3	-	1	-	-	-	74	21	2	1	4	12	2	164
3	-	1	-	-	-	5	17	-	-	10	-	-	-	3	1	1	1	-	-	1	7	-	-	1	1	-	100	24	10	11	1	8	7	210
4	-	-	3	1	-	3	6	-	1	5	-	-	-	1	-	-	-	-	1	-	4	-	-	-	2	-	64	6	-	3	4	1	-	105
5	-	1	-	-	-	-	11	-	-	12	2	1	-	-	-	-	-	-	-	1	1	-	-	1	1	-	39	4	2	2	7	2	-	87
6	-	1	-	-	-	-	10	-	-	8	-	1	-	-	-	-	-	-	-	-	2	1	-	-	-	2	109	3	-	-	1	2	-	140
7	-	-	1	-	-	1	9	2	2	9	2	2	-	-	-	1	1	1	-	1	1	1	-	1	-	-	45	1	-	4	-	-	-	85
8	2	1	-	-	-	1	5	-	-	9	1	-	-	-	-	-	-	-	1	1	1	-	-	-	1	-	46	-	-	2	1	1	1	73
9	-	-	-	-	-	1	3	-	-	4	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	20	2	-	1	-	-	1	34
10	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	3
11	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Total	2	4	4	7	1	19	81	2	3	68	5	5	1	5	2	3	2	1	2	6	19	2	1	3	5	2	505	62	14	27	21	28	11	923

* Does not include 4 bone artifacts.

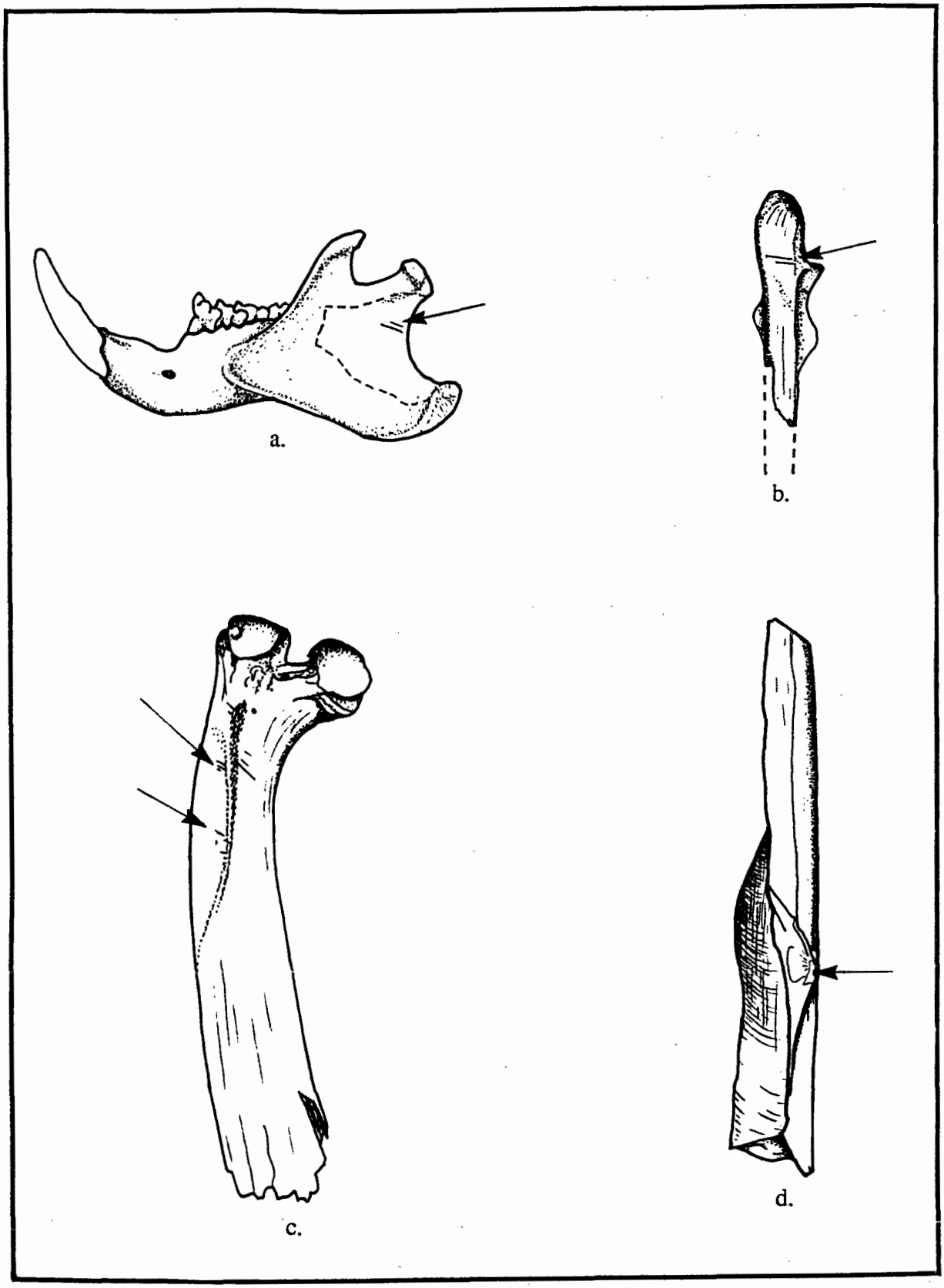


Figure 95. Butchering marks on selected mammal bones, 26Ek3092. No scale.

Table 107. Butchering Marks on Mammal Bones by Site.

Site (26Ek)	Spec. No.	Species	Element	Type, Location	Figure	Type*	Function
3092	6042-9	*Bison bison*	Humerus mid shaft	Large, pronounced impact scar, latero-anterior	--	--	Marrow extraction
3092	6067-4-1	cf. *Ovis canadensis*	Dorsal rib	Multiple, parallel striae, distal to tubercle on ventral surface	95c	RS-3	Dismemberment
3092	6082-15-1	*Marmota flaviventris*	Dorsal mandible	Two horizontal striae, buccal face of the ascending ramus	95a	M-5	Dismemberment
3092	6082-15-2	*Marmota flaviventris*	Proximal ulna	Two horizontal striae, posterior surface of the olecranon ca. 8 mm distal to the proximal terminus	95b	RCp-7	Filleting
3092	6107-1-1	Artiodactyl	Mid-distal tibia shaft	Impact scar, posterior	95d	--	Marrow extraction
3200	2501-1	*Bison bison*	Distal scapula	Multiple, deep acute striae (chop marks?), medio-cranial border of the neck ca. 30 mm proximal the tuber scapulae	--	S-2	Dismemberment
3251	6065-3-1	Artiodactyl	Distal humerus shaft	Multiple transverse striae, postero-medial surface just proximal the olecranon fossa	--	Hd-7	Filleting

* Binford's (1981) Most Similar Type

26Ek3192

Represented largely by the remains of marmot and other (undifferentiated) Class III bone fragments, archaeological excavations at 26Ek3192 yielded 155 bones. Most (n=106, 68%) were recovered from a single unit/level in block excavations at Feature 1. Identified taxa include badger, marmot, and round squirrel, as well as a wealth of taxonomically unidentifiable Class III fragments (Table 108). Based on the clustered context of these remains and the recovery of two *Marmota* left mandibles (i.e., a minimum number of two individuals are represented), I suspect most of the undifferentiated class III remains to be marmot.

Table 108. Faunal Remains Recovered from Unit 42, Level 2, Feature 1, 26Ek3192.

Species/Class	Element	Total No.	No. Burned
Taxidea taxus	Skull fragment	1	0
Marmota flaviventris	Skull fragments	11	4
Marmota flaviventris	Mandible fragments	4	0
Marmota flaviventris	Isolated teeth	2	0
Marmota flaviventris	Humerus shaft	1	1
Marmota flaviventris	Distal humerus	1	1
Marmota flaviventris	Distal radius	1	1
Marmota flaviventris	Proximal ulnae	2	2
cf. *M. flaviventris*	Mandible fragments	2	0
cf. *M. flaviventris*	Vertebra	1	0
Spermophilus sp.	Skull fragment	1	0
I - II	Skull fragments	2	0
I - II	Innominate	1	0
III	Skull fragments	15	10
III	Misc. fragments	59	33
V	Long bone fragments	2	2
Totals		106	54

Approximately one-half (51%) of the bones are burned (most are fire-blackened, but some variation in color and cracking is evident) and, except for a complete (probably intrusive) rodent innominate and two marmot teeth, all are highly fragmented. These data, and the recovery of only 19 additional faunal items from Feature 1, strongly suggest that the aggregation represents human subsistence refuse. It may reflect a food preparation locus and/or a refuse dump resulting from hearth cleaning, or the disposal of bones charred prior to stewing.

Elsewhere at 26Ek3192, excavations in Feature 2 recovered 30 bones (33% burned); this assemblage, too, is dominated by marmot and undifferentiated Class III skeletal fragments.

26Ek3204

Limited excavations at Whining Rock Shelter returned the largest faunal assemblage recovered at Tosawihi. Represented primarily by the remains of Class I, II, and III mammals (n=835, 87% of the total assemblage), 955 faunal specimens were recovered (Table 109). With the exception of two *Bos* or *Bison* molariform fragments in Unit 2 outside the dripline, all were retrieved from units excavated within the shelter; 497 specimens came from Unit 1 near the center of the shelter, and 456 specimens from Unit 3 adjacent the rear wall. Faunal remains were particularly abundant in the upper 30 cm of the deposits (Table 109), with the highest unit/level frequency (n=218) recovered from Level 3 of Unit 1.

Table 109. Numbers of Identified Specimens per Taxon/Animal Size Class by Excavation Level at Site 26Ek3204.

Level (10 cm)	*Sylvilagus* sp.	*Sylvilagus idahoensis*	*Sylvilagus* cf. *nuttallii*	*Sylvilagus nuttallii*	*Lepus* sp.	*Marmota flaviventris*	*Spermophilus* sp.	*Spermophilus* cf. *townsendii*	*Spermophilus beldingi/elegans*	*Thomomys* sp.	*Perognathus* sp.	*Perognathus parvus*	*Peromyscus* cf. *maniculatus*	*Neotoma cinerea*	*Microtus* sp.	*Lagurus curtatus*	Microtine	*Taxidea taxus*	Artiodactyl	cf. *Ovis canadensis*	Aves	Osteichthyes	Reptilia	I-II	II-III	III	V	VI	0	Total
1	1	-	2	-	4	-	2	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	4	56	9	54	6	-	6	147
2	1	1	1	-	11	-	-	1	1	-	1	1	-	1	1	2	2	-	1	-	-	-	-	64	6	62	6	-	10	173
3	2	3	1	-	5	1	3	-	1	-	1	2	1	1	1	1	2	1	3	1	-	1	2	89	9	137	17	-	28	313
4	2	-	-	1	4	-	2	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	1	32	5	37	-	-	5	92
5	1	-	3	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	1	32	6	30	6	-	8	89
6	1	-	-	-	1	-	-	-	-	-	2	1	-	1	-	-	-	-	-	-	-	-	-	24	3	36	3	-	4	76
7	-	-	2	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	-	-	17	5	16	-	-	-	44
8	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	1	6	-	3	1	21
Total	8	4	9	1	26	2	7	1	4	1	4	5	1	4	5	3	5	1	5	1	1	1	8	323	44	378	38	3	62	955

Attritional analysis of the Whining Rock Shelter faunas disclosed many partially digested specimens. Scat bones occurred throughout the deposits (Table 110), with the highest frequencies found in the upper 30 cm; two partially dissagregated coyote scats were found in Level 1 of Unit 1 and a scat fragment in Level 2, while another was collected from the surface in a small, cleared (denning?) area inside the dripline. The shelter also evidenced occupation by wood rats ("pack rats"), which often accumulate scatological and other organic material (Stones and Hayward 1968; Wells 1976).

Class I and II scatological bones dominate the assemblage (n=175, 48.2%; Table 110), especially between 10 and 20 cm below surface, followed closely by Class III specimens (n=174, 40.7%). Although scat bones appear to have been introduced by coyotes, some specimens (especially rodent remains) may have been deposited by raptors; regurgitated (i.e., pellet) bones often display similar corrosive modification (cf. Dodson and Wexlar 1979; Mayhew 1977). Similarly, some small animal bones may represent human subsistence refuse deposited in coprolites (cf. Heizer and Napton 1970), but most, especially the Class II and III skeletal fragments, appear too large for humans to digest and pass (cf. Dansie 1984); their attributes compare favorably with coyote scatological bone breakage and attrition (Andrews 1990:Figure 3.28; Schmitt and Juell 1989).

Table 110. Attributes of Small Mammal Bones by Size Class*
by Excavation Level at Site 26Ek3204.

SIZE CLASS	LEVEL (10 cm)								
I - II	1	2	3	4	5	6	7	8	TOTAL
Total No. Bones	60	74	102	37	34	28	19	9	363
No. Scat	25	43	48	17	13	15	11	3	175
% Scat	41.7	58.1	47.1	45.9	38.2	53.6	57.9	33.3	48.2
No. Burned	0	1	2	0	2	0	0	0	5
II - III									
Total No. Bones	9	6	9	5	6	3	5	1	44
No. Scat	3	2	2	1	1	1	2	0	12
% Scat	33.3	33.3	22.2	20.0	16.7	33.3	40.0	0	27.3
No. Burned	0	0	2	1	0	0	0	0	3
III									
Total No. Bones	61	76	149	44	34	38	19	7	428
No. Scat	29	32	62	16	16	13	4	2	174
% Scat	47.5	42.1	41.6	36.4	47.1	34.2	21.1	28.6	40.7
No. Burned	3	8	9	4	0	0	2	0	26
TOTALS									
Total No. Bones	130	156	260	86	74	69	43	17	835
No. Scat	57	77	112	34	30	29	17	5	361
% Scat	43.8	49.4	43.1	39.5	40.1	42.0	39.5	29.4	43.2
No. Burned	3	9	13	5	2	0	2	0	34

* Includes all taxonomically identified specimens.

In sum, the occurrence of dissagregated coyote feces, the number of identifiable scat bones, and the presence of some complete, undamaged elements suggest most, if not all, of the Whining Rock Shelter fauna accumulated through non-cultural mechanisms. Although some burned bone was recovered (cf. Table 110), the paucity and diffuse distribution of charred remains inhibit confident assignment, particularly in the presence of wood rat occupation (cf. Hockett 1989).

26Ek3251

One hundred fifteen faunal items were recovered from 26Ek3251. Remains were most abundant at Feature 6 (n=100, 87%); Feature 1 and non-feature excavations units yielded the remainder (11 and 4 specimens, respectively).

With the exception of a single marmot maxilla, Feature 1 yielded only fragmented Class V mammal bones and teeth; mule deer have been identified specifically. While the assemblage is small (possibly due to the shallow cultural deposits), large mammal bone fragments, including 4 burned specimens associated with a multifunctional tool kit and fire-cracked rock suggest that it represents human subsistence refuse.

Faunal remains were recovered throughout Feature 6; they include fragmented, often burned, large mammal bones and intrusive, unmodified rodent remains. Forty-eight large mammal bone fragments (Classes IV - V) were collected, including 14 specimens (29%) which display various degrees of burning (i.e., black to "chalky" white; cf. Shipman et al. 1984). Large mammal bones were collected across the feature, with two small clusters in neighboring Units 31 (n=10, 50% burned) and 32 (n=19, 37% burned).

Although these fragmented and burned bones *probably* represent human subsistence refuse, only a single artiodactyl distal humerus fragment displays unequivocal evidence of human manipulation (cf. Table 107). These markings resemble Binford's (1981a) filleting mark Hd-7, but easily could have been produced during dismemberment (mark code Hd-3); they are separated by only a few millimeters and ca. 45° in orientation (compare Figure 4.30 [mark Hd-3] vs. Figure 4.39 [mark Hd-7] in Binford 1981a). Although striations on the specimen from 26Ek3251 were produced by human action, the intent of that action is ambiguous; numerous factors (e.g., dietary status of hunters, distance to camp, time of day, condition of carcass) can affect any butchering episode (Lyman 1987).

The remaining fauna from Feature 6 consist largely of Class I and II bones and teeth; the remains of vole (*Microtus* sp.), Belding's and/or Wyoming ground squirrel (*Spermophilus beldingi/elegans*), and undifferentiated ground squirrels are included. Although some specimens are fragmented, the small mammal assemblage lacks evidence of human utilization. Seven scat bones deposited by carnivores and 11 complete, undamaged elements (probably reflecting burrow deaths), as well as sparse occurrences of cottontail jackrabbit, and marmot appear to be results of natural accumulation as they, too, are largely undamaged.

Artifactual Bone

Five sites returned 15 bone artifacts. Although small, the assemblage contains an array of functional classes; bone beads, awls, a flaking tool, an expedient (i.e., utilized) bone fragment, and three quarrying tools were recovered (Table 111).

Beads

Excavations at 26Ek3092 and 26Ek3208 retrieved a total of eight bone beads. At 26Ek3092, a single large bead manufactured on a bird ulna was collected from level 5 of Unit 8 (Table 111, Figure 96a). The artifact displays numerous manufacture and/or use wear striations parallel and perpendicular to its long axis and is polished by use wear at and within each scored end. Large beads much like this specimen have been recovered from James Creek Shelter (Schmitt 1990), the Vista site (Drews and Schmitt 1986), and Gatecliff Shelter (Thomas 1983b).

Table 111. Provenience and Attributes of Bone Artifacts.

Site (26Ek)	Spec. No.	Unit	Depth (cm)	Feature	Species	Element	Complete	mm Max. Length	mm Max. Width	mm Max. Thick.	Weight (gm)	Type
3032/L23	2599-1	a	-	1	*Cervus elaphus*	Antler	+	249.5	58.4	52.7	319.0	WE
3092	6109-6	9	80-90	-	Artiodactyl	Femur Shaft	?	67.1	23.1	4.3	10.3	EX
3092	6403-6	24	20-30	-	Artiodactyl	Long bone	-	31.9	9.5	3.1	0.5	AL
3092	8382-1	23	10-20	13	Artiodactyl	Rib ?	-	33.7	9.4	1.7	0.4	FL
3092	9085-5	8	40-50	-	Bird	Ulna	+	52.0	9.0	7.9	2.7	BE
3200	2501-1	b	43	1	*Bison bison*	Scapula	-	183.0	70.2	43.3	109.6	SO
3208	2500-1	c	157	3	*Bison* or *Cervus*	Scapula	-	152.1	36.3	25.4	30.1	SO
3208*	2599-19	d	82-84	3	Rabbit or bird	Long bone	+	(11.6)	(4.3)	(2.4)	(0.1)	BE
3251	6122-5	31	10-20	6	Artiodactyl	Scapula	-	47.6	9.9	3.4	1.3	AL

*Seven beads (5 complete and 2 fragmented) were recovered. Parentheses bracket mean measurements and weights of the 5 complete specimens.

Unit
a = Discovered in backhoe trench backdirt.
b = Discovered in south wall of backhoe Trench 1, Horizon II.
c = Discovered in east wall of Trench 1, Stratum 23.
d = Discovered in east wall of Trench 1, Stratum 22.

Type
AL = Awl
BE = Bead
EX = Expedient Tool
FL = Flaker
SO = Scoop, Shovel
WE = Wedge

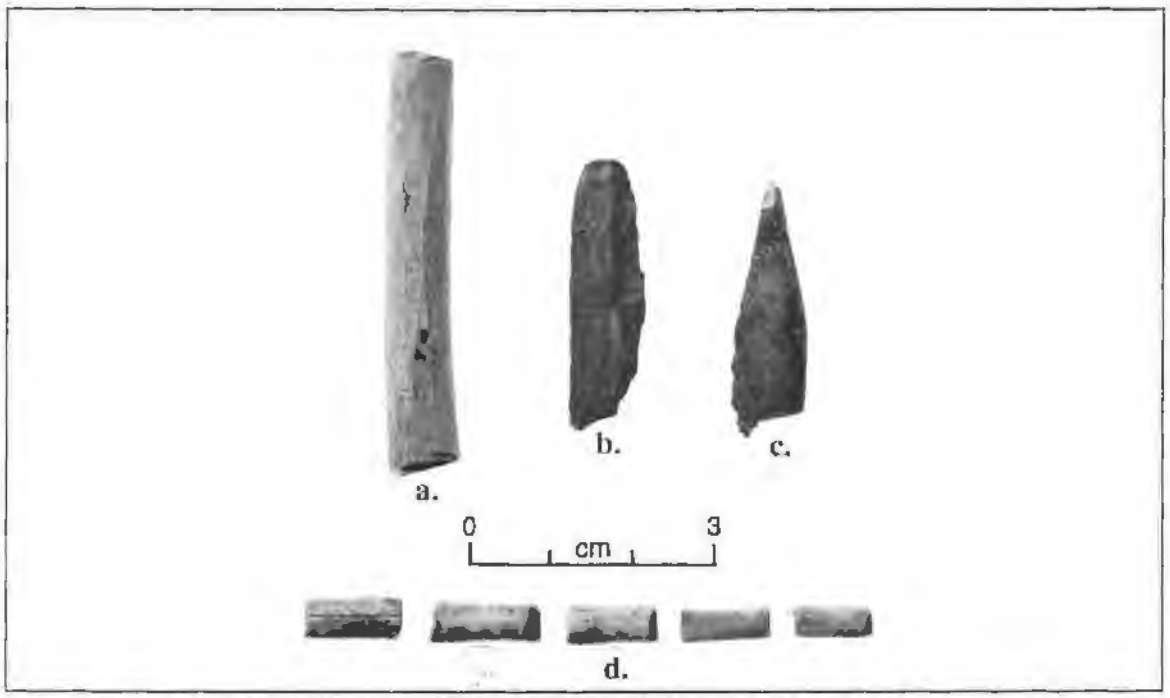


Figure 96. Selected bone artifacts. a. bead; b. flaker; c. awl; d. beads.

Five complete and two fragmented beads were discovered in the Feature 3 quarry pit wall profile at 26Ek3208 (Table 111, Figure 96d). All occurred in a small cluster in Stratum 22, probably representing a portion of a single adornment (Stewart 1941) lost during toolstone acquisition; similarly, size and overall morphology indicate they were manufactured from the same long bone (cf. Figure 96d).

Awls

Two awls (a tip from Unit 24 at 26Ek3092 and a "handle"/midsection from Feature 6 at 26Ek3251) were recovered (Table 111). The former, manufactured on an artiodactyl bone, appears to represent fortuitous use of a long bone splinter; manufacturing techniques involved simple transverse abrasion of one end to create a gradually tapering point, terminating at small shoulders ca. 18 mm back from the tip (cf. Figure 96c).

The specimen from 26Ek3251 is a proximal awl fragment manufactured from a large mammal scapula (Table 111). Although truncated, the distal end exhibits a remnant of purposeful tapering/rounding indicative of use in weaving and/or perforating. The artifact is highly polished from "hands-on" use and is slightly fire blackened, perhaps from purposeful fire-hardening. Complete and fragmentary awls have been recovered from archaeological deposits throughout the Great Basin (e.g., Aikens 1970; Ambro 1970; Lucius 1980; Pendleton 1985a; Schmitt 1988b, 1990; Thomas 1983b).

Flaking Tool

A single pressure flaking tool was recovered from Level 2, Unit 23, at 26Ek3092 (cf. Table 111, Figure 96b). It apparently was manufactured on an artiodactyl rib, an element

commonly employed in lithic flaking (for example, cf. Pendleton 1985a:227 and references therein). Its tip/end is blunted from use wear is and slightly ground along its margins, possibly from resharpening (cf. Pendleton 1985a; Schmitt 1988b). Although fragmentary, it appears that the flaker was small enough for hafting. Bone and antler flaking tools have been described ethnographically in the Great Basin (e.g., Steward 1937; Stewart 1941), and have been identified in numerous archaeological assemblages (e.g., Dalley 1970; Hattori 1982; Pendleton 1985a; Schmitt 1988b).

Expedient Tool

Unit 9 at 26Ek3092 yielded an undifferentiated artiodactyl femur midshaft fragment displaying use wear along a slightly convex fractured edge (cf. Table 111). The artifact displays no evidence of modification other than contiguous microflaking and slight polish along one edge as a result of expedient use, probably as a scraper/flesher (cf. Dalley 1970; Schmitt 1990; Thomas 1983b:308).

Quarrying Tools

Quarrying tools of bone consist of two scapulae scoop/shovels and a wapiti antler billet/wedge (cf. Table 111). Although both of the scapulae lack evidence of modification/use as tools and each is fragmentary (i.e., the 26Ek3200 specimen is a distal portion [also cf. Table 107] and the 26Ek3208 specimen is a blade/spine fragment), they are considered artifactual on the basis of actualistic studies, additional archaeological evidence, and context.

First, Carambelas and Raven (1991) conducted quarrying experiments during field investigations at Tosawihi and found large mammal (i.e., cow) scapulae to be of great utility in digging (i.e., toolstone exposure/acquisition), and as "dust pans" for the removal of debitage. Second, two bison scapula exhibiting spine removal, battering, and striations, probably from use as digging tools or shovels, were recovered from the Knife River Flint Quarries (Ahler 1986:75-76 and references therein). Finally, the context of the Tosawihi large mammal scapula fragments supports this functional interpretations, since both were retrieved from quarry pits and comparable specimens were recovered from no other context.

One of the most striking artifacts recovered at Tosawihi is a wapiti ("elk") antler wedge discovered in trench backdirt from backhoe operations at Feature 1 (a quarry pit), Locality 23. Manufacturing techniques involved longitudinal splitting of a portion of the antler in order to create a beveled (25°) working edge on the distal end (Figure 97). Both ends exhibit various degrees of use wear; the distal end is blunt, polished, and slightly battered from use, and the proximal end (i.e., the horn core) is faintly battered, probably from use as a hammer (e.g., assaying extracted toolstone).

Although usually smaller (shorter) and more extensively modified than the specimen from Locality 23, elk antler wedges have been recovered from numerous archaeological sites in Oregon and Washington, often in association with toolkits and relative and absolute dates of great antiquity (for example, cf. Brauner 1985). Similarly, in the Great Basin, a single, small, highly modified elk antler wedge retrieved from Stratum 4 of Hogup Cave may be as old as 8,000 years B.P. (Aikens 1970:28, 91, 93). Obviously, this does not confer early Holocene age on the Tosawihi specimen, but it signals that the artifact may be of great antiquity. Regardless of context, the artifact represents a durable, high utility quarrying tool.

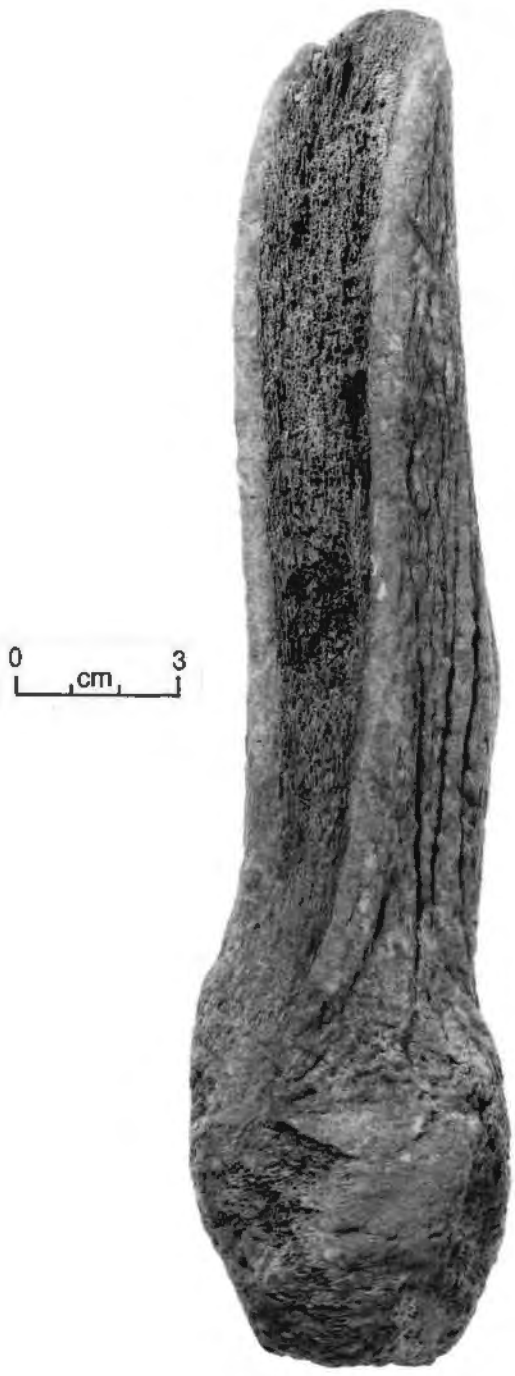


Figure 97. Antler wedge, 26Ek3032, Locality 23.

Summary and Conclusions

Analysis of the Tosawihi archaeofaunas has identified the remains of a variety of mammalian taxa and, through attritional studies, has disclosed evidence of human subsistence, non-human fossil accumulations, and artifactual bone. At sites 26Ek3092, 26Ek3192, 26Ek3251, and, to a lesser extent, 26Ek3237, unequivocal evidence of human exploitation of large (i.e., Class III-VI) mammals for subsistence resources is demonstrated by numerous burned, fragmented, and/or butchered bones. Large mammal presences, inter- and intra-site large mammal attritional comparisons, and intra-site bone distributions (especially at 26Ek3092 and 26Ek3192) suggests that many of these remains have passed through a "cultural filter" (Daly 1969:146), whether or not they are *unequivocally* artifactual. Similarly, multifunctional toolkits (often in association with hearth features) at each of these sites indicate use as camps where faunal and floral subsistence debris should be anticipated in the archaeological record. This pertains particularly to 26Ek3237 and 26Ek3251, both located some distance from the quarries in rich riparian settings; habitation there probably was not conditioned exclusively by the occurrence of the Tosawihi Quarries.

Most small mammal skeletal remains appear to be products of natural mortality (e.g., burrow deaths) or non-human predation. This is the case especially at Whining Rock Shelter, where conservative identification of scatological remains found approximately one-half of the Class I-III bones to have been deposited by terrestrial carnivores. The problem (and frustration) here is in discerning the taphonomic origin of the remaining specimens.

Small mammals, including rats, chipmunks, and squirrels, were encountered daily during our field operations in the quarries and surrounding areas, often in great abundance. Because rodents possess a high ratio of edible meat to total weight (Stahle 1982), offer higher caloric return rates than most Great Basin plant resources (Simms 1987), and often were described as common constituents of prehistoric aboriginal diets (e.g., Steward 1941; Stewart 1941), I suspect the rather healthy Tosawihi rodent population to have been exploited for food by prehistoric inhabitants. Unfortunately, due to our small, scattered rodent assemblages and our present naivete regarding small animal taphonomy, archaeological evidence of such activities remains scarce.

Regardless of taphonomic origin, animal bones at most Tosawihi sites are scarce, posing at least two scenarios. First, if the paucity of "food bones" truly reflects the intensity of food-animal exploitation, virtually all of the sites investigated represent palimpsest accumulations resulting from a series of *extremely* short-term forays to the quarries; the caloric value represented would sustain few people for a very limited amount of time. Alternately, the multitude of reduction features and debris suggest that prehistoric peoples often expended a great deal of time and energy while acquiring toolstone, and I suspect the rarity of food bones largely to be a product of poor bone preservation in the shallow contexts of most Tosawihi sites.

Chapter 15

PLANT MACROFOSSILS

Elizabeth E. Budy

Thirty-seven sediment samples from carbonized features at four sites (26Ek3251, 26Ek3237, 26Ek3092, and 26Ek3198) were floated and their light fractions examined for charcoal, seeds, and other plant macrofossils. The intent was to isolate data informative of feature function, subsistence patterns, season of site use, and past plant communities.

Methods

Two liter sediment samples were processed through an agitated flotation system segregating light organic material (e.g., woody charcoal, rootlets, seeds) from the soil matrix (cf. Wagner 1982). The light fraction was collected in a series of graduated meshes (3.2 mm, 1.5 mm, and cheesecloth), dried, and scanned under 10x - 20x magnification. The heavy fraction was collected in 1.5 mm mesh screen.

Where possible, seeds were identified by comparison with known specimens collected by the author and seminal collections at the University of Nevada (Reno) Herbarium. Additional light fraction constituents (e.g., woody charcoal, feces, rootlets) were noted and/or weighed, but species identifications were not attempted systematically.

26Ek3251

One sample was collected at 26Ek3251 from a faint charcoal stain 26 cm below surface (Feature 6). The light fraction contained tiny bits of woody charcoal (mostly *Artemisia tridentata*) and a number of charred seeds (Table 112).

Table 112. Light Fraction Recovery from Feature 6, Site 26Ek3251.

Sample Number	Charcoal (gm)	Charred Seeds	Fresh Seeds	Inclusions
1	<1	3 *Carex* sp. 28 POACEAE (cf. *Phleum*, *Muhlenbergia*, *Poa*) 1 Unidentified	2 *Chenopodium* (cf. *album*)	rootlets

The sample is dominated by small grass seeds (POACEAE), including alpine timothy (*Phleum* cf. *alpinus*) and either muhly (*Muhlenbergia* sp.) or bluegrass (*Poa* sp.). Alpine timothy generally is a high elevation plant, but it can be found at lower elevations in wet environments (Linda Nelson, UNR Herbarium, personal communication 1990). All these grasses are common inhabitants of wet streambanks (Cronquist et al. 1977); the assemblage of grass and sedge (*Carex* sp.) seeds suggests a more productive riparian habitat near the site in the past than prevails at present.

Willow Creek now is deeply entrenched (ca. 3 m), and its former floodplain (occupied by 26Ek3251) is blanketed by a thick cover of big sage and a sparse understory of cheatgrass. In the past, such areas likely hosted rich and diverse stands of native grasses as did similar streams tributary to the upper Humboldt (Tremewan 1964). The invasion of shrubs into former grasslands as a result of fire suppression and intensive livestock grazing is well documented (Young et al. 1976). Charred seeds from Feature 6 suggest a wider riparian belt when 26Ek3251 was occupied (little grows in the steep cut of Willow Creek channel today); spring or early summer visits concurrent with seedripe (Munz and Keck 1973) may have exploited the seasonal harvest.

The charred seeds from Feature 6 are not unequivocally the products of food processing. Fowler (1986:73, 76) lists species of *Poa*, *Muhlenbergia*, and *Carex* as common aboriginal food plants in the Great Basin, but our recovered seeds are very small and their harvest would have entailed high costs relative to caloric returns (cf. Simms 1985). On the other hand, they are unusually numerous considering the small amount of associated woody charcoal. Seed coats generally are intact, suggesting transformation under very low heat (as from parching). Apart from two fresh lambsquarter seeds (*Chenopodium album*), an introduced plant common to disturbed or over-grazed areas, there are few recent inclusions. The charcoal stain of Feature 6 may be the remnant of a seed parching area associated with a hearth, most of which has been lost to deflation or erosion.

26Ek3237

Sediment samples from site 26Ek3237 were taken from three hearth-like charcoal concentrations (Features 2, 3, and 4) and one rock pile (Feature 5). All but one were collected as vertical sections of feature interiors (i.e., from central charcoal concentrations). The hearth samples are characterized by abundant woody charcoal (mainly *Artemisia tridentata*) and a sparse scattering of diverse charred seeds (Table 113).

Table 113. Sample Provenience and Light Fraction Constituents, Site 26Ek3237.

Sample Number	Feature Number	Depth (cm below Surface)	Feature Context	Woody Charcoal (gm)	Charred Seeds	Fresh Seeds	Other Inclusions
1	2	2-10	Inside	23	1 *Plantago* sp.	none	rootlets
2	2	10-20	Inside	13	none	none	rootlets
3	3	16-20	Inside	6	none	none	rootlets
4	3	16-20	Outside	<1	none	none	1 leaf
7	3	20-30	Inside	20	none	1 POACEAE	rootlets
6	4	40-50	Inside	5	1 Unidentified *4 *Carex* sp.	1 *Chenopodium* (cf. *album*)	rootlets
8	4	30-40	Inside	18	1 *Brassica* (?) (cf. *nigra*)	none	rootlets
9	4	40-50	Inside	22	none	none	rootlets
11	5	30-40	Rock Pile	<1	1 POACEAE	none	rootlets

* These consist of split perigynia that are only lightly charred (or perhaps merely stained dark).

Charred seeds from the hearths include one plantain (*Plantago* sp.) in Feature 2, and four *Carex* perigynia, one possible mustard seed (*Brassica* sp.), and one unidentified specimen from Feature 4. Feature 5, the rock pile, included one charred grass seed. All species represented were used aboriginally for food or medicine (Fowler 1986; Train, Henricks, and Archer 1957), but sample interpretation is problematic. The possible mustard seed is similar

to the introduced *Brassica nigra*. The *Carex* perigynia (fragile papery covers enclosing the seeds) may simply be stained rather than charred. Great Basin peoples used plantain for medicine, the leaves to reduce swellings and root decoctions for colds (Train, Henricks, and Archer 1957:79-80); more generally, however, the seeds are known for their laxative powers (Munz and Keck 1973:405), with no record of their use as food.

The charred seeds from 26Ek3237 may well be incidental inclusions rather than subsistence products. As environmental indicators, plantain and sedge signal persistently wet riparian habitats, while mustard is common to disturbed and over-grazed dry sites.

26Ek3198

Plant macrofossils from two samples from a hearth at 26Ek3198 provide little evidence of prehistoric subsistence or environment (Table 114).

Table 114. Sample Provenience and Light Fraction Constituents, Site 26Ek3198.

Sample Number	Feature Number	Depth (cm below Surface)	Feature Context	Woody Charcoal (gm)	Charred Seeds	Fresh Seeds	Other Inclusions
14	25	15-20	Outside	<1	1 Unidentified	1 *Chenopodium* (cf. *ambrosioides*)	rodent feces, insect casings, rootlets
23	25	10-20	Inside	3.3	1 fruit fragment (cf. *Amelanchier* sp.)	none	rootlets

Sample 14 included many recent inclusions, among them a pigweed seed resembling introduced *Chenopodium ambrosioides*; a single unidentifiable charred seed also was recovered. Sample 23 included the apparently charred remains of a small fruit, probably serviceberry (*Amelanchier* sp.), a local resident species.

26Ek3092

Most of the sediment samples analyzed are from 26Ek3092 (Table 115). Two charcoal features thought to be heat-treatment hearths (Features 9 and 24) were examined with multiple samples. Two samples were taken from a nonfeature column for control, and one is from fire-altered soil below a charcoal stain (Feature 18).

Fourteen samples from Feature 9 were selected at different depths from both inside and outside the hearth basin. Charred seeds recovered from the hearth and its vicinity include buckwheat (*Eriogonum* sp.), sedge (*Carex* sp.), plantain (*Plantago* sp.), and various grasses (POACEAE), including one specimen from Sample 24 that looks like bent grass (*Agrostis* sp.). Except for plantain, the seeds are from plants used aboriginally for food (Fowler 1986:69-79; Stewart 1941:374; Steward 1938:306-310), and all of which grow in the vicinity today.

The small number of charred seeds does not suggest intensive subsistence functions for Feature 9; rather, it would appear that some seeds were altered incidental to primary use of the hearth for heat-treatment of stone. The restricted distribution of charred seeds in samples adjacent the hearth and on its south side (i.e., between the fire pit and the large boulder; cf.

Chapter 16) supports the notion. A food preparation or eating area may be located here, maximizing shelter provided by the boulder.

Table 115. Sample Provenience and Light Fraction Constituents, Site 26Ek3092.

Sample Number	Feature Number	Depth (cm below Surface)	Feature Context	Woody Charcoal (gm)	Charred Seeds	Fresh Seeds	Other Inclusions
4	9	20-30	Outside/ adjacent	<1	none	1 *Chenopodium* (cf. *album*)	rootlets
5	9	20-30	1 meter outside	<1	1 *Eriogonum* sp. 1 POACEAE	none	rootlets
13	9	27-30	Outside/ adjacent	<1	none	none	rootlets
14	9	27-30	1 meter outside	<1	none	none	rootlets
15	9	33	Inside	26	1 POACEAE	3 *Chenopodium* sp. 2 *Bromus tectorum*	rootlets
18	9	33	Outside	<1	none	1 grass spike frag. (*Bromus tectorum* ?)	rootlets, grass chaff
19	9	33	Outside/ adjacent	<1	2 *Eriogonum* sp.	1 *Chenopodium* (cf. *album*)	rootlets, grass chaff
24	9	34-40	Outside/ adjacent	48	1 POACEAE (cf. *Agrostis*)	none	rootlets
26	9	40-47	Bottom/ inside	15	2 *Carex* sp. 2 Unidentified (possible CYPERACEAE)	none	rootlets
27	9	40-48	Bottom/ inside	<1	none	none	rootlets, grass chaff
33	9	33-40	Inside	17	none	3 *Bromus tectorum* 1 *Chenopodium* sp.	rootlets
37	9	40-43	Bottom/ inside	8	none	2 *Chenopodium* sp.	rootlets, grass chaff
38	9	40-44	Bottom/ inside	<1	none	none	rootlets
39	9	33-35	Outside/ adjacent	<1	1 *Plantago* sp.	5 *Chenopodium* (cf. *ambrosioides*)	rootlets
12	18	18-30	Below F.17 Basin	<1	none	4 *Chenopodium* (cf. *album*)	rootlets, matted fiber (cf. rodent nest)
28	N/A	10-20	Column Sample	<1	2 Unidentified	none	rootlets, grass chaff, insect casings
30	N/A	30-40	Column Sample	<1	none	none	rootlets
43	24	63	Below Cobbles	<1	1 Unidentified	16 *Chenopodium* (cf. *ambrosioides*)	rootlets
45	24	60-70	Inside	<1	none	none	rootlets
46	24	65-67	Inside	<1	none	none	rootlets
48	24	67-70	Inside	<1	1 POACEAE	1 *Chenopodium* (cf. *album*)	rootlets
50	24	72-76	Inside	<1	none	none	rootlets
52	24	80	Inside	<1	none	1 *Chenopodium* (cf. *album*)	rootlets
55	24	85-90	Inside	<1	none	3 *Chenopodium* sp.	rootlets, lichen (?), rodent feces
57	24	80-90	Inside	<1	1 POACEAE	1 *Chenopodium* sp.	rootlets, rodent feces

Likewise, it is possible that seeds naturally introduced from the nearby stream (e.g., *Carex* and *Plantago*) and adjacent dry slopes (e.g., *Eriogonum*) were burned incidentally during use of the Feature 9 hearth. However, nonfeature column samples (Samples 28 and 30) include none of the species found charred in Feature 9. In any case, seed samples provide some indications of season of aboriginal use; as grasses ripen in early summer (March-July) and buckwheat matures variously by species throughout summer (May-August; cf. Munz and Keck 1973), an early summer use of Feature 9 is suggested.

The eight samples from Feature 24 yielded only two charred grasses and one unidentified specimen (cf. Table 115); all are severely modified as if from high heat, although virtually no charcoal was recovered. The samples provide little clear indication of subsistence, season, or environment. Recent rodent disturbance is noted in these deep deposits, both from feces in Samples 55 and 57 as well as from the numbers of introduced pigweed seeds (*Chenopodium album* and *C. ambrosioides*).

Finally, Sample 12 from Feature 18 included no burned seeds, but matted plant fiber in the light fraction resembles rodent nesting material.

Chapter 16

ARCHAEOLOGY OF THE WESTERN PERIPHERY

Melinda Leach, Daniel P. Dugas, and Robert G. Elston

West of the Tosawihi Quarries lies a steeper, more dissected terrain that offered prehistoric quarriers a wholly different suite of resources (Figure 98). In this Western Periphery are the occasionally watered canyons, seeps and pools, and root-bearing slopes that provided temporary campsites, foraging opportunities, and tool production workshop locales. The area subsumes approximately 480 acres (194 hectares) of moderately sloping terrain adjacent the principal Quarries (Figure 99). The physical settings of the larger Tosawihi study region and the more confined Western Periphery have been described in detail by others (Elston, Raven, and Budy 1987; Budy 1988, 1989; Budy, Elston, and Raven 1989). We provide a brief review here.

Moderate (10–30%) to steeply (30–50%) sloping ridge lines broken by small flats, basins, terraced knolls, and saddles characterize the topography of the western area. From Twin Buttes (6125 ft, 1867 m amsl) at the northwestern extreme, the study area descends across a series of southeast-trending ephemeral drainages that empty into Little Antelope Creek Canyon (5425 ft, 1654 m amsl) on the east, terminating at a ridgecrest. Rodent Valley, a small elevated basin, lies at the northern edge of the area and marks a transition zone between the primary toolstone sources in the Quarries to the north and the intensively exploited, though localized, outcrops on Red Hill to the south (Budy 1989).

Red Hill (5820 ft, 1774 m amsl) is a distinctively colored, terraced knoll punctuating the southern edge of Rodent Valley. Intensive minerals exploration since 1963 has circumscribed the knoll with jeep trails, dirt roads, and drill pads. The south slope of Red Hill descends abruptly to Basalt Canyon, a narrow, steep-sided drainage that bisects the study area and flows ultimately into Little Antelope Creek Canyon. The canyon is bordered on the southwest by a series of thinly-mantled, southeast-trending ridgelines that comprise the Bitterroot Ridge Complex (Budy 1989).

Unlike the adjacent Quarries, the Western Periphery is not a rich repository of lithic sources; abundant deposits of opalite are rare, save for small outcrops on Red Hill and in Rodent Valley. Occasionally, prehistoric quarriers collected opalite cobbles from the drainage gravels of Basalt Canyon. As well, cobbles and slabs of tabular andesitic basalt, which surface along knolls forming prominent talus stripes on the steeper slopes of the study area, were transported to nearby localities for use in the manufacture of percussion and digging tools and seed-grinding implements (Budy 1988:10).

Undifferentiated tuff caps Red Hill and adjacent portions of the Western Periphery above about 5700 ft (1737 m) amsl on the northeastern slopes of Basalt Canyon (Cornucopia 1987). The tuff contains pockets of silicified reworked tuffaceous sediments and is capped here and there by patches of sinter. The lower southern slopes and nearly all the terrain southwest of Basalt Canyon are mapped as basalt (Cornucopia 1987). A relict cap of tuff with some silicification occurs on the top and southeastern slopes of Prospector Point, and a couple of small silicified basalt ("jasper") outcrops have been mapped, but these do not appear to have been quarried prehistorically.

No permanent water sources exist within the Western Periphery. Ephemeral seeps and streams in the Little Antelope Creek, Velvet, and Basalt Canyon drainages provide water only seasonally, as do several temporary springs just beyond the boundaries of the subarea.

The western area supports vegetative communities typical of the Sagebrush-Grassland zone that dominates the high desert valleys and foothills of the northern Great Basin (Elston,



Figure 98. Overview (north) of the Western Periphery. Twin Butte on western horizon, Red Hill on eastern horizon, Basalt Canyon at photo center, and Big Butte in background.

Raven, and Budy 1987:7). A low sage community, converging on basaltic ridges where soils are thin, includes low sage, phlox, snakeweed (*Gutierrezia sarothrae*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and occasional bunch grasses, such as squirreltail and Idaho fescue (*Festuca idahoensis*). Several plants with edible tubers are moderately abundant, as well, on thin soils edging the ridgetops of Bitterroot Ridge (Budy 1989:213). These include, not surprisingly, bitterroot, onion (*Allium* sp.), and sego lily (*Calochortus nuttalli*). Big sage, with occasional rubber rabbitbrush (*Chrysothamnus nauseosus*), Great Basin wildrye, and bluebunch wheat grass grow on steep north-facing slopes, in drainage bottoms, and where soils attain some depth on ridge tops (Budy 1988:11).

Recently observed fauna include coyote, cottontail rabbit, chipmunk, and badger. Antelope and mule deer also are known to frequent the area seasonally (Elston, Raven, and Budy 1987:8).

Descriptive Site Summary

Unlike the virtually continuous distribution of prehistoric materials in the primary quarry zone north and east, the 129 prehistoric sites identified in the Western Periphery are spatially distinct (Figure 100; cf. Budy 1988), and many are functionally diverse. These sites include quarries focused on opalite exposures, possible short-term residential loci containing food-processing implements and exotic materials, small lithic scatters, lithic reduction loci, and isolated artifacts (Budy 1988:i).

From the 129 sites identified in our initial reconnaissance, 30 quarry and non-quarry locales were selected for testing of surface and subsurface deposits (cf. Figure 100; cf. Budy 1989). Seven proved significant particularly for the information they could provide in support

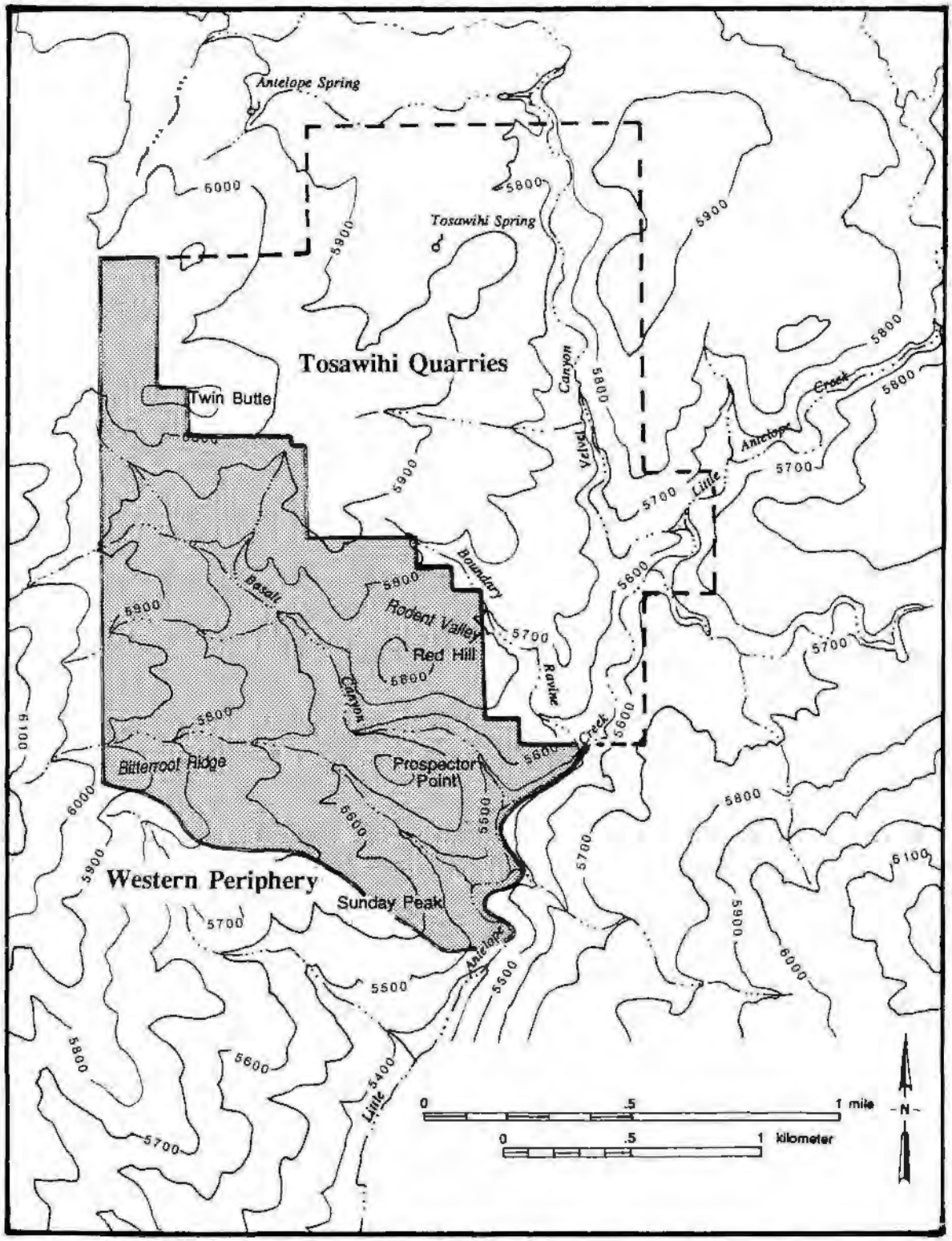


Figure 99. Topography of the Western Periphery.

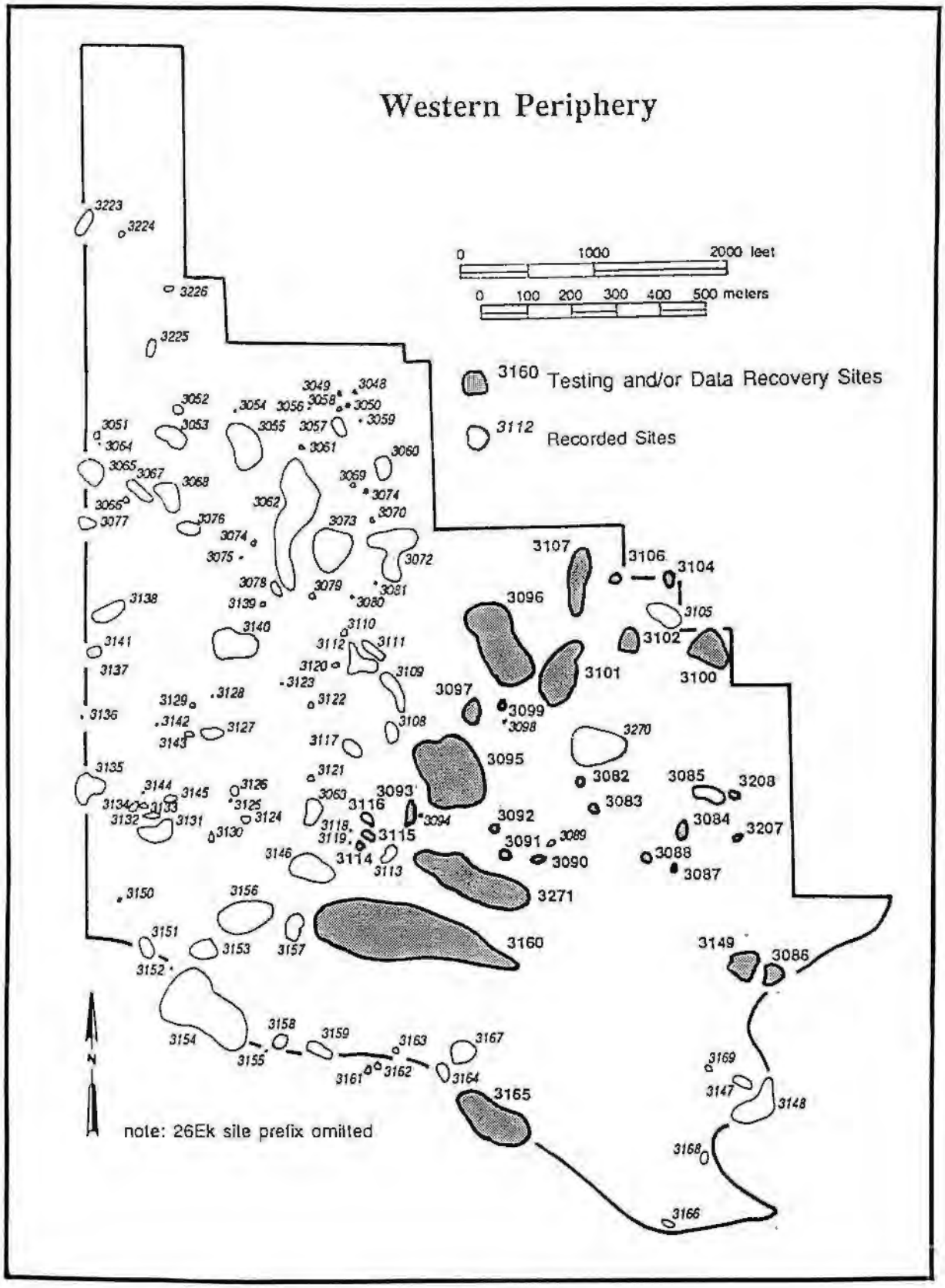


Figure 100. Locations of sites in the Western Periphery.

of research issues outlined for the Tosawihi study area (cf. Elston 1988a; Intermountain Research 1988b). These sites warranted more intensive data recovery, and in 1989 we returned to them for further excavation (Table 116).

Table 116. Sites Investigated in the Western Periphery.

Site	Quarry Features (n)	Non-Quarry Features† (n)	Elevation (ft. amsl)	Maximum Site Area (sq m)
26Ek3082 (T)	+	3	5775	300
26Ek3083 (T)	+	-	5700	2,000
26Ek3084 (T,DR)	1	1	5600	4,250
26Ek3085 (T,DR)	5	-	5750	1,178
26Ek3086 (T)	-	-	5750	1,100
26Ek3087 (T)	-	-	5530	300
26Ek3088 (T)	-	-	5545	650
26Ek3090 (T)	-	-	5595	150
26Ek3091 (T)	-	-	5605	400
26Ek3092 (T,DR)	-	24	5625	4,800
26Ek3093 (T)	-	6	5750	1,875
26Ek3095 (T,DR)	-	25	5650	15,000
26Ek3096 (T)	-	7	5775	14,250
26Ek3097 (T)	-	-	5700	500
26Ek3099 (T)	-	4	5735	750
26Ek3100 (T)	-	2	5725	5,850
26Ek3101 (T)	-	-	5775	11,250
26Ek3102 (T)	-	5	5850	2,400
26Ek3104 (T)	+	-	5775	600
26Ek3106 (T)	-	7	5800	5,175
26Ek3107 (T)	-	5	5800	6,750
26Ek3114 (T)	-	1	5765	100
26Ek3115 (T)	-	1	5775	100
26Ek3116 (T)	-	1	5780	200
26Ek3149 (T)	-	3	5500	2,500
26Ek3160 (T,DR)	-	25	5575	46,000
26Ek3165 (T,DR)	-	2	5670	4,500
26Ek3207 (T)	+	-	5670	1,200
26Ek3208 (T,DR)	3	-	5740	10,367
26Ek3271 (T)	-	22	5650	19,500

† Prehistoric features only
(T) Testing only performed
(T,DR) Testing and data recovery performed
+ Sites with on-site opalite sources, yet which lack discrete quarry features

Quarry Locales

Quarry locales in the Western Periphery range from exposed opalite outcrops (associated with accumulations of quarry debris) to prehistorically excavated quarry pits, to surficial cobble beds from which quarrying material was collected. Toolstone sources vary in both quality and quantity of exploitable material. With little evidence of on-site activities other than toolstone procurement, quarry assemblages are dominated by debitage and shatter, numerous assay chunks, cores, hammerstones, biface blanks, and fragments.

Rimrock exposures on the steep southern slope of Red Hill constitute the primary opalite outcrops in the West, and these were used enthusiastically by prehistoric quarriers. Indeed, one

Red Hill quarry pit complex (26Ek3208) is among the most intensively exploited opalite outcrop so far observed at Tosawihi. Its numerous pits and deeply stratified accumulations of quarry and reduction debris reflect extraordinary expenditures.

Six quarry sites (26Ek3082, 26Ek3083, 26Ek3084, 26Ek3085, 26Ek3207, and 26Ek3208) oriented around the Red Hill opalite exposures were tested, and three (26Ek3084, 26Ek3085, 26Ek3208) received additional data recovery (cf. Budy 1989; Intermountain Research 1988b). We also tested one small outcrop quarry (26Ek3104) situated in Rodent Valley, north of Red Hill.

Non-quarry Locales

Lithic Reduction Stations and Complexes

These sites generally are characterized by relatively little tool diversity and a notable scarcity of projectile points and maintenance or processing tools. They are the archaeological remains of discrete core and biface reduction episodes, yielding cores, bifaces, occasional flake tools, debitage, and shatter. Small reduction scatters may represent single episodes of tool production, while larger complexes with overlapping features may result from multiple visits and/or longer-term use.

Seven of the non-quarry locales we investigated (26Ek3086, 26Ek3087, 26Ek3088, 26Ek3090, 26Ek3091, 26Ek3097, 26Ek3099) rest on the lower slopes of steep-sided Basalt Canyon (cf. Figure 100); four others (26Ek3093, 26Ek3114, 26Ek3115, 26Ek3116) lie on elevated benches along Bitterroot Ridge, overlooking Basalt Canyon (Budy 1989). The remaining reduction complexes we examined (26Ek3096, 26Ek3100, 26Ek3101, 26Ek3102, 26Ek3106, 26Ek3107) consist of large, diffuse sites clustered in Rodent Valley.

Reduction/Residential Complexes

Reduction/residential sites characteristically reveal diffuse to concentrated deposits of toolstone-processing debris, sometimes arrayed in discrete activity areas, accompanied by diverse assemblages suggesting domestic activities. Assemblages may include projectile points, preforms, pottery, choppers, flake tools, abraders, ground stone, cooking and heat-treating hearths, scrapers, hammerstones, bifaces, and cores. In the Western Periphery, residential complexes appear to represent relatively short-term campsites, although they unquestionably were re-occupied, sometimes over millennia.

We investigated six residential complexes to define the structure of social groups exploiting the Quarries and to clarify the logistical patterning of their toolstone collection and subsistence forays (cf. Chapters 4, 24, 26). One stratified, buried site (26Ek3092), probably occupied over many, relatively short-term episodes, lies in the broad meadow adjacent the seasonally-watered floor of Basalt Canyon (cf. Figure 100). 26Ek3149, hosting several features and a diverse tool assemblage, is located on the rocky eastern slope of Basalt Canyon, above its confluence with Little Antelope Creek. We investigated four additional reduction loci with subsistence-related assemblages (26Ek3160, 26Ek3165, 26Ek3095, 26Ek3271) among the elevated ridges and slopes of the Bitterroot Ridge Complex.

Testing and Data Recovery Methods and Results

Testing at 30 sites in the Western Periphery consisted of intensive surface reconnaissance, mapping, and systematic artifact collections based on close-order transect survey. All formal artifacts

and obsidian suitable for sourcing were collected, and discrete features were defined by characterizing surface debitage patterns.

In specific instances, where concern with site structure, site function, or site formation processes demanded, we undertook controlled surface scrapes and subsurface excavation, sampling both discrete reduction features and inter-feature areas where present (Table 117).

Table 117. Summary of Collection Procedures, Western Periphery.

		FEATURES RECORDED		FEATURE CONTEXT		NONFEATURE CONTEXT	
Site Number	Phase	Total (n)	Sampled (n)	Surface Scrape (m^2)	Subsurface Excavation (m^3)	Surface Scrape (m^2)	Subsurface Excavation (m^3)
26Ek3082	T	3	1	0.06	-	-	-
26Ek3083	T	-	-	-	-	-	-
26Ek3084	T	2	2	0.50	- *	-	-
	DR	-	1	-	- *	-	-
26Ek3085 - See 26Ek3208							
26Ek3086	T	-	-	-	-	-	-
26Ek3087	T	-	-	-	-	-	-
26Ek3088	T	-	-	-	-	-	-
26Ek3090	T	-	-	-	-	-	0.45
26Ek3091	T	-	-	-	-	-	-
26Ek3092	T	6	-	-	-	-	2.30*
	DR	19	19	-	1.51	-	22.75*
26Ek3093	T	6	1	49.00	0.09	-	-
26Ek3095	T	25	5	28.31	0.59	-	-
	DR	-	6	-	11.23	-	-
26Ek3096	T	7	1	4.00	-	-	-
26Ek3097	T	-	-	-	-	-	-
26Ek3099	T	4	-	-	-	-	-
26Ek3100	T	2	1	2.00	-	-	-
26Ek3101	T	-	-	-	-	2.00	0.70*
26Ek3102	T	5	1	8.00	-	-	-
26Ek3104	T	-	-	-	-	-	0.03
26Ek3106	T	6	2	42.00	0.24	1.00	-
26Ek3107	T	5	1	4.00	-	-	0.01*
26Ek3114	T	1	1	10.00	-	-	-
26Ek3115	T	1	1	-	-	10.00	-
26Ek3116	T	1	1	12.00	-	-	-
26Ek3149	T	3	1	4.00	-	-	0.25
26Ek3160	T	23	6	50.00	0.09	-	1.20
	DR	2	6	57.00	2.16	-	9.30
26Ek3165	T	2	2	16.00	-	-	0.25
	DR	-	1	32.00	0.64	-	3.70
26Ek3207	T	-	-	-	-	0.06	-
26Ek3208/3085	T	8	1	-	- *	-	-
	DR	-	1	-	- *	-	-
26Ek3271	T	22	5	67.00	0.56	-	0.20

* Backhoe or hand excavated trenches were placed in these contexts; their volume is not included.

Because quarrying locations regularly manifest massive accumulations of lithic debris that defy standard collection procedures, we employed in these settings methods aimed at reducing the bulk of redundant material while still recovering adequate information about reduction strategies. Each quarry locale was scrutinized for surface artifacts, time-markers, and toolstone extraction features. We documented physical characteristics of the geological formation, noted dimensions and density of associated lithic scatters, and mapped discrete features. Artifacts were collected, as were samples of opalite for chemical sourcing studies. We conducted no further collection at sites with little surface variability or cultural depth. Where quarry pit features and thick reduction debris deposits were evident, however, we opened backhoe trenches; profile drawings recorded natural and cultural stratigraphy. We collected measurable charcoal for ^{14}C assay, as well as strata-based bulk samples for mass debitage analysis.

A detailed discussion of the character and findings at each of the investigated sites follows. Formal artifacts recovered during the Tosawihi testing and data recovery phases are shown in Table 118, where frequencies differ, occasionally, from those reported in earlier volumes of testing phase results (Intermountain Research 1988b; Elston 1989). With increased insight gained from in-depth analyses, we have re-evaluated some classes of artifacts, and present new ascriptions here.

Table 118. Artifacts Recovered from Sites in the Western Periphery During Testing and Data Recovery.

	DEBITAGE[b]		FORMED ARTIFACTS										
Site	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
26Ek3082	4	17.9	-	-	-	-	-	-	-	-	-	-	0
26Ek3083	-	-	-	-	-	-	-	-	-	-	-	-	0
26Ek3084	8,476	25,651.4	-	-	2	-	3	-	4	-	-	1	10
26Ek3085	-	-	-	-	1	-	-	-	2	-	-	-	3
26Ek3086	-	-	-	-	4	-	2	-	-	-	-	-	6
26Ek3087	-	-	-	-	4	-	-	-	-	-	-	-	4
26Ek3088	-	-	-	-	3[a]	-	1	-	-	-	-	-	4
26Ek3090	120	616.5	-	-	5	-	1	-	-	-	-	-	6
26Ek3091	-	-	-	-	6	1	-	-	-	-	-	-	7
26Ek3092	132,194	177,392.5	37	29	530[a]	13	147	7	22	8	60	5	858
26Ek3093	2,575	2,925.8	2	6	38	2	3	-	1	-	-	-	52
26Ek3095	82,493	76,690.8	36	17	480[a]	7	59	4	13	13	-	17	646
26Ek3096	790	996.9	-	-	13	-	-	1	3	1	-	-	18
26Ek3097	-	-	-	-	-	-	-	-	-	-	-	-	0
26Ek3099	-	-	1	-	7	1	-	-	2	-	-	-	11
26Ek3100	845	2,883.3	-	-	-	-	-	1	-	-	-	-	1
26Ek3101	2,120	1,818.5	1	-	21	-	3	1	1	-	-	-	27
26Ek3102	1,369	6,677.0	1	-	11	-	1	1	-	-	-	-	14
26Ek3104	1,328	3,856.8	-	-	7	4	-	1	2	-	-	-	14
26Ek3106	12,420	26,416.1	2	-	50	2	3	1	2	1	-	-	61
26Ek3107	1,614	4,822.7	1	-	4	-	-	-	1	-	-	-	6
26Ek3114	3,772	5,024.9	1	-	15	-	2	-	1	-	-	-	19
26Ek3115	1,787	1,887.7	-	-	8	-	4	-	-	-	-	-	12
26Ek3116	2,383	3,500.4	6	3	11	-	8	-	-	-	-	-	28
26Ek3149	468	561.3	3	-	12	-	4	-	1	2	-	-	22
26Ek3160	47,034	62,673.4	58	51	756[a]	2	83	4	11	18	61	3	1,047
26Ek3165	13,067	16,331.4	3	3	75[a]	-	10	1	-	4	-	-	96
26Ek3207	7	184.5	-	-	-	-	-	-	-	-	-	-	0
26Ek3208	175,455	244,122.5	1	-	-	-	3	-	6	-	-	2	12
26Ek3271	53,252	67,525.2	23	10	372[a]	6	44	2	18	6	-	-	481
Totals	543,573	732,577.5	176	119	2,435	38	381	24	90	53	121	28	3,465

[a]Count includes "possible" bifaces
[b]Includes obsidian surface debitage isolates

Quarry Locales

26Ek3082, 26Ek3083, and 26Ek3207

26Ek3082, 26Ek3083, and 26Ek3207 surround small outcrop exposures on the south slope of Red Hill, and are characterized by amorphous zones of quarry debitage. These outcrops were exploited minimally, and their assemblages reflect mostly primary material assay and preliminary toolstone reduction (Budy 1989:169–176). Evidently, the quality of the toolstone did not warrant more labor-intensive exploration. No intrusive quarry pit features are present, although a shallow adit-like excavation was observed in the outcrop at 26Ek3082; three small (< 2 m^2) reduction features were noted along the outcrop as well.

26Ek3082 and 26Ek3207 lie in the vicinity of bedrock mapped as silicified reworked tuffaceous sediments, exposed on the southern margin of the tuff beds capping Red Hill. 26Ek3083, however, lies farther down the southern flank of Red Hill, well within the basalt that underlies the tuff. A small, white opalite outcrop in this terrain suggests that a chunk of silicified tuff broke off the margin of the tuff cap and slid down the colluvial slope to rest on the basalt erosional surface.

We tested 26Ek3082 and 26Ek3207 by employing a series of small (25 cm x 25 cm) surface scrapes to recover technological information (cf. Table 118 for debitage yields from this exercise). We collected nothing at 26Ek3083 save a rock sample for potential chemical sourcing and lithic comparison. None of these small quarry sites warranted additional data recovery, owing to the minimal variability reflected in surface deposits and the apparent lack of subsurface accumulations (Budy 1989:172).

26Ek3084

26Ek3084, the smallest of the Red Hill quarry pit sites, lies on the steep (25–45%) southern slope of the knoll. Prehistoric toolstone procurement was directed at a colorful, high quality, jasper outcrop producing reduction debris in various shades of greenish-white, brown, yellow, orange, red, maroon, and purple. Indeed, the distinctive colors and composition of the material at this source make it possible to trace lithic material transport from 26Ek3084 to nearby reduction stations.

Excavation Methods and Rationale

At this discrete, intensively exploited quarry we observed a shallow depression, apparently the remnant of a prehistoric quarry pit (Feature 1), an associated pile of quarry rubble (Feature 2) surfacing midway down the slope near the center of the site, and a larger lithic scatter (Figure 101) from which we collected an early stage biface. The two features provided an opportunity to collect specific information about opalite extraction strategies, raw material variability, and staged reduction trajectories.

Features 1 and 2 were transect-sampled via small, regular surface collections for the recovery of debitage samples. The Feature 1 depression, truncated by a jeep trail, was trenched through its midline to verify its subsurface identity, to isolate the source of the toolstone, and to expose its internal structure for stratigraphic profiling. Once trenching was accomplished, dangerously unstable slope deposits prohibited our planned column excavations in exposed walls. Data collection was limited therefore to stratigraphic analysis and lithic sampling.

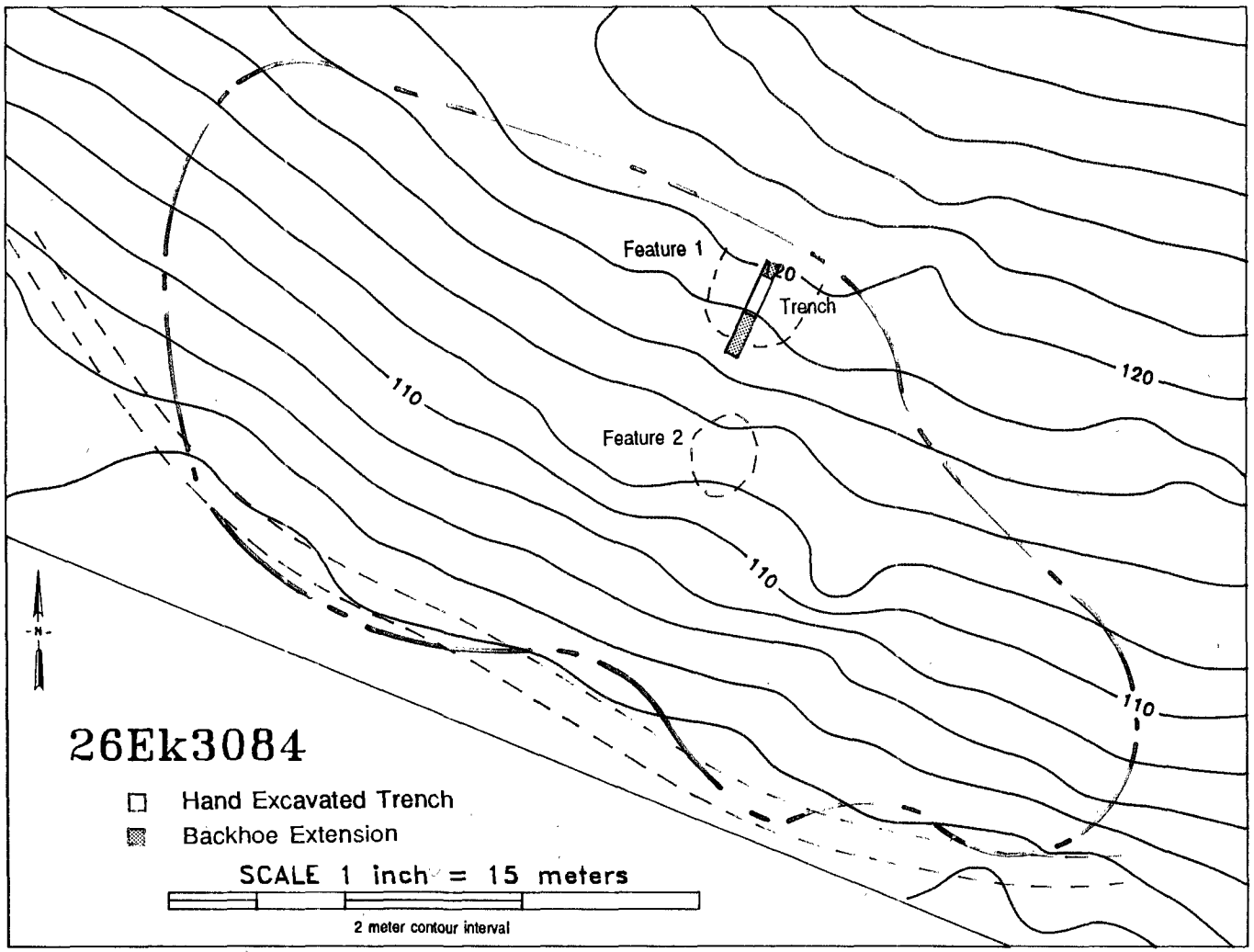


Figure 101. 26Ek3084 site map.

Feature 1

Feature 1, a shallow surface depression measuring approximately 1.5 meters in diameter, was plan mapped and a systematic surface collection was undertaken during testing phase. We aligned a four-meter transect across the north-south axis of the feature, parallel to the slope, to crosscut the depression and intersect its berm (cf. Figure 101). Four surface scrapes (25 cm x 25 cm x 2 cm) were executed at one meter intervals along the transect, and the proceeds screened through 1/4 inch mesh. Opalite and jasper debitage, comprised mostly of core reduction debris, and a single retouched flake were recovered (Table 119).

Table 119. Summary of Artifacts Collected from Feature 1 at 26Ek3084.

		DEBITAGE			
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Flake Tools	Total
1 (SF)	.00125	6	10.9	-	0
2 (SF)	.00125	55	239.6	-	0
3 (SF)	.00125	51	459.4	1	1
4 (SF)	.00125	40	82.6	-	0
15 (TR)	N/A	8,177	22,946.1	-	0
Totals	.005	8,329	23,738.6	1	1

(SF) = Surface Scrape
(TR) = Backhoe or Hand-dug Trench

We then hand-excavated a trench (3 m x .6 m x 1.6 m) through the middle of the depression, exposing the berm and downhill edges of a prehistoric quarry pit. The revealed cross-section reflected several strata sloping north opposite the trend of the surface, varying in particle size, artifact content, and sediment color—the product of discrete quarrying events, including pit floor excavation and quarry waste disposal (cf. Budy 1989:178–182 for a detailed description of Feature 1 cultural stratigraphy revealed during testing).

Because our hand-excavated trench exposed only the margin of the quarry feature, and we surmised that the center of the pit and the toolstone extraction area must lie farther north under road fill, we deemed that further exposure was necessary to address research questions about site formation and toolstone extraction strategies more specifically (cf. Elston 1988a). In 1989, we returned to remove the overlying road fill that obscured the subsurface jasper formation, and extended the exposure with the use of a backhoe (Trench 2). Characterization of the revealed toolstone source was completed and a new stratigraphic profile (described below) was produced.

Twenty-three reduction debris samples were collected from discrete strata in the east wall of Trench 2 for technological characterization (cf. Table 119). Analysis of eighteen of them indicates at least two technological trajectories, including core reduction and Stage 2 biface reduction (cf. Chapter 10).

Quarry Pit Stratigraphy at Feature 1

Our 1989 backhoe trench (Trench 2) extended the hand-dug exposure (Trench 1) one meter to the north and three meters to the south, deepening it by approximately one meter. Retrenching also moved the profile face 50 cm east of the original. Stratigraphy remarkably

different in both extent and character was revealed in the new profile (Figure 102). Despite these differences, however, the overall depositional story is similar. An approximate match between the original and new profiles occurs where the 2.0 meter point of the 1989 profile (Figure 102) aligns with the 1.6 meter point of the 1988 profile (cf. Budy 1989:Figure 37a).

The following description of the stratigraphy of the Trench 2 profile provides definition of the strata as grouped by major horizons. Particle size, artifact content, and sediment color often change within a few centimeters, but it is possible to organize groups of strata into horizons, each a broad time-stratigraphic unit including one or more related events marked by surfaces and conformable strata. Horizon boundaries are virtually all truncation surfaces created by excavation through one or more strata of the underlying horizon. The reader should note that this unit horizon connection is used whenever possible in subsequent stratigraphic descriptions.

The duration of stratigraphic events probably varies considerably. For instance, surfaces were created through excavation (pit floors) and by deposition (surfaces of depositional units). Cultural surfaces, pit floors and slopes, and strata (layers deposited through quarrying and processing waste disposal) were created instantaneously in archaeological terms, while strata created through natural processes (colluviation, slope wash, eolian deposition) no doubt took longer to accumulate.

As described above, the bedrock at this location is highly altered material. Bedrock strata appear to dip toward the north. The lowest stratum in the stack observed here is soft, fine grained, tuff-like, white, orange, and pink rock. Originally identified as tuff (Budy 1989), it is more likely altered, leached, andesitic basalt (Bartlett, Enders, and Hruska 1991; Chapter 4, this volume). This is overlain by at least three layers or lenses of highly silicified, jasper-like rock, the object of quarrying here. From lowest to highest, the predominant colors of the layers are reddish-purple, white, brown, purple, and banded yellowish-brown to chocolate brown. The brown jasper is overlain by a dark purple layer ca. 50 cm thick of what appears to be clay loam, resulting from intense hydrothermal alteration that has completely transformed the parent material into clay. The argillicized layer in turn is overlain by ca. 1.5 m of altered, tuff-like bedrock containing angular gravel to cobble sized clasts, suggesting a colluvial origin.

The argillization and bright colors of the bedrock here are due to alteration and silicification of a paleosol (now the argillic layer) developed on middle to late Miocene basalt (Bartlett, Enders, and Hruska 1991:15–16). The silicified, jasper-like toolstone retains flaggy to bouldery structure reminiscent of that observed in unaltered basalt outcrops to the west, and probably is altered basalt.

The present south slope of Red Hill is an erosional surface that truncates all the strata described above, exposing the toolstone. Bedrock weathering from that surface in a zone 40–50 cm thick forms Units 2, 31, and 33. Unit 30 is older colluvium, with carbonates, that predates quarry pit excavation.

A series of generally alternating fine and coarse depositional episodes in the new profile form four distinct stratigraphic horizons in sediments filling quarry pits. *Horizon IV*, the oldest, is comprised of Units 2, 30, 31, 33. These natural deposits probably covered much of the bedrock surface before pit excavation took place. Units 23–29, 32, 34, and 35 of *Horizon III* are silty and compact with a fair amount of carbonate accumulation. They comprise the fill of the deepest pits visible, which were excavated through Units 30–33 into the bedrock. The units of Horizon III give the impression of having been in place for a fair amount of time and may have undergone pedogenesis; certainly,strata are less distinct. Unit 26 of this horizon appears to have formed from illuviation of carbonate, acquiring a distinct reddish color in the process. The truncation of the upper units (Units 23 and 23/25) is easily observed.

Deposits of *Horizon II* include Units 5–22, a series of complex, stratified coarse quarry debris and fine sediments. These are not as compact as units in Horizon III, but they do have notable carbonate accumulation, especially on the underside of the opalite clasts. Such carbonate accumulation in quarry debris is rare in the Tosawihi area. These units fill a pit excavated through Units 23 and 23/25 on the south and possibly Unit 2 on the north. The alternating coarse units of opalite chunks and debitage (6, 8, 11, 13, 15, 17, 19, 21) and fine sediments (7, 9, 10, 13, 14, 16, 8, 20, 22) appear to represent episodes of quarrying and processing on the one hand and periods of slope wash accumulation on the other. Many of the coarse units are characterized as "open framework," that is, deposits in which coarse pieces of rock lie on or against one another with open spaces between the clasts. These are divided into poor, moderate, or typical open frameworks, depending on the relative amount of space and finer matrix present. When matrix is abundant, and the larger pieces do not rest on one another, the deposit is described as "matrix supported."

Trenching apparently cut through the eastern quadrant of the quarry pit. Horizon II units exposed in the western trench wall were much thicker and coarser with larger overall particle size. This wall was not profiled because we anticipated collapse of the coarse, openwork sediments during wall cleaning.

Horizon I is comprised of Unit 1 and possibly Unit 4. Unit 1 is a poorly sorted mix of sandy silt with common subangular to subrounded pebbles and rare large tuff blocks. Although the deposit generally is homogeneous, pebble lines, vague color changes, and mottling are present. This unit probably originated by colluvial slopewash processes, but it has been disturbed by road construction as well.

The flaggy-bouldery structure of the toolstone seems to have made it relatively easy to extract. The virtual absence of charcoal in the pit deposits (unlike most of the other quarry features described in this report) suggests that fire setting was not necessary to assist procurement of toolstone from this source.

Feature 2

Feature 2, a thick deposit of quarry rubble located midway on the slope near the center of the site and about 10 m below Feature 1, supports no obvious outcrop or extraction features. Barring the possibility that there remain undiscovered subsurface quarry features, Feature 2 likely represents a colluvial deposit of larger items discarded from Feature 1. Lending support, the average weight per debitage item in Feature 2 is significantly larger than that in Feature 1 (12.5 gm and 3.7 gm, respectively; cf. Budy 1989:178).

We sampled Feature 2 by retrieving four hammerstones from the surface and by taking four small (25 cm x 25 cm) surface collections of opalite artifacts at one-meter intervals along the north/south axis of the talus pile (Table 120). This systematic sampling yielded a biface, a retouched flake, an end scraper, and a shaped, opalite shovelling implement (probably used for scraping quarrying debris out of the active pit).

Table 120. Summary of Artifacts Collected from Feature 2 at 26Ek3084.

		DEBITAGE		FORMED ARTIFACTS				
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Bifaces	Flake Tools	Perc./ Cobble Tools	Other/ Exotic	Total
1 (SF)	.00125	3	353.6	-	-	-	1	1
2 (SF)	.00125	21	656.8	1	1	-	-	2
3 (SF)	.00125	65	285.7	-	1	-	-	1
4 (SF)	.00125	58	616.7	-	-	-	-	0
Surface	N/A	-	-	-	-	4	-	4
Totals	1.005	147	1,912.8	1	2	4	1	8

(SF) = Surface Scrape

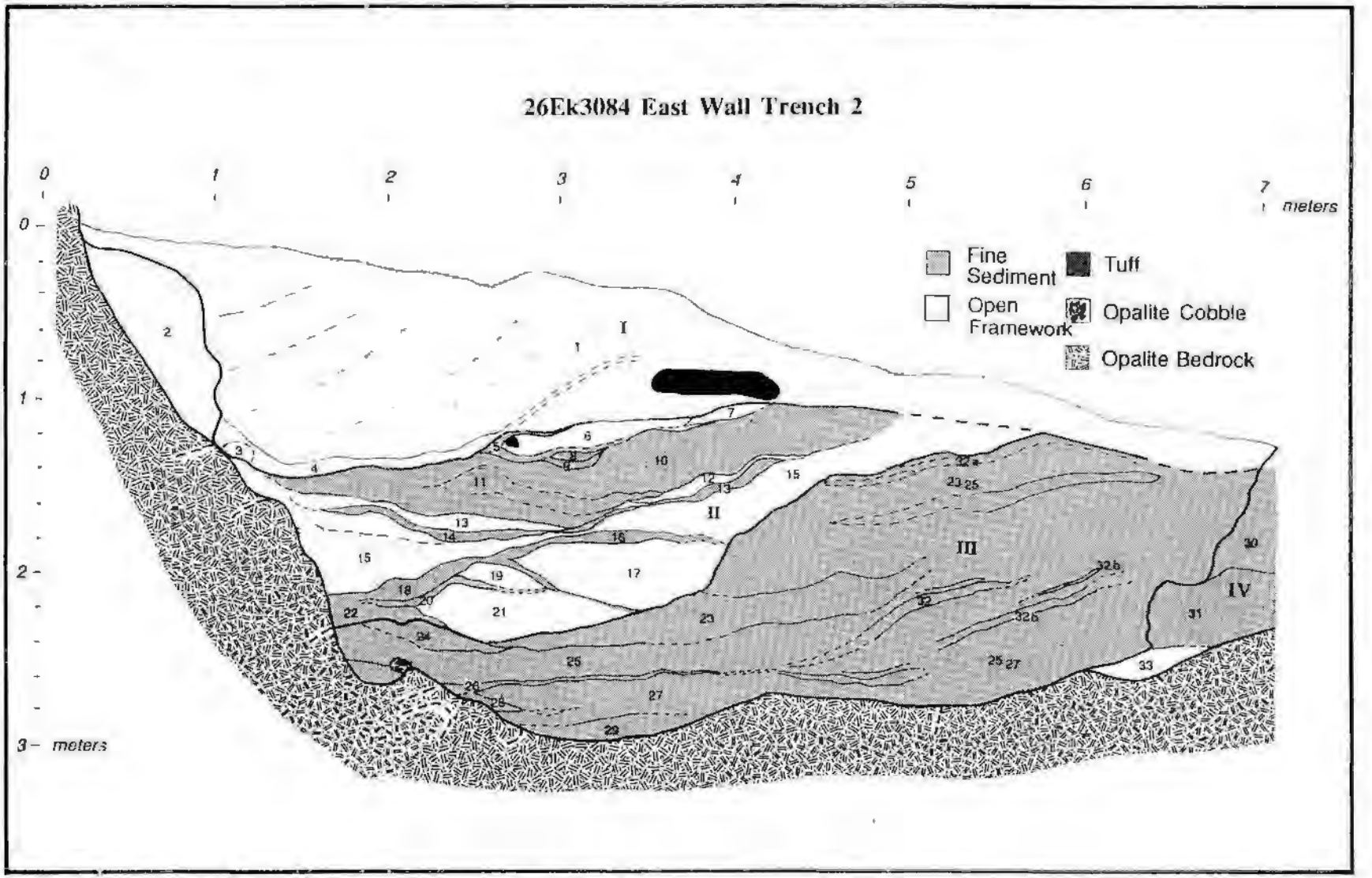


Figure 102. Description of stratigraphic units, Trench 2, Feature 1, 26Ek3084.

Figure 102. Description of stratigraphic units, east wall of Trench 2, Feature 1, 26Ek3084.

Horizon	Stratum	Description
I	1	Light brownish gray (2.5Y 6/2) dry; weak coarse mottling, brownish gray (10YR 6/2) dry; sandy, vesicular, silt, with common slope debris of sand to medium subangular to subrounded tuff pebbles; rare coarse angular tuff clasts; common fine to medium roots; boundary clear and irregular.
	3	Dusky red to weak red (10YR 3/2 to 5/4) dry; weathered bedrock clasts with chalky to clayey texture.
	4	Matrix supported, poor open framework, coarse to very coarse angular, banded yellow and purple, tuff chunks; sandy silt matrix as in Unit 1; strong reaction on calcareous coatings on the underside of large clasts, weak reaction in matrix.
II	5	Same as Unit 1.
	6	Moderate open framework, medium to coarse, yellowish brown to purple opalite chunks; moderate matrix as in Unit 1; along the bottom of this unit there is an accumulation of fine opalite chips.
	7	Dusky red (10YR 3/2) dry and grayish brown (10Yr 5/2) dry; sand and silt with common fine yellowish brown to purple opalite chunks.
	8	Poor open framework, fine to medium, yellowish brown to purple, opalite and tuff chunks and chips; common matrix as in Unit 7.
	9	Similar to Unit 7, except for a more grayish matrix from common charcoal.
	10	Pale brown (10YR 6/3) dry; silty sand; common poorly sorted sand to gravel; rare medium tuff and opalite chunks; moderate acid reaction of carbonate accumulated on underside of larger clasts.
	11	Matrix supported, poor open framework, medium to coarse, yellowish white, opalite and tuff chunks; matrix and carbonate as in Unit 10.
	12	Same as Unit 11.
	13	Moderate open framework, medium to coarse, yellowish brown to purple, opalite and tuff chunks; moderate silty sand matrix, pale brown (10YR 6/3) dry; strong acid reaction on carbonate accumulation on the bottom of clasts.
	14	Poor open framework, very pale brown to pale brown (10YR 7/3 to 6/3) dry; silty sand; common to rare medium opalite chips and chunks; moderate acid reaction on carbonate accumulations on the bottom of some larger tuff clasts.
	15	Typical to moderate, medium to coarse, open framework, fine to coarse, yellowish brown to purple opalite chips and chunks with some tuff; sorted generally coarse to fine from north to south in unit; sparse to common matrix and carbonate as in Unit 14.
	16	Same as Unit 14.
	17	Same as Unit 15.
	18	Same as Unit 14.
	19	Poor to moderate open framework, fine to very coarse, yellowish brown, opalite chips and chunks; moderate silty sand matrix same as Unit 14.
	20	Dusky red to weak red (10YR 3/2 to 5/4) dry; silty sand; common fine to medium yellowish brown to purple tuff chunks.
	21	Same as coarse parts of Unit 15.
	22	Same as Unit 23.
III	23	Pale brown to light brownish gray (10YR 6/3 to 6/2) dry; sandy silt loam; common fine to medium pebbles; moderate acid reaction on dispersed carbonate. Unit 23/25 is a combination of Unit 23 and Unit 25-like materials with intermittent pebble lenses; also some minor lenses of gray silt; 23/25 grades into Unit 1.
	24	Moderate open framework, fine to coarse yellowish brown and purple to gray opalite chunks, chips, and some possible flakes, also some tuff; general fining of clast size north to south; moderate sandy silt loam matrix as in Unit 23.
	25	Very pale brown to pale brown (10YR 7/3 to 6/3) dry, with weak mottling, reddish brown (10YR 5/3) dry; silty sand; common to rare medium opalite chips and chunks; strong acid reaction on carbonate accumulations on the bottom of some larger tuff clasts; firmly cemented by dispersed carbonate.
	26	Very distinct silty lens, banded and filamentous, white to weak red (10YR 4/2), with some yellowish red (10YR 5/6) banding in lowest part of unit; this material appears to be illuvial deposited.

Figure 102, continued.

	27	Same as Unit 25.
	28	Grayish brown (10YR 5/2) dry; sandy clayey silt; rare fine tuff pebbles and purple sand-size grains.
	29	Fine chalky weathered bedrock, mottled and vaguely banded, dusky red to red (10YR 3/2 to 4/8) dry.
	32	Pale red to weak red (10YR 6/2 to 5/2) dry; sandy silt occurring in discontinuous bands.
	34	Reddish brown, clayey sand with purple to brown opalite clasts; reddish orange clay about 2 cm thick along bedrock.
	35	Gravel in silty matrix grading to coarse opalite flakes; carbonate accumulations on clast bottoms.
IV	30	Very pale brown to pale brown (10YR 6/3 to 7/3) dry; vesicular, loam; rare to common fine pebbles; moderately cemented and mottled with carbonate.
	2	White chalky weathered bedrock; mottled reddish yellow (7.5 YR 8/6) dry; gravelly to blocky; moderately calcareous in places.
	31	Fine gravelly weathered tuff, white, with reddish yellow coatings (7.5YR 7/6).
	33	Chalky weathered tuff, yellow (10YR 8/8 to 7/8) dry.

Summary

26Ek3084 is a singular opalite source, relative to others at Tosawihi Quarries. Although the upper surface of the Miocene basalt at Tosawihi frequently is altered and argillicized, less often is it silicified. Consequently, brightly colored, jasper-like toolstone, like that seen here, is considerably less common than white or pink opalite. Jasper-like rocks are less compliant, more brittle, and require higher temperatures for heat treatment. Nevertheless, this outcrop provided highly flakeable toolstone that, by virtue of its distinctive visual characteristics, can be traced to several nearby reduction stations. Finished artifacts contribute little to the total assemblage, confirming our impression that site activities focused on toolstone extraction at the exposed jasper outcrop, material assay, and early stage toolstone (mostly core) reduction.

26Ek3208 and 26Ek3085

Sharing the south-facing slopes of Red Hill with 26Ek3084, 26Ek3208 and 26Ek3085 lie to the north on a pronounced saddle, along the southeast edge of the ridgeline (Figure 103). When first observed, they were thought to be distinct. During later testing, however, we discovered that they represent a quarry pit complex centering on a single geologic formation with disparate surface outcrops (Budy 1989:183–184).

At 26Ek3208 (as originally defined), a thick debris talus containing many biface and core fragments and basalt and rhyolite hammerstones, extended below the base of a prominent opalite ledge (13 m east/west) containing superb quality white and blue/green-white toolstone. A road cut through the talus cone 10 m below the outcrop revealed a rich deposit of debitage and quarry debris. Two large, shallow pits (Features 2 and 3), averaging approximately 5 meters in diameter, were visible on the surface at the foot of the steep opalite outcrop, and a smaller pit (Feature 1) was noted below a lesser outcrop to the east. Features 4–10 consist of historic mining pits, scrapes, and trenches that intruded on prehistoric quarry deposits. These historic features were not sampled for archaeological data, save for the collection of a basalt Great Basin Stemmed projectile point from the margin of one (Feature 5; Table 121). Additionally, Feature 5 was trenched to expose a clean profile for stratigraphic analysis.

Associated with a low opalite exposure atop the saddle and west of the prominent outcrop at 26Ek3208, 26Ek3085 contains a more restricted debris scatter and a cluster of five shallow quarry pits ranging in diameter from 2 to 4 meters (Features 3 and 5–8; cf. Figure 103). Unlike the large pits directed at the prominent ledge at 26Ek3208, the shallow quarry pits at 26Ek3085 were excavated into narrow colluvial pockets intruding low bedrock ledges. These pockets might have contained fractured opalite bedrock or cobbles suitable for reduction (Budy 1989:184). Features 1, 2, and 4 are historic phenomena (e.g., pits and bulldozer trenches).

We noted few formal artifacts in the pits at 26Ek3085, and collected only three—a basalt hammerstone and a tabular basalt chopping tool from Feature 8, and a Stage 3 opalite biface from Feature 5.

We compiled a detailed surface map of quarry pit complex 26Ek3208/26Ek3085, documenting the structural relationships between exposed outcrops and prehistoric pit features (cf. Figure 103). Backhoe trenches were excavated in Features 2, 3, and 5 at 26Ek3208, revealing an astonishingly complex deposit of quarry debris, several meters thick, overlying multiple pits in the heavily battered bedrock surface. A single trench was placed at 26Ek3085 as well. The exposed toolstone was of comparatively low quality, and the shallow quarrying deposits testified to far less energetic investment.

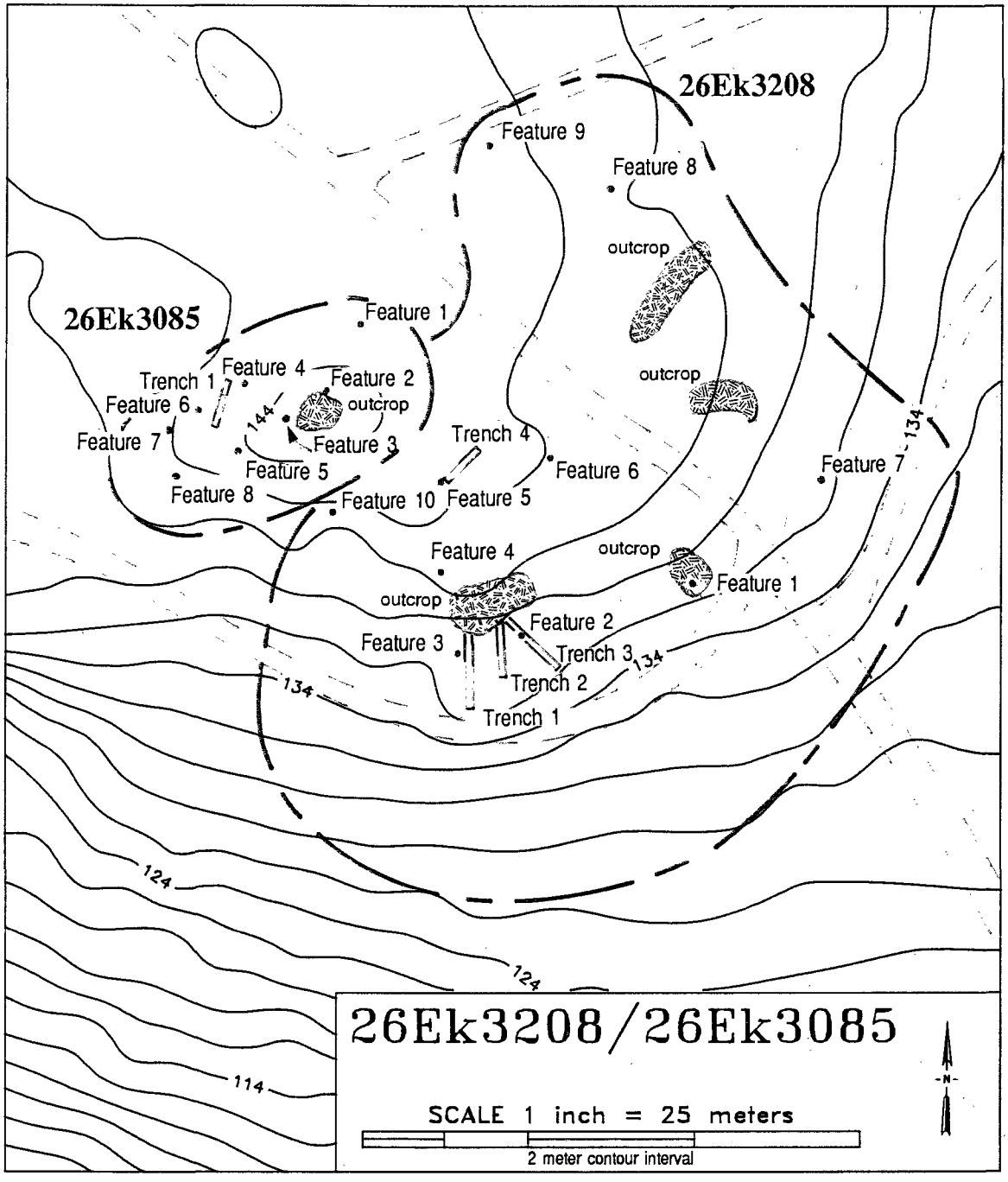


Figure 103. 26Ek3208/3085 site map.

Though we inventoried all features at 26Ek3208, we limited our collections to the few formal tools and ornaments observed on the surface or in trench sidewalls (bone beads, a scapula scoop, flake tools, hammerstones, a scratched stone), taking no systematic surface collections (Table 121). We did, however, collect 153 debitage and sediment samples from discrete strata in Feature 3 trench walls. The debitage was subjected to mass analysis and technological assessment, and was found to consist chiefly of the debris from core reduction, blank preparation, Stage 2 biface reduction, and rare Stage 3 reduction (cf. Chapter 10).

Table 121. Summary of Artifacts Collected from Features at 26Ek3208.

	DEBITAGE[a]		FORMED ARTIFACTS				
Feature	n	wt. (gm)	Proj. Points	Flake Tools	Perc./ Cobble Tools	Other/ Exotic	Total
1	-	-	-	1	2	-	3
3	175,455	244,122.5	-	2	3	2	7
5	-	-	1	-	-	-	1
8	-	-	-	-	1	-	1
Totals	175,455	244,122.5	1	3	6	2	12

[a]Debitage samples collected from discrete stratigraphic units in trench walls.

Trench 1, excavated during testing through the Feature 3 surface depression, revealed deposits composed of complex strata extending over two meters below surface (stratigraphy described by Budy 1989:185–190). Remains of several quarrying-related activities were revealed, including debris from sequential episodes of pit excavation against the bedrock face, toolstone processing and reduction, waste discard, pit filling, berm buildup, and reworking of older quarry waste in pit fill. Natural processes of slope wash between quarrying episodes were observed as well. A bison scapula fragment, found in Horizon V, probably served as a shovel or scoop for removing quarry waste from the pit. Large quarrying tools such as battered andesitic basalt boulders and hammerstones also were recovered.

The backhoe was used to face up the road cut running parallel to and below the outcrop. The resulting "trench" was shallow and uninformative; the deposits appeared highly turbated and poorly stratified. We subsequently noticed the same phenomenon at other localities in trenches cut perpendicular to the axis of quarrying. In any case, a stratigraphic profile of this trench was not prepared, nor was it given a formal number. (Its cross section appears in Figure 104, labelled as "Back filled cross trench.")

The deeply stratified deposits of quarry waste and colluvium found at the Red Hill quarries are, on occasion, interlaced with small charcoal lenses and fragments of burned tuff and opalite. These lenses may indicate use of fire set against massive bedrock faces to weaken tuff or, alternatively (and more likely), to break off isolated masses of toolstone and ease extraction. At 26Ek3208, we found such charcoal lenses in basal strata of Trench 1 through the Feature 3 quarry pit. Charcoal samples from these lenses returned two radiocarbon dates, 650 ± 60 B.P. (Beta-26755) and 800 ± 60 B.P. (Beta-26754).

Three additional backhoe trenches were excavated in 1989: Trench 1 was extended, and Trench 2 was located to crosscut an adjacent segment of Feature 3 (cf. Figure 103). Trench 3 intersected Feature 2, the second large pit visible on the surface. We obtained several additional radiocarbon dates from charcoal lenses in these new exposures, ranging from 480 ± 60 B.P. to 840 ± 60 B.P. (Appendix L). The dates appear stratigraphically reversed, reflecting probable disturbance caused by complex pit clearing and dumping; they are summarized in Table 122. Detailed stratigraphy of the 1989 trenches is described below.

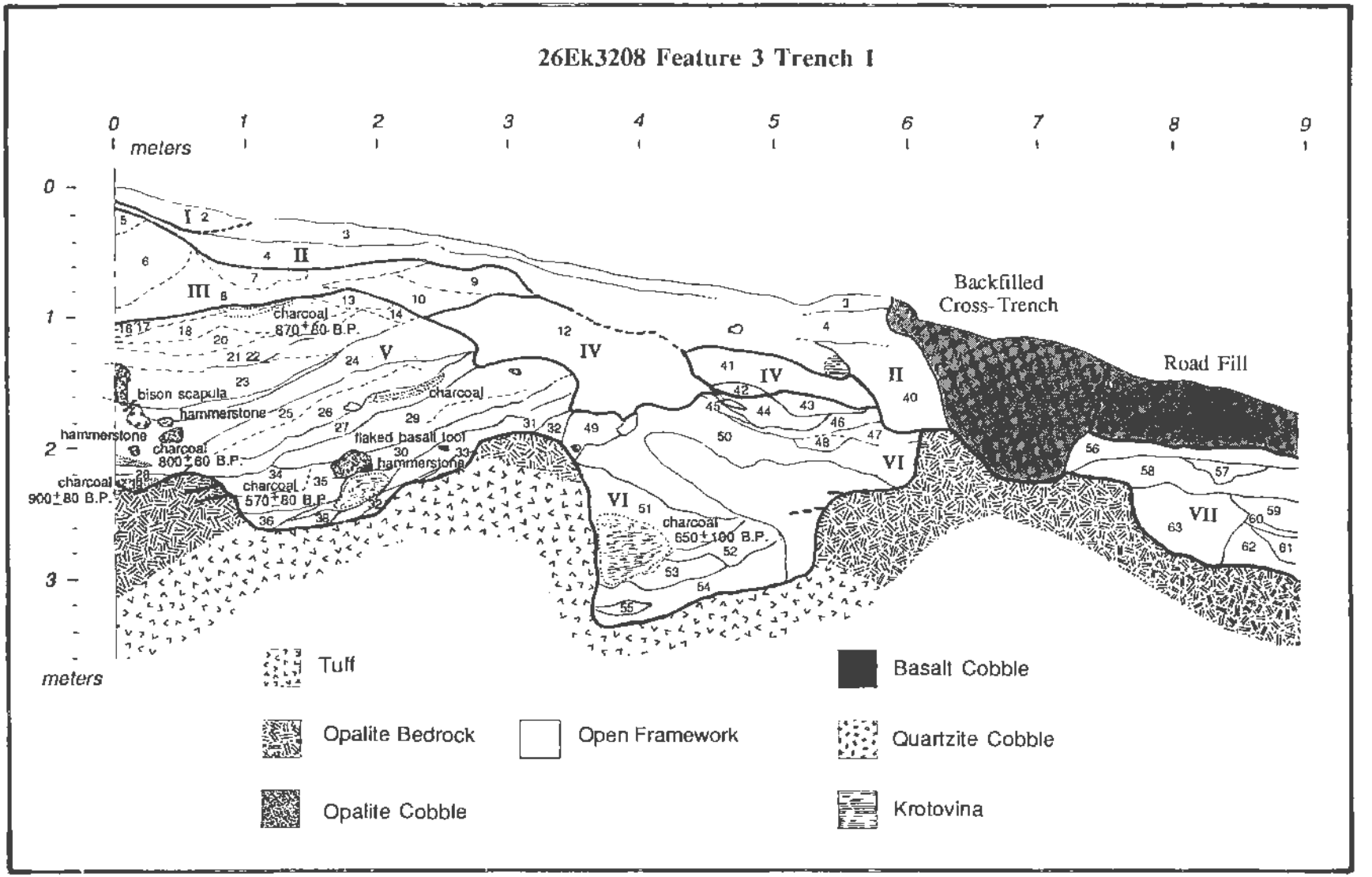


Figure 104. Description of stratigraphic units, Trench 1, Feature 3, 26Ek3208.

Figure 104. Description of stratigraphic units, Trench 1, Feature 3, 26Ek3208.

Horizon	Stratum	Description
I	1	Very dark brown (10YR 2/2) moist; silt ; weak fine granular; rare to common medium opalite and tuff chunks, rare opalite flakes; boundary clear and smooth. Observed in test - not shown on this profile.
	2	Moderate open framework, very dark grayish brown (10YR 3/2) moist; very fine to coarse opalite and tuff chunks, rare flakes and cores, clasts are generally coarser to the south.
	3	Black (10YR 2/1) moist; abundant organics with very common very fine flakes; possibly old ant midden.
II	4	Moderate to poor open framework; medium to coarse opalite chunks, some flakes; moderate sandy silt matrix, very dark brown (10YR 2/2) moist.
	40	Same as Unit 12, except for some areas of open framework coarse opalite chunks and flakes with sparse matrix.
III	5	Brown (10YR 5/3) moist; silty tuff sand; rare opalite flakes.
	6	Moderate to typical open framework; coarse tuff and opalite chunks; sparse sandy silt matrix, dark grayish brown (10YR 4/2) moist.
	7	Moderate open framework, medium to coarse opalite and tuff chunks; moderate sandy silt matrix, brown (10YR 5/3) moist.
	8	Dark grayish brown (10YR 4/2 moist; weathered tuff with coarse opalite flakes.
	9	Moderate open framework; medium tuff chunks and rare opalite flakes..
	10	Decomposed tuff with angular chunks of rubble.
	11	Black (10YR 2/1) moist; organic layer with no free charcoal. Observed in test - not shown on this profile.
IV	12	Dark grayish brown (10YR 4/2) slightly moist; poor open framework; silty sand matrix, with sand size tuff clasts and rare opalite flakes.
	41	Typical open framework, coarse opalite flakes and chunks, some tuff; sparse silty sand matrix, light brownish gray to grayish brown (10YR 6/2 to 5/2) dry; rare medium angular basalt chunks; rare charcoal flecking.
	42	Coarse hash; dark grayish brown (10YR 4/2) slightly moist; medium to coarse tuff sand in silt loam, with common fine opalite chips; some medium to coarse opalite and tuff chunks.
V	13	Grayish brown (10YR 5/2) slightly moist; poor open framework; silty sand, with rare opalite flakes.
	14	Grayish brown (10YR 5/2) slightly moist; silty sand, with rare to common medium to coarse opalite and tuff chunks.
	16	Dark grayish brown (10YR 4/2) slightly moist; silty sand, with medium to coarse opalite flakes.
	17	White (10YR 8/2) slightly moist; pulverized tuff with medium to coarse opalite and tuff chunks and common medium to coarse opalite flakes.
	18	Typical open framework, fine to coarse opalite chunks and flakes.
	20	Dark grayish brown (10YR 4/2) slightly moist; silty sand, with abundant flakes; flakes are larger in upper portion, smaller below but forming more open framework toward bottom.
	21	Dark gray (10YR 4/1) slightly moist; silt sand, with abundant charcoal flakes.
	22	Moderate open framework, medium to coarse opalite and tuff chunks, also large 20 cm x 25 cm) rhyolite boulder, and rhyolite hammerstones; moderate silty sand matrix, dark grayish brown (10YR 5/2) slightly moist, with abundant charcoal. Observed in test - not shown on this profile.
	23	Grayish brown to pale brown (10YR 5/2 to 6/3) slightly moist; decomposed tuff and angular chunks, unit becomes finer to the south; notable large rhyolite boulder (20x 35 cm); abundant charcoal. A bison scapula was found in Unit 23 at contact with Unit 24.
	24	Moderate open framework, medium to coarse opalite and tuff chunks; moderate silty sand matrix, dark grayish brown (10YR 4/2) slightly moist; abundant charcoal.
	25	Very dark gray (10YR 3/1) slightly moist; silty opalite sand; common fine chunks of burned opalite and tuff; abundant charcoal. Radiocarbon date.

Figure 104, continued.

	26	White to pale brown (10YR 8/2 to 6/3) slightly moist; sandy silt with common medium opalite chunks, becoming very dark grayish brown (10YR 3/2) slightly moist, pulverized tuff sand with flakes toward south.
	27	Moderate to poor open framework, medium opalite chunks and flakes; moderate to common pulverized tuff sand, light brownish gray (10YR 6/2) slightly moist.
	28	Very dark gray (10YR 3/2) slightly moist; silty sand, with burned fine opalite and tuff chunks. Observed in test - not shown on this profile.
	29	Typical to moderate open framework, medium to coarse opalite chunks; moderate silty sand, dark gray (10YR 4/1) slightly moist, sometimes forming partial lenses.
	30	Dark grayish brown (10YR 4/2) slightly moist; pulverized tuff hash, with fine tuff chunks; contains narrow lenses of charcoal.
	31	Moderate to open framework, medium to coarse tuff and opalite chunks; common silty tuff sand, pale brown (10YR 6/3) slightly moist.
	32	Dark gray (10YR 4/1) slightly moist; silty sand with charcoal; rare to common fine opalite and tuff chunks.
	33	Light gray (10YR 4/1) slightly moist; pulverized tuff hash; rare charcoal flecking.
	34	Moderate open framework, medium opalite and tuff chunks and flakes, and rare coarse opalite chunks; moderate silty sand matrix, light brownish gray to pale brown (10YR 6/2 to 6/3) slightly moist; common charcoal flecking.
	35	Similar to Unit 34, except for generally more tuff and less opalite, coarser clasts, with less matrix.
	36	Same as Unit 31.
	37	Grayish brown to dark grayish brown (10YR 5/2 to 4/2) slightly moist; silty tuff sand, with fine opalite chips, chunks and flakes; rare basalt and quartzite fragments; common charcoal flecks.
	38	Same as Unit 37, except generally less matrix and coarser clasts.
	39	Same as Unit 26, except for abundant charcoal and burned opalite chips.
VI	43	Dark brown (10YR 3/3) slightly moist; silt loam, with some medium opalite and tuff chunks.
	44	Typical to moderate open framework, coarse opalite chunks and flakes; moderate silty sand matrix, light brownish gray (10YR 6/2) dry.
	45	Coarse hash, mixture of pulverized tuff, white (10YR 8/2) slightly moist, and sandy silt with fine tuff clasts, grayish brown (10YR 5/2) slightly moist.
	46	Brown (10YR 4/3) slightly moist; vesicular silt loam, with some coarse sand-sized tuff, fine and opalite chips, chunks and flakes; rare coarse tuff clasts.
	47	Typical open framework, coarse opalite chunks and some tuff; sparse silty sand matrix, brown (10YR 5/3) dry.
	48	Same as Unit 45.
	49	Poor open framework; dark grayish brown (10YR 4/2) slightly moist; sandy silt loam, with common medium to coarse sand-sized opalite and tuff grains; common coarse to very coarse opalite chunks and rare basalt.
	50	Dark grayish brown (10YR 4/2) slightly moist; sandy silt loam, with common medium sand-size to coarse opalite and tuff chunks and flakes.
	51	Same as Unit 50, except generally coarser clasts.
	52	Poor open framework; dark grayish brown (10YR 4/2) slightly moist; sandy silt loam, with common medium sand-sized to coarse opalite and tuff chunks and flakes.
	53	Same as Units 50 and 51, except generally larger clast size.
	54	Poor open framework, white to very pale brown (10YR 8/2 to 8/4) slightly moist; typical pulverized opalite and tuff hash, with common medium to coarse opalite and tuff chunks.
	55	Moderate open framework, fine to medium opalite and tuff chunks; sparse to common tuff hash matrix, grayish brown to dark grayish brown (10YR 5/2 to 4/2) slightly moist; common charcoal flecking.
VII	56	Poor open framework; brown (10YR 5/3) slightly moist; silt loam, moderately hard; common fine to medium opalite chunks, some tuff.
	57	Same as matrix in Unit 56, except coarser and more abundant opalite and tuff clasts.

Figure 104, continued.

58	Yellowish brown (10YR 5/4) slightly moist; similar to Unit 56, except for color.
59	Moderate open framework, coarse to very coarse opalite and tuff chunks and flakes; moderate sandy clay loam, dark grayish brown (10YR 4/2) slightly moist.
60	Very dark grayish brown (10YR 3/2) slightly moist; sandy clay loam; fairly massive; rare fine tuff chunks; matrix has very organic rich appearance.
61	Dark brown (10YR 4/3) slightly moist; sandy clay loam, similar to Unit 60, except for more abundant and coarser tuff clasts, with some opalite chunks.
62	Brown to pink (7.5 5/4 to 7/4) slightly moist; weathered tuff with coarse clasts.
63	Highly jointed, somewhat loose and flaggy, chalky white weathered tuff, with staining, brown (7.5YR 5/4) slightly moist.

Table 122. Provenience of Radiocarbon Dates from 26Ek3208.

Reference Number	Laboratory Number	Date (Years B.P.)	Provenience
2500-2/4	Beta-26754	800±60	Trench 1, Unit 25, Horizon V
2500-4/5	Beta-26755	650±60	Trench 1, Unit 28, Horizon V
2599-15	Beta-36983	900±80	Trench 1, Unit 39, Horizon V
2599-21	Beta-36984	870±80	Trench 1, Unit 20, Horizon V
2599-22	Beta-36985	650±100	Trench 1, Unit 51, Horizon VI
2599-23	Beta-36986	570±80	Trench 1, Unit 37, Horizon V
2599-24	Beta-36987	480±60	Trench 2, Unit 32, Horizon VIII
2599-25	Beta-36988	840±60	Trench 2, Unit 23, Horizon VI
2599-28	Beta-36989	560±70	Trench 2, Unit 29, Horizon VIII
2599-31	Beta-36990	770±80	Trench 3, Unit 14B, Horizon III
2599-33	Beta-36991	740±80	Trench 3, Unit 18, Horizon V
2599-36	Beta-36992	590±80	Trench 3, Unit 26, Horizon V

Quarry Pit Stratigraphy at 26Ek3208 and 26Ek3085

At 26Ek3208, three backhoe trenches were placed on the large talus cone of quarry debris that extends below the prominent opalite outcrop (cf. Figure 103). Topography suggests that, under natural conditions, most colluvial deposition below the outcrop was derived from debris coming around its east side. At 26Ek3085, we excavated a single backhoe trench (Trench 1).

As at 26Ek3084, trench profiles at 26Ek3208 revealed a complex stratigraphy of coarse quarry debris commonly alternating with fine deposits originating from quarrying activities or from natural processes such as slopewash and eolian deposition. Major stratigraphic horizons were recognizable in each profile, delineated by truncation surfaces (contacts defined by truncated depositional units). Each horizon demarcates a set of strata deposited during one or more quarrying episodes. The truncation surfaces appear to have been created by renewed digging through older deposits, and are buried by subsequent deposition of younger debris. Thus, younger units commonly abut or overlie older deposits along truncation surfaces. Some older deposits, and those that apparently remained undisturbed at the surface for extended periods, exhibit physical and chemical evidence of weak soil development in the fine matrix. Too, we encountered a new type of deposit for which we invented the term "hash." Hash consists of very fine opalite chips and chip-like fragments mixed with pulverized tuff, silt, and, sometimes, clay. In experimental quarrying, we have produced hash by battering bedrock during toolstone extraction.

26Ek3208, Trench 1, Feature 3

As noted previously, this trench was initiated during testing and was described by Budy (1989:185–190). The second phase of backhoe excavation in 1989 extended the original depth, length, and width of the trench (cf. Figure 104). The widening moved the location of the profile at least a meter to the west. At other quarry sites where profiles are disturbed similarly, the resulting stratigraphy can differ dramatically from the original profile due to the complex nature of the deposits. In this trench, however, the stratigraphic units previously profiled were still identifiable, possibly because of large scale depositional activity. The original unit numbers were retained and newly exposed deposits begin with Unit 35. Also, the extent of Horizons II, IV, and V were increased in the new trench, and Horizons VI and VII were added.

Radiocarbon dates from charcoal found in Horizons V and VI of 570 ± 80 B.P. (Beta-36986) and 650 ± 100 B.P. (Beta-36985), respectively, are inverted stratigraphically. If standard error is considered, however, they are roughly equivalent. On the other hand, it is also possible that older quarry debris and associated charcoal have been mixed with more recent units, creating the inverted order of dating (cf. "Implications," below).

Bedrock

The bedrock at this site is mapped as undifferentiated sinter and replacement sinter at or near the surface of the Upper Tuff (Cornucopia 1987). As can be seen in Figure 105, silicified sinter overlies unsilicified or poorly silicified tuff; sinter was the object of quarrying. The white sinter of the outcrop exposed at and just below the surface is very deeply checked and cracked. Frost and thermal stress wedge off angular, gravel to cobble sized fragments that accumulate below the outcrop as talus. The quarried rock, in contrast, was protected below the surface, and is massive and much smoother in texture.

Sinter toolstone occurs in bands or lenses, ranging in thickness from 5 cm to 75 cm, that dip to the north (cf. Figure 105). Layers of higher quality toolstone alternate with poorly silicified layers of white chalky or brittle opal rock. The highest quality toolstone (among the best so far observed at Tosawihi) is well silicified, massive chalcedonic sinter, ranging from white to translucent, very pale blue or green. Seams of this material up to 75 cm thick crop out between 145 cm and 220 cm below the surface. Toolstone also occurs in other layers of lesser thickness and is usually intercalated with opal or poorly silicified material. The thicker layers of very pale blue or green toolstone offered much higher quality material, but at greater cost because its massiveness made it more difficult to extract. The quarriers appeared to have taken advantage of the alternating rock densities and friability by removing underlying soft tuff and intervening chalky or opal layers to isolate masses of toolstone that then could be broken off with hammerstones and small fires.

Horizon VII

The deposits of *Horizon VII* comprise Units 56–62 and appear to be derived primarily from slopewash and natural accumulations of opalite talus, rather than from quarrying. The majority of clasts are angular chunks of tuff and opalite, while opalite flakes are rare. Horizon VII is isolated from other deposits owing to disturbance from road construction and an earlier backfilled trench. Since no radiocarbon samples were obtained from Horizon VII, it is impossible to determine stratigraphically whether it is the oldest. Arguing for greater age is the moderate consolidation of the fine matrix in Horizon VII, and its similarity to stratigraphically early deposits in Trenches 2 and 3. Alternatively, the notable compaction of the deposits may be a result of road construction over the site. While it is possible that the deposits of Horizon VII are equivalent to Horizon II (among the last to be deposited), we suspect that Horizon VII represents pre-quarry colluvial deposits that naturally blanketed the slope below the outcrop.

Horizon VI

Units in this horizon include debris that filling the remarkably deep central pit. The exact division between units in this horizon and Horizon V is not clear, but a general change in manner of deposition from a series of rather chaotic units in the central pit to a more uniform

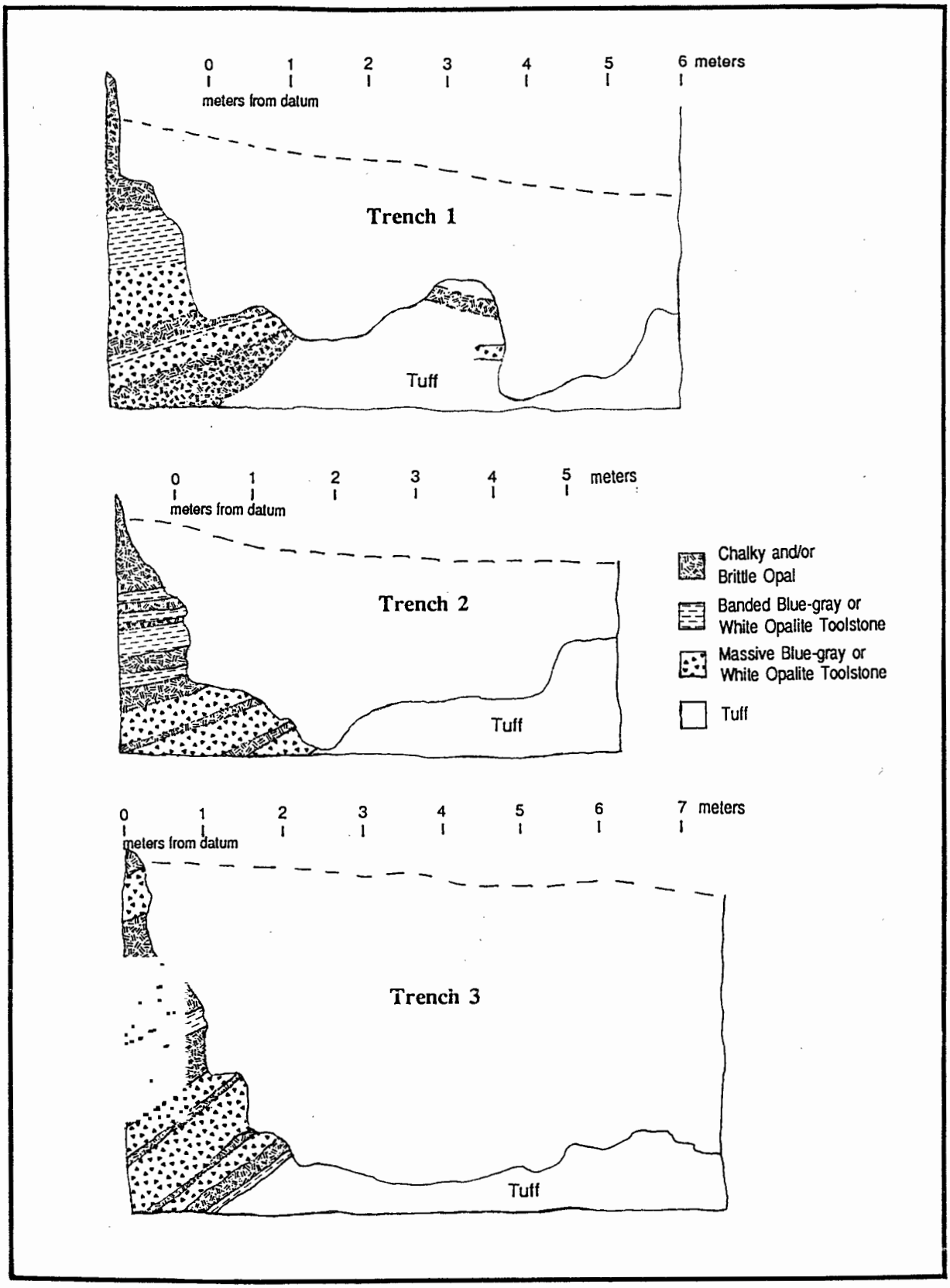


Figure 105. Bedrock profiles at site 26Ek3208.

progression in the northern pit is quite apparent, suggesting that the demarkation lies somewhere between Units 32 and 49. The upper limit of Horizon VI also is unclear, but has been placed immediately below Units 12, 41, and 42 of Horizon IV.

Some units in Horizon VI, such as Units 53, 54, and 55, probably were formed during quarrying of the central pit itself, while much of the debris overlying these may have resulted from backfilling during quarrying of adjacent pits. Units 50 and 51, especially, contained abundant matrix and appeared poorly sorted and reworked.

Horizon V

This horizon is composed of the most uniformly deposited units in the trench. This arrangement is very similar to sequences in Trenches 2 and 3 that also abut the vertical opalite bedrock face. These units appear the least disturbed after initial deposition, and they provide the clearest stratigraphic record of quarrying. Despite the primary nature of this sequence of units, it remains difficult to reconstruct clearly the specific order of quarrying activities. Higher units are sequentially displaced northward, suggesting some northward retreat of the opalite bedrock face as it was mined. From the general, though not perfect, alteration of layers of coarse tuff and opalite rubble and sandy or loamy fine units, it is likely that specific techniques switched between the battering of bedrock, producing fine units, and the reduction of large extracted cobbles and boulders of opalite, producing coarse units. The often clear distinction between the two types of units and the large volumes they contain implies that each technique may have been employed for extended periods until the desired conditions or materials were produced. The presence of distinct units composed of a single type of bedrock, such as the white pulverized tuff of Unit 17, suggests that one section of the bedrock face may have been preferentially worked at any one time. The presence of such distinct units ideally *could* be traced to a specific location on the bedrock face, but we were not able to do this with confidence.

Finally, it should be noted that some fine grained units, especially those with abundant gray silt, probably were derived from natural slopewash and eolian activities that added materials while pits were abandoned temporarily. That fine units are not concentrated along horizon boundaries provides further support for the hypothesis that truncation surfaces usually were not exposed for long.

Horizon IV

This horizon is dominated by the poorly sorted silts and opalite and tuff debris of Unit 12, which probably are products of reworking and backfilling primary quarry debris. The lower boundary truncates several units of Horizons V and VI, and provides the earliest clearly defined example of primary debris being reworked with previously mined opalite debris. This distinct removal of older deposits and the subsequent filling with reworked debris without apparently reaching bedrock was recognized in several instances in quarry debris at this site, especially in Trench 2. We add the caveat that, although bedrock was not reached by some pits seen in these profiles, it is possible they extend deeper in unexposed sediments beyond the limits of the trench wall. Indeed, a pit extending through older debris to reach bedrock may have to have been very wide due to the unstable nature of some of the deposits; trench profiles may expose only the margins of these re-excavations.

Horizons I, II, and III

Previously described (Budy 1989), these horizons contain coarse opalite chunks and flakes in vaguely defined lenses that, together, comprise fairly uniform, massive accumulations of quarry debris with sparse to common silty matrix. They represent the final episodes of quarrying at the site. In Horizons I and II there is an overprinting from present soil development and organic activity. Slopewash also has reworked these materials to some degree.

26Ek3208, Trench 2, Feature 3

Trench 2 exposed the most complex stratigraphy of the three (Figure 106). In its western profile, several episodes of re-excavation and renewed digging into older deposits are reflected, and at least ten major stratigraphic horizons are present. It is likely that, were any position chosen for renewed digging into previously quarried debris without foreknowledge of the composition and character of underlying materials, it would be near the center of the debris cone and outcrop. Here, the resource is most abundant and the option of shifting the excavation laterally is maximized.

Since this trench displayed interesting complexity, had several truncation surfaces, and was freshly exposed, it was chosen for detailed analysis to determine the quantities of several chemical oxides in the fine matrix component. These chemical data are used in the following discussion to examine the presence of possible weak soil formation on formerly stable surfaces in the quarry pit deposits.

Radiocarbon dates from charcoal samples taken from Horizons VI, VII and VIII were inverted in a manner similar to those in Trench 1 (840 ± 60 B.P., 560 ± 70 B.P., and 480 ± 60 B.P., respectively, for each horizon). These dates probably are inverted because of the reworking of older sediments with stratigraphically younger materials and horizons. Differences between the subsets of the two oldest and two youngest dates are not significant, but the oldest and youngest dates clearly are different (critical value of t at .05 level = 1.96).

Horizon X

Stratigraphically, this horizon is the oldest exposed in the trench; in addition, the degree of compaction and signs of weak soil development indicate a relatively old age. A chemical profile through Units 44, 45, 34, and 46 provides evidence for soil development (Figure 107). There is increased leaching of iron and aluminum at the surface of this sequence, especially in the distinctive silty Unit 44. The presence of a higher phosphorus percentage also suggests that this was a former stable surface. The high base content of Unit 44 may be the result of high carbonates in this apparently partially eolian-derived sediment. The overlying Unit 43 also may be a later addition to the soil surface. Despite the dominance of fine matrix, the presence of opalite flakes indicates that deposits of this horizon originate partly from quarrying activity.

Horizon IX

These units appear stratigraphically to be the second oldest in the trench. Their gentle slope to the north suggests that once may have been in contact with a vertical outcrop face, in a fashion similar to some s in Horizon VI. However, it also is possible that they are equivalent to deposits in Horizon

Figure 106. Description of stratigraphic units, Trench 2, Feature 3, 26Ek3208.

Horizon	Stratum	Description
I	1	Dark gray to dark grayish brown (10YR 4/1 to 4/2) dry; silt; weak fine granular, common medium opalite and tuff chunks, and rare to common opalite flakes; boundary clear and smooth.
	2	Moderate to poor open framework, medium opalite flakes and chunks with sparse matrix of silt and dry organic matter; opalite with yellowish "patina" distinguishes this unit from Unit 1.
	3	Poor open framework; gray to dark gray (10YR 5/1 to 4/1) dry; silt with abundant coarse sand to medium opalite and tuff clasts, generally finer clasts than Unit 1.
II	4	Poor open framework; grayish brown (10YR 5/2) dry; silt with common chunks of opalite and tuff and common opalite flakes.
III	5	Moderate open framework, coarse opalite chunks with some tuff; sparse sandy silt matrix as in Unit 4.
	6	Poor to typical open framework with coarse chunks of yellowish opalite as in Unit 2, and some tuff, matrix greyish brown to brown (10YR 5/2 to 5/3) dry; silt to silt loam, common against bedrock, becoming more sparse to the south; matrix appears slightly ashy, possibly from matrix in Unit 7.
	7	Moderate to poor open framework, medium opalite chunks and flakes; matrix sandy silt with abundant ash and charcoal, grey to very dark gray (10YR 5/1 to 7.5YR N3/1) dry; framework is typically open with sparse silt matrix in charcoal rich area, while in peripheral areas of unit, matrix is more abundant and opalite and tuff chunks are generally finer; charred upper surfaces of opalite pieces in base of ashy areas is notable, while opalite pieces are charred on all surfaces within ashy area.
	8	Poor open framework to coarse hash; gray (10 YR 5/1) dry; sandy silt with abundant medium sand to medium gravel sized opalite and tuff chunks and flakes; matrix also has an ashy appearance.
	9	Typical open framework, medium opalite chunks and flakes, sparse matrix of sandy silt as in Unit 8.
IV	10	Moderate open framework, medium to coarse opalite chunks and flakes with some tuff; matrix of fine sandy silt and pulverized tuff, light gray to light brownish gray (10YR 7/2 to 6/2) dry; vague subunits are indicated by subhorizontal flake bands, and lenses of finer flakes and matrix.
V	11	Coarse hash; light brownish gray (10YR 6/2) dry; sandy silt with rare fine, common medium, and rare coarse opalite chunks and flakes.
	12	Moderate open framework, medium to coarse opalite chunks and flakes; common matrix increases downward, distinguishing Unit 12 from 13, matrix same as sandy silt of Unit 11.
	13	Same as Unit 12.
	14	Same as Unit 11.
VI	15	Moderate open framework, fine to coarse opalite chunks and flake with some tuff; matrix sparse to common sandy silt, light gray (10YR 7/2) dry.
	16	Coarse hash to poor open framework; light gray (10YR 7/2) dry; sandy silt with common fine to medium opalite and tuff chunks and flakes.
	17	Typical open framework, medium to coarse, opalite and tuff chunks and flakes; sparse matrix same as sandy silt as in Unit 16, also minor amounts of pulverized chalky opalite. Distinct large rhyolite hammerstones and a fist-sized angular piece of basalt.
	18	Light brownish gray (10 YR 6/2) dry; fine sandy vesicular silt, with a "fine" open framework of coarse sand to fine gravel-size opalite and tuff clasts, some fine to medium opalite flakes; rare orangish red cinnabar patches.
	19	Typical open framework, medium to coarse opalite chunks and flake with some tuff; sparse matrix same as sandy silt of Unit 18; notable large opalitic rhyolite cobbles.
	20	Light gray to gray (10YR 7/1 to 6/1) dry; fairly massive, vesicular sandy silt, with matrix supported fine to medium gravel-size opalite chunks and flakes, some rare tuff; rare to common charcoal flecking.

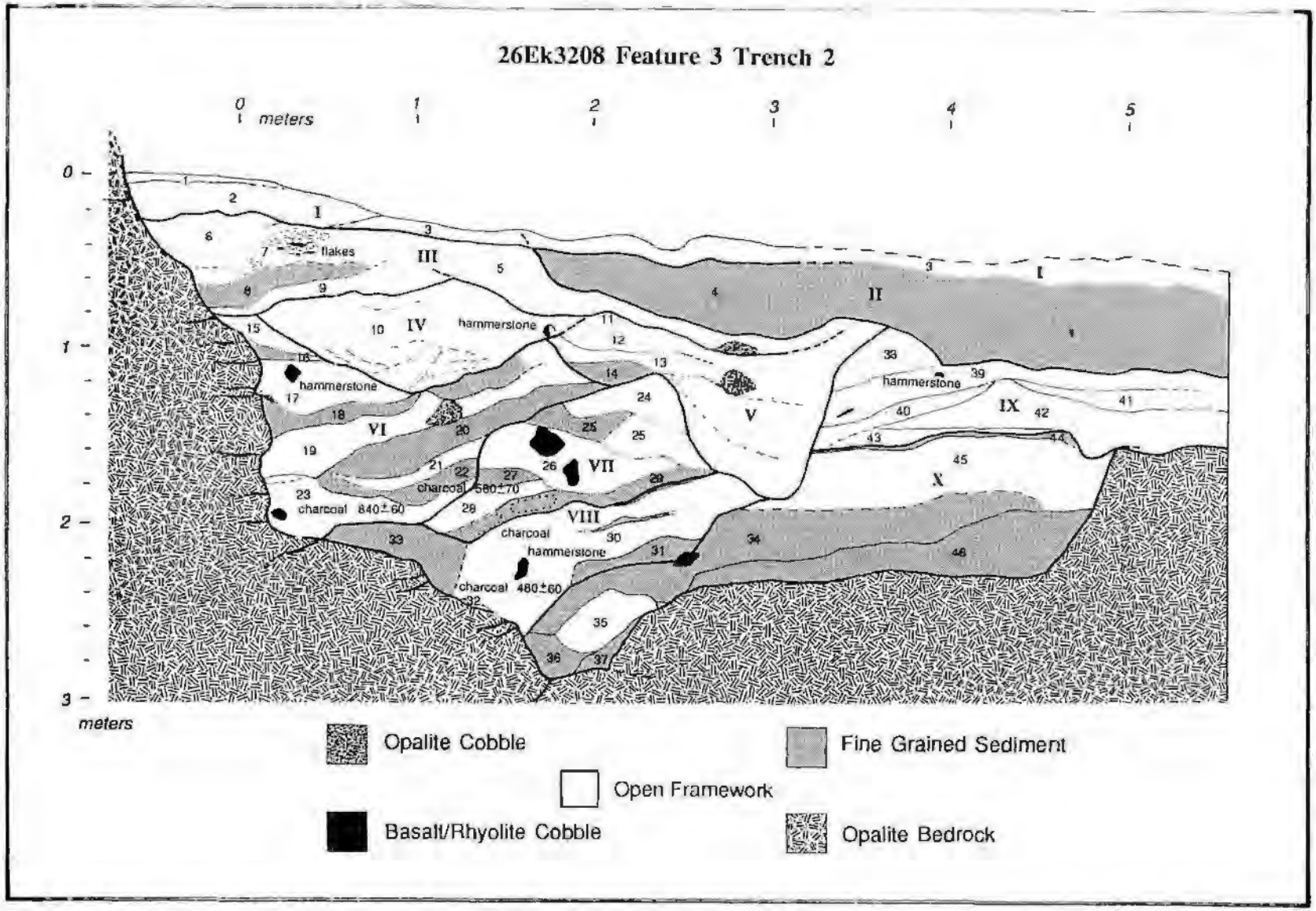
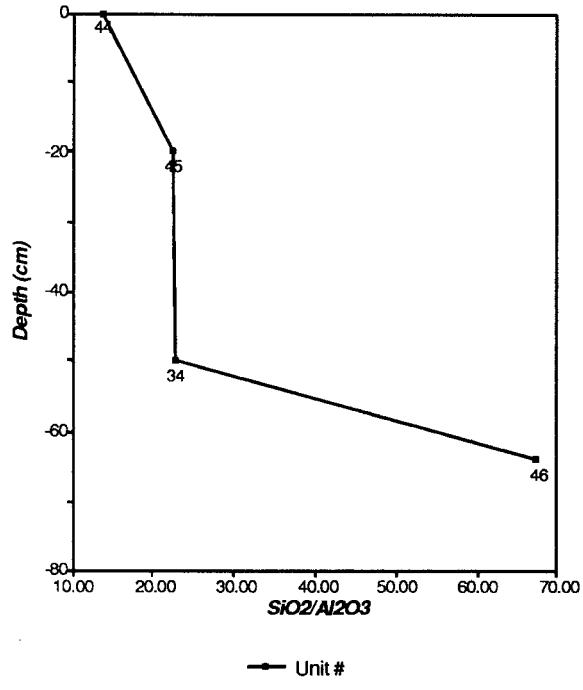


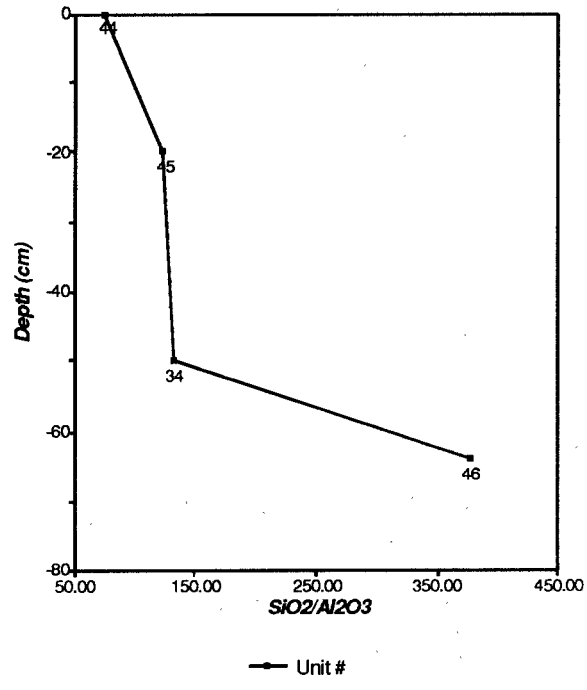
Figure 106. Description of stratigraphic units, Trench 2, Feature 3, 26Ek3208.

Figure 106, continued.

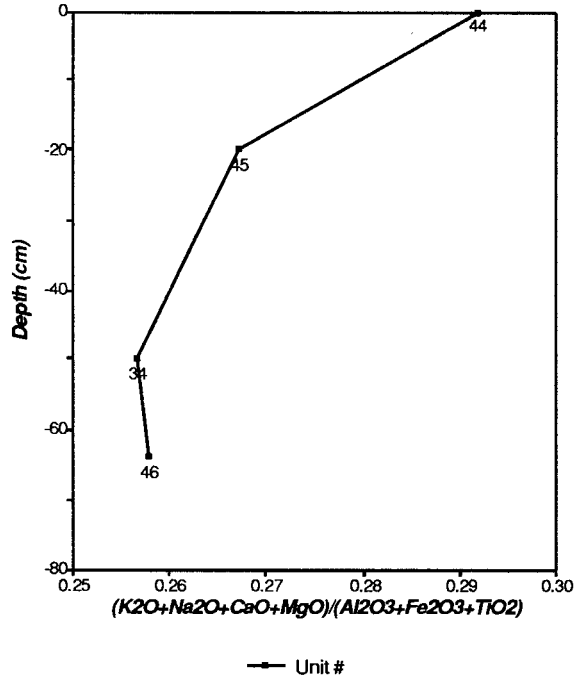
	21	Typical to moderate open framework, medium opalite chunks and flakes; varying amounts of sandy silt matrix as in Unit 20.
	22	Same as Unit 20.
	23	Same as Unit 19.
VII	24	Moderate, fine open framework, predominantly subhorizontal, fine to medium opalite flakes and some chunks; fairly common matrix of sandy silt, light brownish gray (10YR 6/2).
	25	Fine half of unit, light gray to light brownish gray (10YR 6/1 to 6/2) dry; silt, with "hashy" abundant fine to coarse sand-sized opalite and tuff chunks and chips; Coarse half of unit, moderate open framework, medium to coarse opalite chunks and flakes, fairly common matrix as in fine part of this unit.
	26	Typical open framework, medium to very coarse opalite and tuff chunks, with large rhyolite clasts; sparse matrix same as silt in Unit 25.
	27	Same as Unit 25, except for slightly coarser matrix with fine gravels; some moderately coarse charcoal pieces.
	28	Poor open framework, medium to coarse opalite flakes; matrix common, same as Unit 27.
	29	Fine hash; white (10YR 8/1) dry; pulverized chalky opalite, with fine to medium opalite chips, chunks and flakes; some distinct charcoal accumulations.
VIII	30	Typical open frame work, medium to very coarse opalite chunks, and some tuff, also rare rhyolite and basalt cobbles; sparse matrix same as chalky opalite in Unit 29; some intermittent lenses of "hashy" fine to coarse sandy loam, brown (10YR 5/3), with charcoal flecking.
	31	Coarse hash, mixture of pulverized chalky opalite and sandy loam; fairly common matrix supported fine to medium opalite chunks and flakes.
	32	Charcoal lens with matrix similar to Unit 33.
	33	Fine hash; light brownish gray (10YR 6/2) dry; fine to coarse sandy silt, with common fine gravel-size tuff and medium opalite flakes.
IX	38	Poor open framework; same as Unit 20.
	39	Poor to moderate, fine open framework, medium to coarse opalite chunks and some medium flakes; fairly common sandy silt matrix, light gray to light brownish gray (10YR 7/8 to 6/2) dry; some possible basalt and opalite hammerstones.
	40	Poor open framework to coarse hash; very pale brown (10YR 7/3 to 7/4 dry, to light brownish gray (10YR 6/2) dry, pulverized tuff and minor silt, with common very fine to fine tuff chunks, rare to common medium opalite chunks and flakes; some charcoal flecking.
	41	Poor open framework; same as Unit 20.
	42	Poor to moderate open framework, fine to coarse opalite chunks, with fine to medium flakes; moderate matrix same as in Unit 40.
	43	Same as Unit 20; boundary between Units 40 and 43, a vague band of opalite flakes.
X	34	Fine hash; same as Unit 31. except more massive with fewer clasts and slightly more matrix.
	35	Typical open framework, medium to very coarse opalite and tuff chunks and flakes; sparse matrix, pulverized chalky opalite and brown (10YR 5/3) sandy silt loam, with abundant fine to medium opalite and tuff chunks.
	36	Fine hash; same as Unit 34, except fine sand dominates over silt.
	37	Brown (10YR 5/3) dry; sandy clay loam; common fine opalite and tuff chunks; some moderately coarse pieces of charcoal.
	44	Dark brown (10YR 3/3) slightly moist; sandy loam, slight coarsening downward of sand size; weak medium granular; fine to medium thin reduction flakes as fine lenses within loam.
	45	Coarse hash; brown (10YR 4/3) dry; sandy silt; common poorly sorted very fine to coarse opalite and tuff chunks and flakes; intermittent poor, texturally defined lenses.
	46	Typical fine pulverized hash tuff, with rare fine to medium flakes.



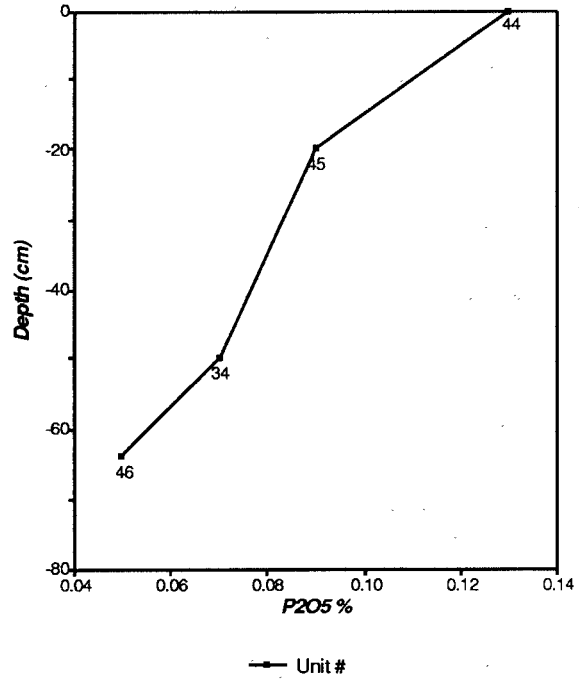
a.



b.



c.



d.

Figure 107. Molecular weathering ratios for 26Ek3208, Trench 2, Feature 3, profile A displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

Horizon VIII

Deposits in this horizon lie directly on the truncated surface of Horizon X and on one of the lowest bedrock surfaces. The abrupt transition between the fine materials of Unit 33 and the coarse debris of Unit 30 probably is the result of excavation of the fines of Unit 33 and the subsequent filling by Unit 30. Alternatively, Unit 33 may be equivalent to Unit 34, thus making it part of the earliest stratigraphic horizon.

Horizon VII

These deposits probably were much more extensive at one time, judging by the truncated surface on which Horizons V and VI lie. The gentle slope of Horizon VII units away from the retreating outcrop face suggest that they may have been reworked, unlike the typical primary deposits that slope towards the bedrock face. The more uniform alternation of coarse and fine units, however, is similar to undisturbed debris.

An arbitrary chemical profile was plotted through units of Horizon V, Horizon VI above, and Horizons VIII and X below (Figure 108). This profile revealed consistent leaching of iron, aluminum, and calcium, as well as accumulations of phosphorous, from units immediately below truncation surfaces, including Units 18, 25, 27, 30, and 34. Unit 24, not included in the profile, also exhibited this trait. Such signs of surface weathering suggest that these truncation surfaces were stable for limited periods, and contradict the idea that pits were excavated and then filled by debris during the same quarry episode.

Horizon VI

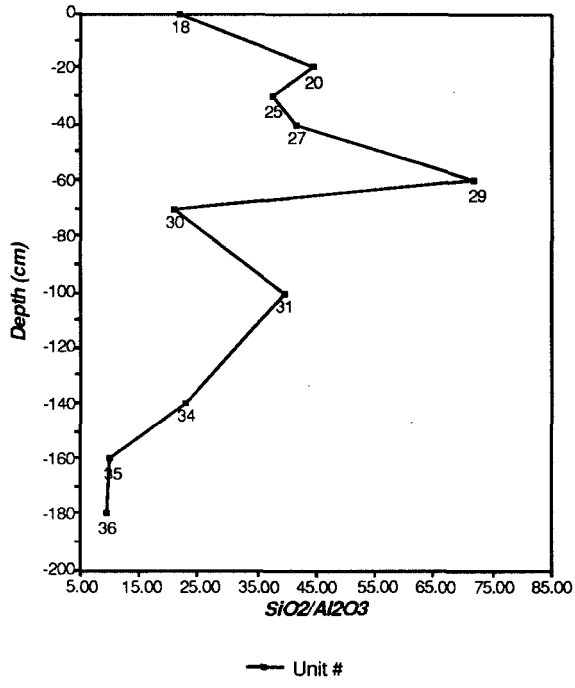
Units in this horizon form a typical sequence of well defined, alternating coarse and fine deposits that slope into the vertical outcrop face, much like those of Horizon V in Trench 1. They probably have experienced little or no reworking subsequent to initial deposition.

Horizon V

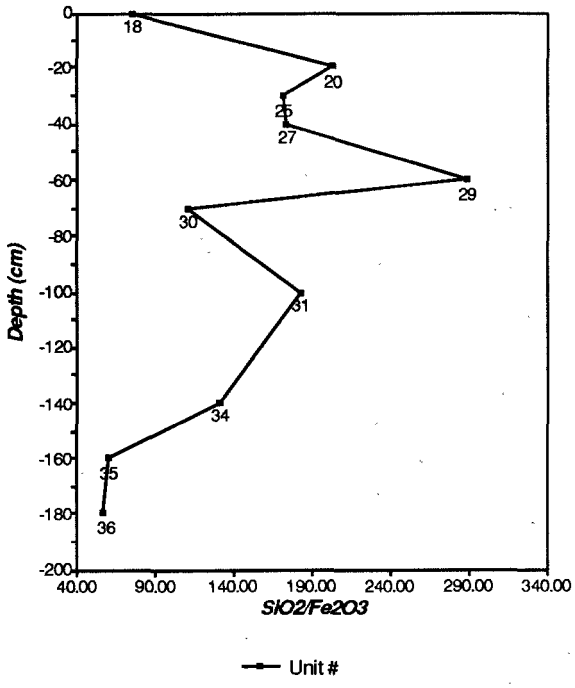
The cavity created by initial excavation of this horizon exhibits the greatest vertical relief of any such feature, yet it fails to reach bedrock in the exposed profile and may have been excavated to exploit large opalite chunks in Units 30 and 45. Alternatively, it may extend down to bedrock beyond the profile wall. This re-excavation truncated units in Horizons VI, VII, VIII, IX, and X. The debris filling the cavity generally is composed of coarse opalite flakes and chunks. Vague separations in the deposits are discernable by changes in the abundance of fine matrix and in poorly defined subhorizontal flake lines.

Horizon IV

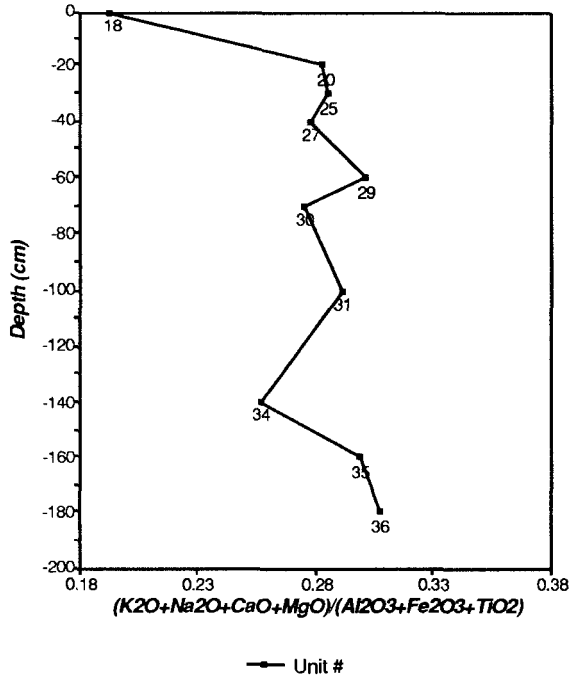
Deposits in this horizon are essentially the same as the coarse opalite flakes and chunks in Horizon V. They are discernible from Horizon V by the configuration of the cavity that they fill, and the orientation of flakes vaguely parallel to its bottom.



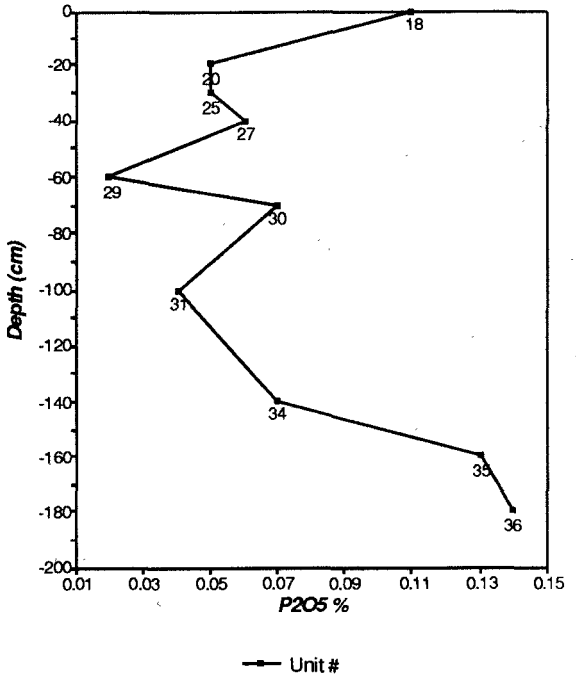
a.



b.



c.



d.

Figure 108. Molecular weathering ratios for 26Ek3208, Trench 2, Feature 3, profile B displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

Horizons I, II, and III

These horizons are very similar to Horizons I, II, and III of Trench 1, and may be roughly equivalent. More fine matrix generally occurs between the coarse clasts, however, especially in Unit 4, a trend that continues into the near surface deposits of Trench 3. A notable accumulation of charcoal occurs in Unit 7 of Horizon 3, where medium and large flakes of opalite are charred on their upper surfaces. An equivalent accumulation of charcoal is present in the west wall of Trench 3 at this depth.

26Ek3208, Trench 3, Feature 2

The profile in Trench 3 is the most extensive exposure in the debris cone at 26Ek3208 (Figure 109); the deposits reach a depth of nearly four meters, and the stratigraphy suggests quarry pits more than 3 meters in depth. The stratigraphy is complex, but it differs from Trenches 1 and 2. Many fill units are massive and poorly sorted. Individual stratigraphic units, and their orientation within the more massive deposits, are difficult to trace, suggested only by vague flake lenses. Only five major stratigraphic horizons were recognized. This owes, in part, to the difficulty of discerning some stratigraphic divisions or hiatuses. It also appears that deposits in this easternmost side of the large debris cone have not undergone as much reworking and re-excavation as deposits nearer the central area of the opalite outcrop. Generally poor sorting also suggests that slopewash and debris flow may be more dominant depositional mechanisms, similar to the adjacent unquarried hill slope.

As in Trenches 1 and 2, radiocarbon dates from this trench are inverted; they are 770 ± 80 B.P. (Beta-36990), 740 ± 80 B.P. (Beta-36991), and 590 ± 80 B.P. (Beta-36992), in Unit 14 of Horizon III and Units 18 and 26 of Horizon V, respectively. These dates essentially are equivalent if standard error is considered.

An arbitrary chemical profile was plotted through Units 1 to 22, but, unlike the plots of Trench 2, we discerned no trends or characteristic leaching of iron, aluminum, and calcium or accumulation of phosphorus associated with truncated surfaces (Figure 110).

Horizon V

Deposits in this unit generally are massive sandy silts with common matrix supported opalite and tuff chunks, and flakes interspersed with isolated lenses of open frameworks of coarse opalite chunks and flakes. Much of the material is poorly sorted. It appears that extensive remixing or backfilling may have taken place, alternating with production of large opalite flakes and chunks, forming isolated lenses.

Although all these units have been grouped into one horizon, it appears that more than one episode of activity is represented; there may be three or more. Units 44–47 may represent one such episode; texturally, they differ little from adjacent units to the north, but a vague color difference suggests a stratigraphic break. A second division probably also occurs in Unit 17 at the bedrock berm lying approximately 6.5 meters along the profile. While there is no apparent division in the fine matrix character, the orientation of coarse lenses suggests two separate pit fillings. Units 39, 40, and 41, for example, slope to the south, while Units 28, 29, and 30 slope to the north.

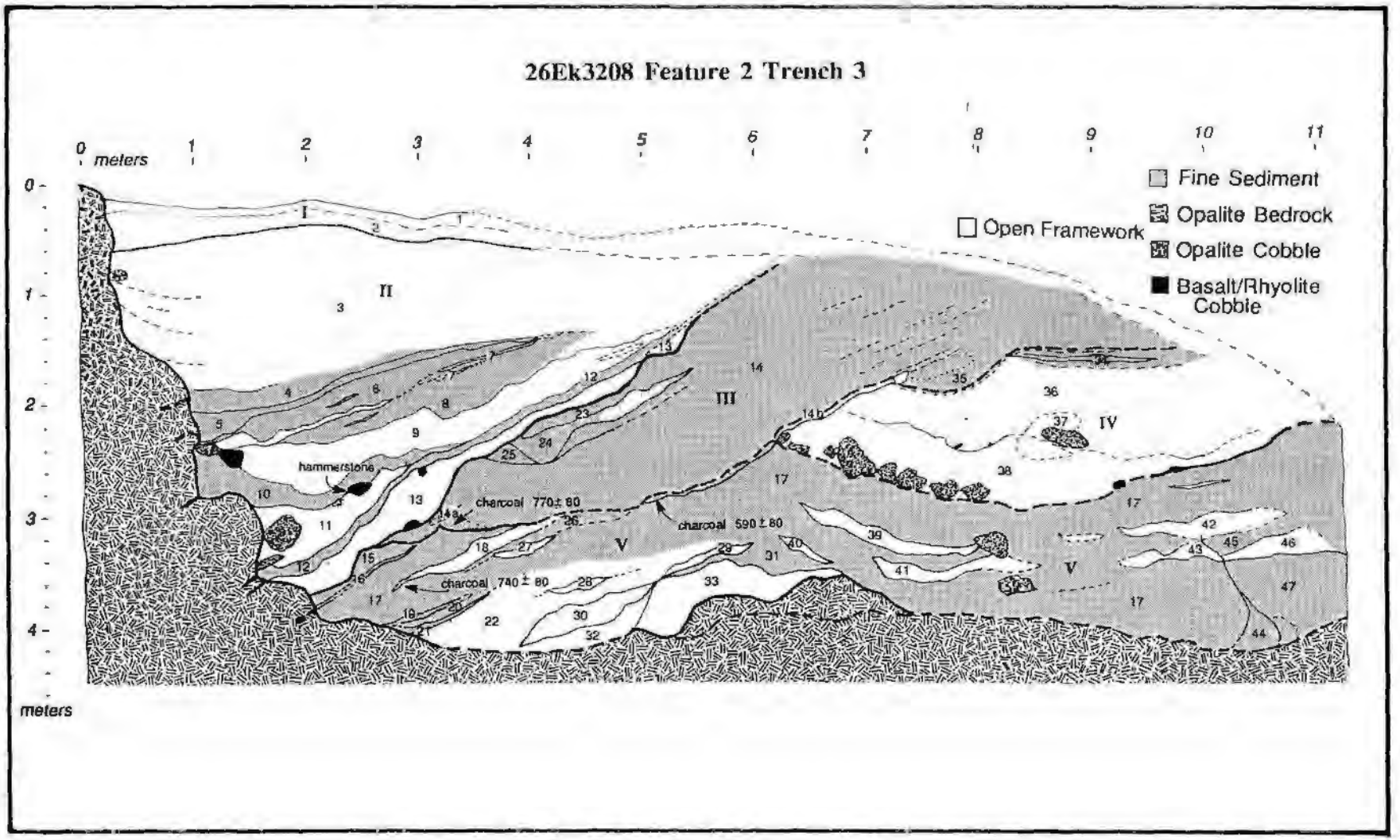


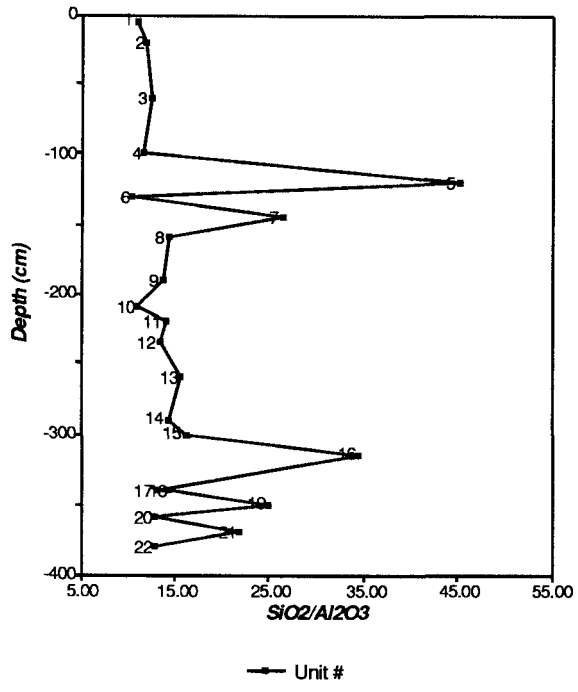
Figure 109. Description of stratigraphic units, Trench 3, Feature 2, 26Ek3208.

Figure 109. Description of stratigraphic units, Trench 3, Feature 2, 26Ek3208.

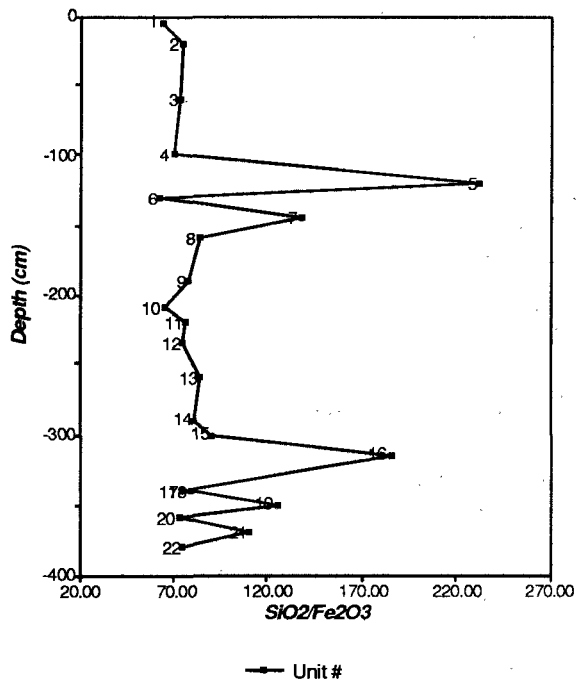
Horizon	Stratum	Description
I	1	Dark gray to dark grayish brown (10YR 4/1 to 4/2) dry; silt; weak fine granular, common medium opalite and tuff chunks, and rare to common opalite flakes; boundary clear and smooth.
	2	Moderate to poor open framework, medium opalite flakes and chunks with sparse matrix of silt and dry organic matter; opalite with yellowish "patina" distinguishes this unit from Unit 1.
II	3	Poorly sorted, moderately homogeneous, poor open framework, grayish brown to gray (10YR 5/2 to 5/1) dry, sandy silt to coarse opalite chunks and flakes, with some tuff; vague bedding suggested by some flake alignment.
	4	Well defined unit within Unit 3, moderate open framework, common fine to rare coarse opalite flakes.
	5	Poorly sorted, coarse hash, white to pinkish white (5YR 8/1 to 8/2) dry, very fine pulverized chalky opalite to medium chunks of chalky opalite, some medium opalite flakes.
	6	Grayish brown (10YR 5/2) dry; see description of Unit 3.
	7	Same as Unit 5.
	8	Same as Unit 6.
	9	Typical to moderate open framework, medium to very coarse opalite chunks with common medium flakes, some of the coarsest opalite chunks show signs of surface weathering; moderate matrix, grayish brown (10YR 5/2) dry, coarse sandy silt.
	10	Same as Unit 8.
	11	Same as Unit 9.
	12	Poor open framework, grayish brown (10YR 5/2) dry; silty sand, with common medium and rare coarse opalite chunks, some fine to medium flakes.
	13	Typical open framework, medium to coarse opalite chunks and flakes, generally more coarse upward; sparse matrix, silty sand with common fine to medium opalite chips and flakes, grayish brown (10YR 5/2) dry.
III	15	Same as Unit 14, except stratigraphically separated by an apparent erosional contact with a notable charcoal accumulation.
	16	Typical pulverized tuff hash.
	17	Mixture of materials similar to Unit 14 with bands of opalite flakes and chunks, with some tuff; also minor lenses of material similar to Unit 16.
	18	Moderate to typical open framework, common medium to coarse tuff and opalite chunks and flakes; moderate matrix of typical pulverized tuff hash mixed with sandy silt, grayish brown (10YR 5/2) dry; distinct charcoal accumulation in north end of unit.
	19	Same as Unit 16.
	20	Same as Unit 17.
	21	Same as Unit 16.
	22	Pale brown (10YR 6/3) dry; sandy silt loam, fairly massive, similar to Unit 17.
	23	Same as Unit 14.
	24	Moderate open framework, medium to coarse opalite chunks and flakes, opalite commonly with surface weathered appearance; sparse matrix, same as Unit 25.
	25	Pale brown (10YR 6/3) dry; sandy silt loam; hard granular silty clasts and randomly oriented clasts of fine to medium pebbles and fine to coarse opalite chunks and flakes forming fine poor open framework, possibly from saturated debris flow.
	26	Same as Unit 17.
	27	Same as open framework of Unit 18.
	28	Same as Unit 27.
	29	Moderate open framework, fine to medium opalite and tuff chunks and flakes; moderate matrix, sandy silt as in Unit 22.
	30	Same as Unit 28, except clasts are generally coarser tuff.
	31	Same as fine matrix of Unit 22.
	32	Same as Unit 22.
	33	Pinkish white to reddish yellow (7.5 YR 8/2 to 8/6) dry; tuff and chalky white weathered tuff and possibly quarried tuff in the form of coarse blocks and very fine to coarse chunks, with a pulverized coarse sand.

Figure 109, continued.

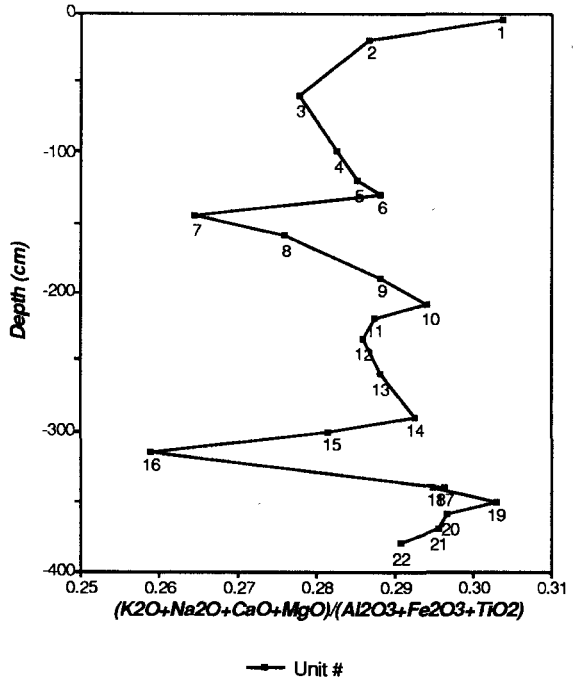
	35	Moderate open framework; coarse to very coarse weathered opalite and pink tuff, with some coarse opalite chunks and flakes; some basalt and rhyolite cobbles; moderate matrix, silt to coarse sand, light brownish gray (10YR 6/2) dry; in upper portions of unit, poorly sorted silt to coarse sand matrix is concentrated in vague lenses.
IV	34	Moderate open framework, common fine to medium tuff chunks, distinct lenses of fine to medium blue-green opalite; sparse matrix, silty fine to medium sand-sized tuff and very fine opalite flakes; unit bounded above and below by distinct poorly sorted silt with common sand-sized to medium chunks of opalite and chunks and flakes.
	36	Chaotic accumulation of vague coarse and fine lenses and poorly sorted silt to very coarse angular chunks of surface weathered opalite, quarried opalite, and tuff.
	37	Grayish brown to dark brown (10YR 5/2 to 3/3) slightly moist; silty clay loam, with common medium sand-sized to fine gravel-sized tuff and opalite chunks, and rare medium to coarse opalite and tuff chunks.
	38	Same as Unit 36, except slightly better sorting into vaguely defined lenses, less of a debris flow-like appearance.
V	14	Dark grayish brown to grayish brown (10YR 4/2 to 5/2) dry; sandy silt loam, fairly massive, with common very fine to fine opalite chips, chunks, and flakes, some chunks appear to be surface weathered; minor lenses, 14a and 14b, ashy clayey matrix, brown to pale brown (10YR 4/2 to 7/3) dry, with common charcoal.
	39	Moderate open framework lenses of very fine to slightly coarse brittle white opalite with some medium to coarse opalite and tuff chunks; moderate sandy silt matrix, light brownish gray to pale brown (10YR 6/2 to 6/3) dry, becoming more abundant to south.
	40	Same as Unit 39.
	41	Same as Unit 39.
	42	Poor open framework, medium to coarse opalite chunks and flakes, some tuff; common matrix, brown to grayish brown (10YR 5/3 to 5/2) dry, fine to coarse sandy silt.
	43	Same as Unit 42.
	44	Moderate, medium to fine open framework, fine to coarse opalite chunks, some with tuff rind; common matrix, silty sand, very pale brown to pale brown (10YR 7/3 to 6/3).



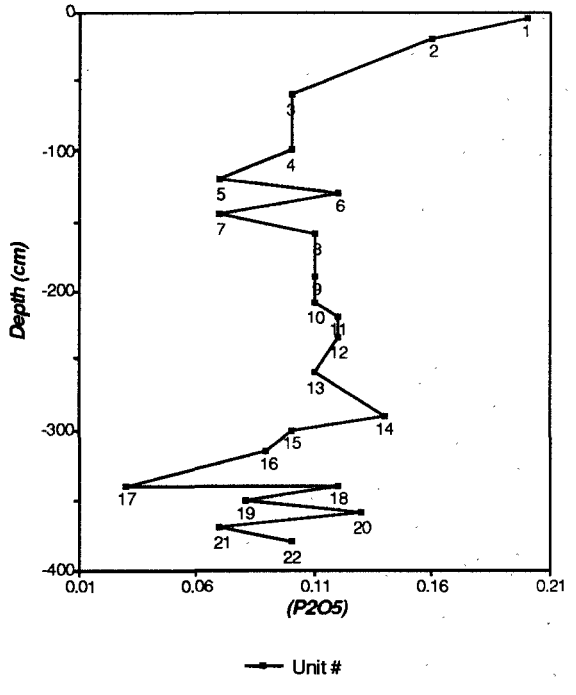
a.



b.



c.



d.

Figure 110. Molecular weathering ratios for 26Ek3208, Trench 3, Feature 2 profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

The upper limit of Horizon V is delimited, at its northern end, by a truncation surface on which charcoal apparently has accumulated at the base of Unit 14. This truncation occurred after the deposition of Horizon IV units. A division between Horizons IV and V is placed below a line of large weathered opalite cobbles at the base of Unit 38.

The high degree of compaction and possible induration of the fine matrix indicates that these deposits may have undergone some pedogenesis, although the chemical profiles, as mentioned previously, showed no clear profile development. Stratigraphically these units are the oldest in the trench, and are similar to the oldest units in Trenches 1 and 2.

Horizon IV

Units of this horizon are poorly sorted, like those of Horizon IV, but generally exhibit less matrix. Although probable quarried debris is included, these units may be largely natural slopewash products. Horizons IV and V are truncated by the same surface on which lie the deposits of Horizon III.

Horizon III

Horizon III is dominated by Unit 14, an accumulation of poorly sorted debris similar to Unit 17 in Horizon V, but exhibiting less compaction and hardness in the fine matrix. Although vague flake lines are visible, and some units (such as 24 and 25) uniformly slope to the north in a manner similar to primary units in Horizon II, the deposits in Horizon III appear to be mostly remixed or derived from slopewash. Distinct accumulations of charcoal at the bottom of Unit 14 serve to emphasize the truncation surfaces of Horizons IV and V.

Horizon II

This horizon appears to consist of primary deposits that have undergone very little, if any, human reworking after initial formation. The units are typical of deposits near the vertical face of the opalite outcrop. They generally are more distinct and well defined than more remote deposits, and they slope uniformly toward the vertical face. Although the massive coarse Unit 3 is included here, it may be part of a separate horizon and a unit filling a re-excavated depression, in a manner similar to other near surface deposits (such as Unit 10 in Trench 1). Vague subhorizontal flake lines suggest the presence of separate events within Unit 3.

The vertical and horizontal extent of units in Horizon II are remarkable. Unit 12, for example, is over 5 meters in length with over 3 meters of relief. The scale of this and other units implies either that a lot of effort was expended in shoveling quarry debris up a rather steep slope away from the outcrop face, or that material was sliding downslope from above. For the latter process to occur, the presence of an outcrop source at least 5 meters from the current outcrop face is necessary. This could indicate a large overhang of the opalite outcrop, and, by implication, a large adit or cave below, where the lower units of Horizon II could accumulate. Alternatively, and perhaps more likely, extensive quarried incursions into the vertical face were made and the resulting flanking bedrock walls quarried back. In either scenario, the present bedrock face has been quarried extensively to its present location.

Horizon I

The coarse opalite chunk and flake debris of Units 1 and 2 are similar to the previously described, near-surface units of Trenches 1 and 2. They represent the final phases of activity at the site. They probably have been reworked by slopewash to some degree and are overprinted by modern soil processes.

Correlation of Horizons

Although the complex nature of the quarry debris exposed in the three trenches on the debris cone at 26Ek3208 makes correlation tenuous, the following relationships can be argued: (1) it is possible that Horizons I and II in Trenches 1 and 2, and Horizon I and the upper deposits of Unit 3 in Trench 3, correlate roughly; (2) the deposits of Horizon VI in Trench 1, Horizon V in Trench 2, and the lower units of Horizon II in Trench 3, also may correlate, although their resemblance may only reflect common formation mechanisms; (3) Horizons VII, VIII, or IX of Trench 2 may be correlated with Horizon III and possibly IV of Trench 3; and (4) Horizon X in Trench 2 may be correlated with Horizon V of Trench 3 and possibly with Horizon VI of Trench 1.

26Ek3208, Trench 4, Feature 5

Located uphill and north of the quarry debris talus cone, backhoe Trench 4 exposed the side of the Feature 5 bulldozer cut where a Great Basin Stemmed point was found on the surface (Figure 111). Four stratigraphic units were identified in the profile: Unit 1, a sandy silt loam at the surface; Unit 2, a sandy silt; Unit 3, a silty fine sand; and finally Unit 4, a chalky white tuff. Notable characteristics include the thickness of the upper silts (with a fairly high organic content), and strong carbonate accumulation in Units 2, 3, and the upper part of 4. These characteristics suggest a fairly old soil where carbonate accumulation is appreciable and the upper silts are an eolian deposited A horizon. The thick accumulation of silts around the perimeter of the opalite outcrop was seen also in Trench 1 at 26Ek3085. It is possible that a lack of surface runoff at the crest of the ridge prevented the removal of silts. Also, the outcrop may have acted as an obstruction to wind and allowed eolian deposition, especially on the lee side where the silt cover is thicker. This effect also may have been more pronounced before the outcrop was reduced through quarrying.

26Ek3085, Trench 1

Trench 1 revealed two, or possibly three, pit-like depressions containing silt with abundant opalite chunks and flakes. Since no opalite bedrock is present, but only a soft white kaolinitic tuff, these may be the marginal extent of quarry pits that lie farther to the east where opalite bedrock does occur. The stratigraphy generally can be summarized as a grayish brown silt cover over a brownish silt loam containing abundant opalite chunks and flakes that fill pit-like depressions. Below this are open matrix deposits of tuff and opalite clasts resting on orangish, iron stained, weathered tuff that grades into extremely white, somewhat platy, tuff bedrock. A thick gray silt mantle over the white tuff bedrock here is the same as in Trench 4 at 26Ek3208.

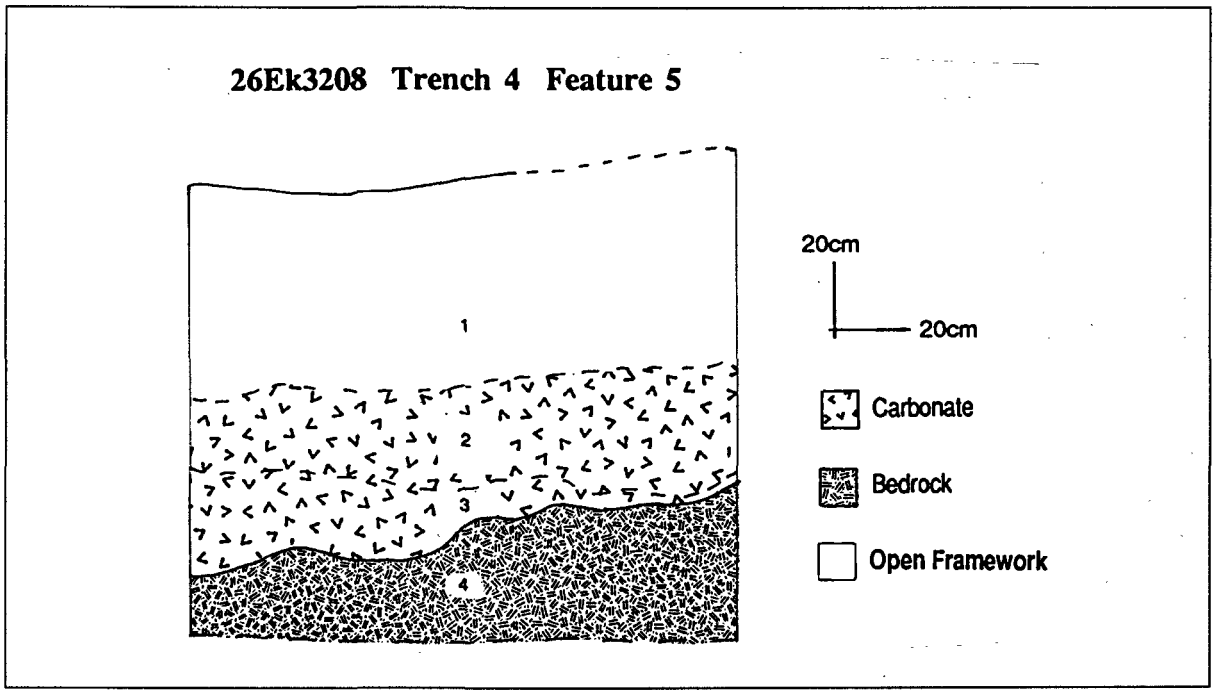


Figure 111. Description of stratigraphic units, Trench 4, Feature 5, 26Ek3208.

Stratum	Description
1	Very dark grayish brown (10YR 3/2) dry; sandy silt loam; vesicular, loose to weak granular; common fine to coarse angular sand-sized opalite and tuff, rare to common fine to coarse opalite and tuff chunks and flakes; common fine roots.
2	Grayish brown (10YR 5/2) dry; sandy silt; common sand-size to coarse opalite chunks, and common medium to coarse, tabular tuff clasts the result of bedrock jointing; strong acid reaction on disseminated carbonate, not visible in profile.
3	Pale brown (10YR 6/3) dry; silty fine sand; common fine to medium tabular and blocky chunks of tuff; strong acid reaction on disseminated carbonate.
4	Very white, weathered to fresh, chalky tuff bedrock with distinct tabular jointing; acid reaction strong in upper part of unit becoming weaker downward.

Implications

26Ek3208 is unique in the Western Periphery for its massive accumulations of quarry debris, for its complex stratigraphic history, and for what it reflects of the sheer energy expended in its formation. The variable depths of quarry pits and the complexity of debris scatters at 26Ek3208 and 26Ek3085 suggest at least three different strategies of toolstone extraction, each conditioned by the quality of source material. One strategy involved the exploitation of the vertical outcrop face, removing soft rock to undermine and expose masses of toolstone weakened by small fires and then broken off with hammerstones. Quarrying tools associated with this strategy include large (>25 cm diameter) basalt and rhyolite hammerstones, smaller hammerstones, and bison scapula scoops. A second strategy employed the excavation of vertical pits into bedrock, using the same tools and exploiting differences in rock density. A third strategy involved re-excavating quarry pit fill to secure opalite chunks formerly discarded as waste. Evidence for this strategy so far is restricted to pits observed in profile that do not appear to penetrate to bedrock (though we may not be observing the full extent of these pits). Large hammerstones and charcoal deposits typically are not associated with such shallow pits.

Continual reworking of quarry waste deposits provides the best explanation for the inverted radiocarbon dates recovered from all three backhoe trenches at 26Ek3208. The stratigraphy suggests that quarrying began 6 to 12 m to the south (downslope) of the present outcrop face, moving northward as the outcrop was quarried back. If quarrying shifted back and forth along the 13 m wide outcrop face, older charcoal easily could become incorporated in deposits overlying younger charcoal, although we might expect less perfect inversion than that modeled in Figure 112. In Table 123, radiocarbon dates are plotted by trench and horizon. Perfect inversion is seen only in the dates from Trench 2. In Trenches 1 and 3, the oldest dates are uppermost and lowermost in the stratigraphic column, while the youngest dates lie in the middle.

Table 123. 26Ek3208 Radiocarbon Dates by Trench and Horizon.

Horizon	Trench I	Trench II	Trench III
I	-	-	-
II			
III	-	-	770
IV			
V	870	-	590
	800	-	740
VI	650	840	-
VII	-	560	-
VIII	-	-	-
On Bedrock	900	480	-

What do radiocarbon dates in this context mean? We cannot assume that any of the dated charcoal deposits contain charcoal only of a single age. Nevertheless, those resting on bedrock are most likely to be in primary position and least likely to be contaminated. As it happens, the oldest *and* the youngest dates are those resting on bedrock. We advance, as an hypothesis subject to further testing, that these bedrock dates (900 B.P. and 480 B.P.) represent the true chronological range of the use of battering and fire setting techniques for toolstone extraction at the site. We do not suggest, however, that these dates represent the chronological extent of toolstone extraction at 26Ek3208. Flakes in older deposits resembling colluvium (Trench 1, Horizon VII; Trench 2, Horizon X), and the presence of small pits ceasing short of bedrock in upper horizons indicate less intensive methods of toolstone extraction during both earlier and later times.

The presence of dateable charcoal in stratified deposits should enable us to segregate quarrying episodes more finely, to calculate volume of debris generated in these discrete episodes, and to examine chronological differences in energy expenditure. Unfortunately (though not unexpectedly), complex stratigraphic mixing and inversion of charcoal deposits diminish our ability to pursue such explicit questions.

26Ek3104

26Ek3104 is a small (600 m^2) outcrop quarry on the south edge of Boundary Ravine, in Rodent Valley (cf. Figure 100). The outcrop is mapped as undifferentiated sinter and replacement

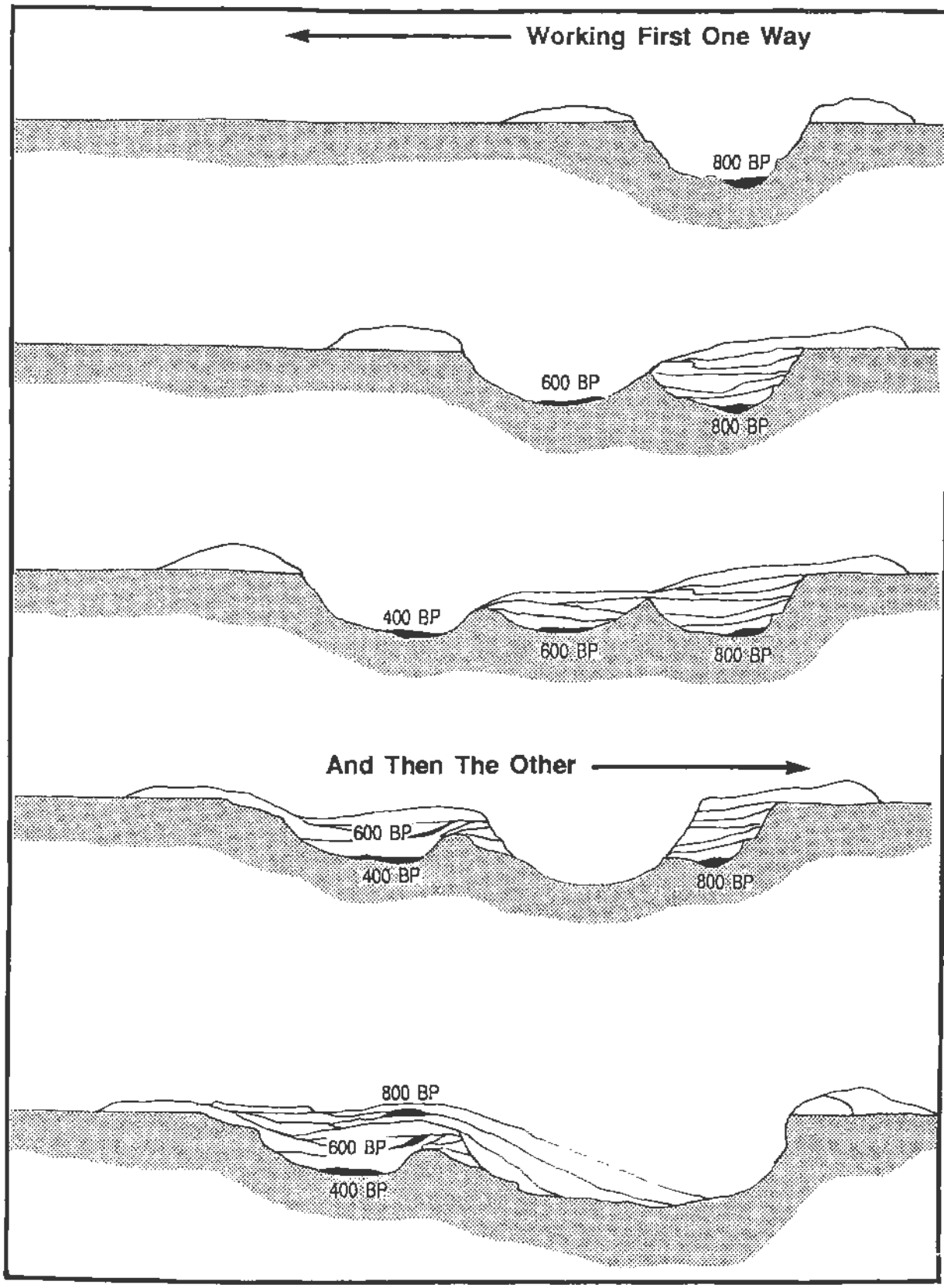


Figure 112. Model of chronological inversion of strata in quarry pit fill.

type silica (Cornucopia 1987). It lies downslope from several high-quality, intensively exploited opalite sources in the Tosawihi Quarries to the north. Here, only limited toolstone assay, as well as limited biface and core production, took place, owing perhaps, to the poor quality of the exposed opalite. No discrete artifact clusters were deposited. We collected surface artifacts and placed four small (25 cm x 25 cm x 10 cm) excavation units to sample cultural and noncultural materials along the slope of the opalite outcrop (Budy 1989:166). Over 1,000 opalite flakes, seven bifaces, four cores, and several percussion tools were collected.

Non-Quarry Locales

26Ek3086

Located on a gravel bar near the confluence of Basalt Canyon and Little Antelope Creek, 26Ek3086 (at 1,100 m^2) is a diffuse scatter yielding evidence of biface reduction and cobble assay (cf. Figure 100). We detected no surface features, and artifact distribution appeared unpatterned. Opalite cobbles and sparse opalite flakes were noted in the gravels, yet none of the four bifaces and two flake tools we collected appears to have been fashioned from on-site opalite (Budy 1989:197).

26Ek3087 and 26Ek3088

Reduction stations 26Ek3087 (300 m^2) and 26Ek3088 (650 m^2) lie on small terraces on the south side of Basalt Canyon (cf. Figure 100). On-site sediments at 26Ek3087 consist of 40 cm of rocky, sandy silt overlying large boulders; 26Ek3088 is mantled more thinly. Cultural deposits at both sites appear confined to the surface, and consist of thin scatters of debitage lacking clear concentrations. Bifaces and a single flake tool retrieved from 26Ek3088 compose the entire formed artifact assemblages (cf. Table 118).

26Ek3090

26Ek3090 is a small (150 m^2) reduction station that extends from a bedrock overhang, across a narrow bench, and downslope approximately 20 m to the streambed of Basalt Canyon (cf. Figure 100). A 1 m x 1 m test unit sampled deposits (to 30 cm below surface) at the base of the low overhang (Budy 1989:198). Below 30 cm, the unit was reduced to 50 cm x 1 m. Soil was screened through 1/8 inch mesh, yielding 120 pieces of opalite debitage, five bifaces, and a flake tool. We observed sediments stratified in three distinct soil units, including (from surface to 25 cm) a dark brown silt loam with abundant natural charcoal flecks and chunks, underlain by 20 cm of dark brown silt loam with cobbles of opalite. The lowest unit is a dark reddish brown silty clay loam containing abundant opalite cobbles and boulders.

26Ek3091

26Ek3091 (400 m^2), located on the moderately steep slopes of Basalt Canyon, is a highly disturbed, sparse reduction locus with no clear feature concentrations (cf. Figure 100). We recovered few formed artifacts (six bifaces and an opalite core) from the surface (Budy 1989:200).

Basalt Canyon unquestionably was attractive for prehistoric settlement. The winding, steep-sided canyon has slowed the course of the stream, building up sediments in a series of small, vegetated terraces (Budy 1989:191). The terraces rise about four m above the north side of the channel, extending another 30 m to the base of Red Hill (Figure 113). Though the stream is ephemeral, water is forced close to the surface by underlying bedrock and is trapped by sediments, contributing to small, persistent pools that provided important seasonal habitat for large and small mammals and a potentially tappable source of drinking water (cf. Chapter 25; Budy 1989:191). Edible grass and sedge seeds are available in early summer (Intermountain Research 1988b).

Stratified alluvial deposits and buried residential and reduction features render 26Ek3092 unique among sites in Basalt Canyon. The site represents a series of short term residential camps and toolstone reduction loci. Its assemblage contains diverse food processing and equipment maintenance tools, pottery, and faunal remains, suggesting multiple uses of the place.

Massive boulders of replacement silica on the southeast flank of Red Hill in and near the bottom of Basalt Canyon are relict masses of the old, regional silica cap (Bartlett, Enders, and Hruska 1991). One of these, on the upper terrace, served as a focal point for many of the domestic activities undertaken at the site (Figure 114a and b). The clustered distribution of artifacts and features at its foot suggest that it was a repeated locus for lithic tool production and maintenance, food preparation, refuse dumping, and raw stone heat-treatment.

Excavation Methods and Rationale

Our goal was to identify buried cultural components in the terrace sediments and compile a relative occupation chronology. Discrete surface concentrations on the steep slopes above the drainage were recorded as Features 1–5; associated surface artifacts were plotted and collected (Table 124). We took no systematic debitage collections from these highly eroded surface features.

Table 124. Summary of Surface Collected Artifacts from 26Ek3092.

		FORMED ARTIFACTS							
Feature	Area (m^2)	Proj. Points	Bifaces	Cores	Flake Tools	Modif. Chunks	Ground Stone	Other/ Exotic	Total
1	14	-	1	-	-	1	-	-	2
2	25	-	3	-	2	-	-	-	5
3	7	-	-	-	-	-	-	-	0
4	6	-	1	-	-	-	-	-	1
5	5	-	2	-	-	-	-	-	2
Nonfeature		3	11	1	3	-	1	1	20
Totals		3	18	1	5	1	1	1	30

During testing, we opened Trenches 1–4 in nonfeature areas to expose cross sections (Budy 1989). These trenches were intersected subsequently by three controlled excavation units located to expose possible cultural surfaces indicated by flake and pebble lines in trench wall profiles (Budy 1989:194).

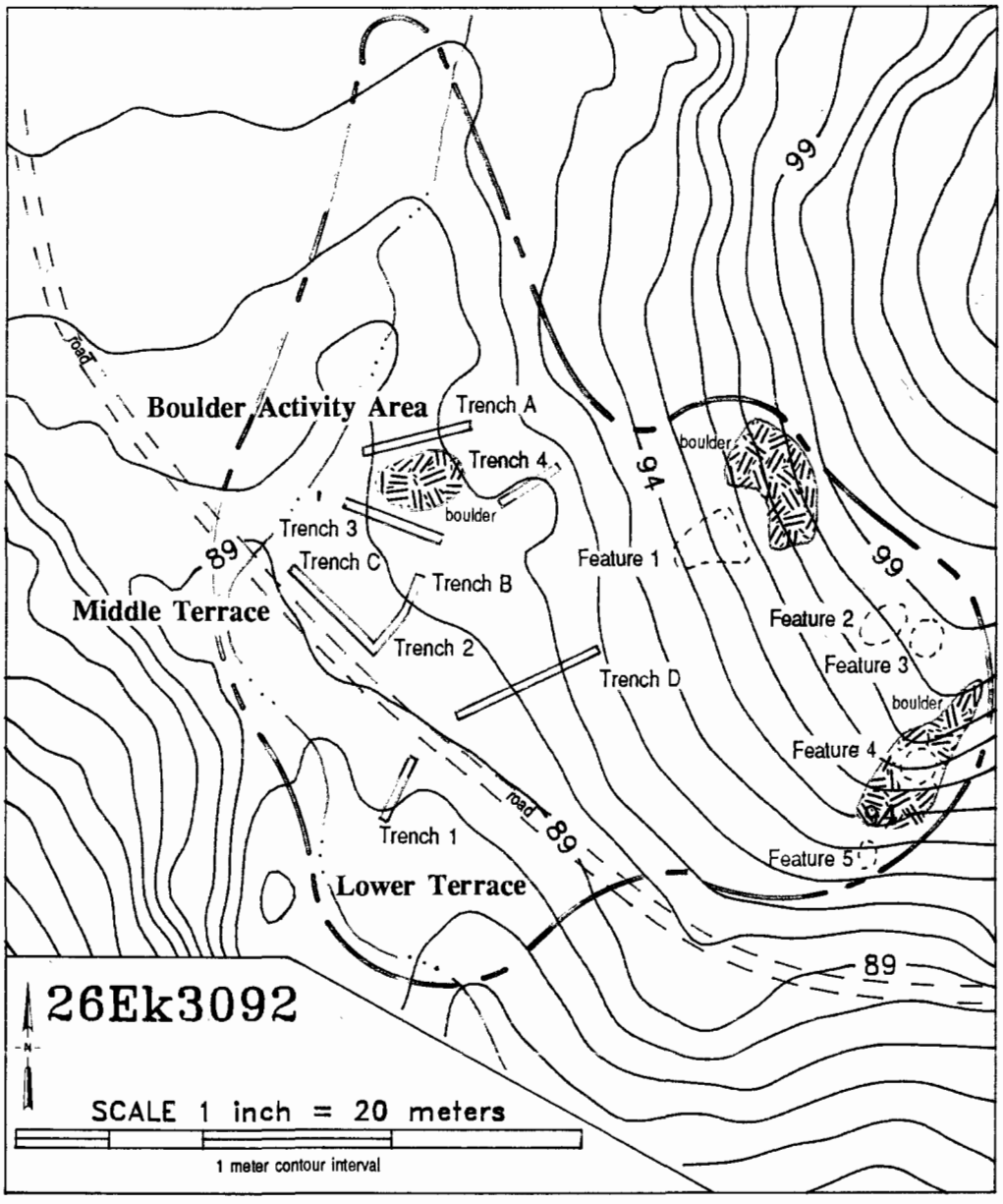


Figure 113. 26Ek3092 site map.



a.



b.

Figure 114. 26Ek3092. a. Large boulder that served as focal point for domestic activities seen at far left; b. Base of large bouler, revealing clustered feature remains.

In 1989, we investigated site stratigraphy more fully by extending Trenches 1–4 and excavating four additional trenches (Trenches A–D; cf. Figure 113). As well, a series of 1 m x 1 m units were excavated throughout the site to recover subsistence data, to assess artifact variability, to retrieve additional chronological indicators, and to search for potential residential features. We placed one block of contiguous excavation units to uncover the hypothesized activity area centered around the prominent boulder on the upper terrace. Twelve randomly drawn excavation units also were placed to sample approximately 10% of the surface area of the middle terrace, immediately south of the large boulder. Two additional units were excavated in the most recent (lower) terrace, close to the modern streambed.

Excavations in the Boulder Activity Area

Trench 3 ran along the southwestern edge of the prominent boulder to explore the depth and content of cultural materials on this portion of the terrace; Trench 4 crossed the steeper slope edging the north boundary of the site (Figure 115). A large, saucer-shaped soil feature and several flake lines were observed in the profile of Trench 3, prompting us to place a test excavation unit (TS 3) on the north wall of the trench, along the west edge of the feature. We recovered a large quantity of debitage and formed tools, including tens of thousands of pieces of opalite, obsidian, and basalt debitage, and many formed artifacts (Table 125). This sample reflects toolstone reduction, tool maintenance, and other more subsistence-oriented activities; a hammerstone and abrader, some expedient flake tools and scrapers, perforators, several projectile points, and numerous bifaces were retrieved. Three sherds of corrugated Great Salt Lake Grayware, including one neck sherd from a cooking jar, lay at about 30 cm (cf. Chapter 13). The unit was excavated to a depth of 70 cm.

Table 125. Summary of Artifacts Collected from Excavation Units in the Boulder Activity Area at 26Ek3092.

			DEBITAGE		FORMED ARTIFACTS										
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Other/ Ceramics	Exotic	Total
SOUTH BOULDER UNITS														
3 (TS)[a]	0.7	16,286	7,105.7	2	-	11	1	8	1	1	-	4	-	28
3 (TR)	N/A	-	-	-	-	2	-	2	-	-	-	-	-	4
16 (EU)	0.6	1,847	2,834.5	-	1	8	-	-	-	1	-	4	-	14
17 (EU)[b]	0.9	16,803	16,809.0	2	1	39[d]	1	24	1	1	-	15	-	84
18 (EU)	0.9	10,895	17,412.6	1	-	33[d]	1	5	-	2	-	10	-	52
19 (EU)	0.8	5,026	9,670.7	3	-	18[d]	-	4	-	1	-	1	-	27
20 (EU)[b]	0.7	2,705	3,904.5	-	1	6	-	3	-	-	-	-	-	10
21 (EU)	0.6	1,468	3,096.0	-	3	6[d]	1	1	1	-	-	-	-	12
22 (EU)	0.5	2,048	4,316.2	2	1	17[d]	-	1	-	1	-	-	-	22
23 (EU)	0.5	2,615	5,379.4	1	-	12	-	2	-	1	-	2	1	19
24 (EU)	0.4	4,906	5,963.4	-	2	15[d]	-	4	-	2	1	-	1	25
25 (EU)	0.5	2,552	4,172.6	1	-	6[d]	-	2	-	-	-	-	-	9
26 (EU)[b]	0.4	2,413	2,329.2	-	1	12	-	1	-	-	-	-	-	14
27 (EU)	0.4	1,461	1,681.8	-	-	2	-	1	-	-	1	-	-	4
28 (EU)	0.4	1,650	2,853.4	1	-	9	-	1	-	1	-	1	-	13
29 (EU)	0.4	1,706	3,178.8	-	1	17	-	5	-	-	-	-	-	23
30 (EU)	0.5	1,769	3,242.2	-	-	23[d]	2	2	-	2	-	-	-	29
31 (EU)	0.5	1,273	4,220.3	1	2	17	2	2	-	-	1	-	-	25
32 (EU)	0.4	623	1,283.9	-	-	7	2	1	-	2	-	-	-	12
EAST, WEST, NORTH BOULDER UNITS														
33 (EU)	0.6	756	1,144.1	-	-	5	1	3	-	-	-	5	-	14
33/36 (EU)[c]	N/A	68	110.2	-	-	1	-	-	-	1	-	-	-	2
36 (EU)	0.4	500	929.5	-	1	4	-	1	-	1	-	2	-	9
37 (EU)	0.6	997	1,863.7	-	-	4	-	-	-	-	-	11	-	15
38 (EU)	0.3	243	846.4	-	-	4	-	4	1	-	-	-	-	9
39 (EU)	0.6	1,110	2,652.9	1	1	1	-	4	-	-	-	-	-	7
40 (EU)	0.8	720	1,420.3	2	-	1	-	-	-	-	-	-	-	3
41 (EU)	0.3	442	741.3	-	-	2	-	-	1	-	-	-	-	3
42 (EU)	0.5	586	1,558.4	-	1	3[d]	-	2	-	-	-	-	-	6
43 (EU)	0.9	1,714	3,629.8	2	-	7	-	2	-	-	-	-	-	11
44 (EU)[b]	0.3	833	1,127.4	-	-	2	-	3	-	-	-	-	-	5
45 (EU)	0.3	489	818.9	1	1	3[d]	-	2	-	-	-	-	-	7
Total	86,504	116,297.1		20	17	297	11	90	5	17	3	55	2	517	

(TS) = Test Excavation Unit
(EU) = Excavation Unit
(TR) = Backhoe Trench

[a]Screened entirely through 1/8 inch mesh
[b]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[c]Feature 9 was excavated as a discrete unit, cross-cutting Units 33 and 36
[d]Includes "possible" bifaces

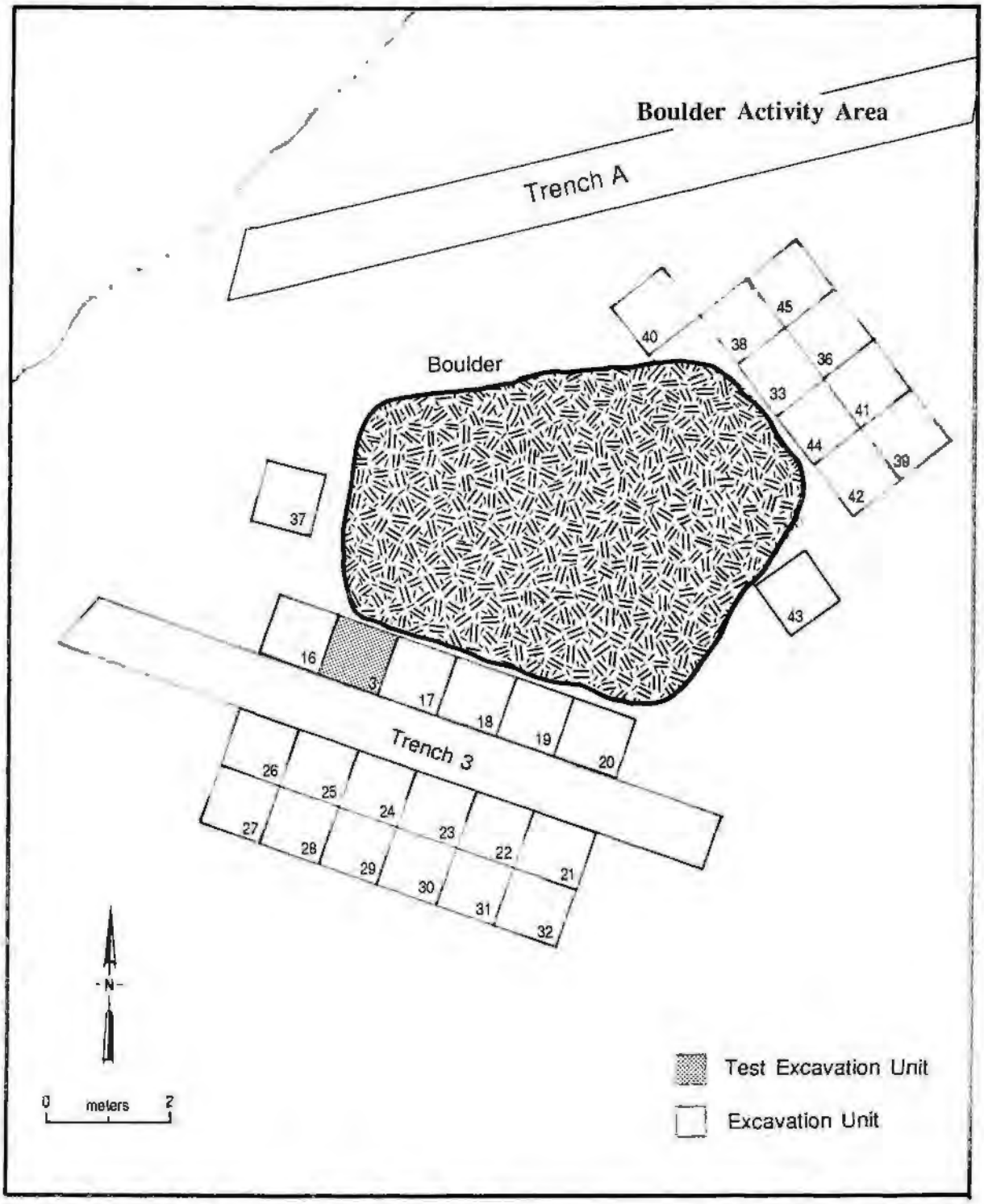


Figure 115. 26Ek3092, excavation units in the Boulder Activity Area.

The presence of this dense, subsurface deposit of reduction debris, specialized tools, and ceramic sherds, suggested that the boulder may indeed have served as a centralized locus for residential and tool production activities. We returned in 1989 to expose the area around the boulder and to search for buried residential features. We excavated a block of 18 1 m x 1 m units south of the boulder, arrayed on either side of Trench 3 (EUs 16–32), and 11 units to the sides (EUs 37 and 43) and north of the boulder (EUs 33, 36–45; cf. Figure 115).

We retrieved a variety of formed items, including additional Grayware ceramics and one sherd of Shoshone Brownware, diverse flake tool forms, a bone awl and a bone flaker, and three tabular basalt metate fragments. The presence of projectile points spanning the pre-Archaic and Archaic periods testifies to the persistent attraction of the boulder as a focal point of activity.

Too, we exposed a number of functionally-diverse subsurface features reaffirming that the boulder served as a long-used central activity area (Table 126 [following page]; cf. Figure 114a and b). Dense flake lenses, cobble accumulations, large tool aggregations, hearths, and ephemeral charcoal stains reflect various domestic uses. These often are interdigitated, reflecting a highly complex depositional history. We conclude, therefore, that use of the boulder area has been virtually continuous, with few episodes defined by discrete soil lenses.

Feature 9, a well-preserved hearth north of the boulder (Figure 116a) is unique at Tosawihi. We exhaustively sampled the soil matrix and recovered a few charred, edible seeds in flotation (cf. Chapter 15). More striking, however, was the presence of small bits of crumbled and heat-crazed opalite, indicating probable use of the facility for heat-treatment of toolstone. Two essentially equivalent radiocarbon dates of 750 ± 70 B.P. and 650 ± 50 B.P. (Beta-36976 and -36977) place the feature in the Late Archaic (Table 127).

Table 127. Provenience of Radiocarbon Dates from Site 26Ek3092.

Reference Number	Laboratory Number	Date (Years B.P.)	Provenience
8584-5	Beta-36976	750±70	Feature 9
8645-1	Beta-36977	650±50	Feature 9

The function of tool/flake/cobble concentrations, like Feature 13 pictured in Figure 116b, remains unclear. This feature, like others in the boulder activity area, is associated with a variety of tools and debitage suggesting an eroded domestic surface or areal cleaning of cobble-lined hearths.

Food residue is scarce in this portion of the upper terrace. Large mammal bones are found more commonly in the meadow to the south, where they appear to have been tossed from food preparation areas at the boulder (cf. Chapter 14).

Excavations on the Middle Terrace

Trenches B, C, and 2 were located on the broadest portion of the middle terrace, oriented to expose an 'L'-shaped profile of terrace deposits (Figure 117). Test Unit 1, placed off the west edge of Trench 2, disclosed deep terrace deposits to 90 cm below surface. The deposits were extremely disturbed by rodent burrowing; thus artifacts, like a Gatecliff projectile point found 85 cm below surface, may have been moved from their original contexts.

Table 126. Subsurface Features in the Boulder Activity Area at 26Ek3092.

Feature No.	Type	Feature Area (m^2)	Volume Excav. (m^3)	Depth Encountered (cm below surf.)	Excav. Unit No.	ASSOCIATED ARTIFACTS									
						Debitage	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Perc./ Cobble Tools	Metate	Ceramics[†]	Bone Flaker
6-636	flake-filled pit	0.03	0.003	18	3	+									
6-638	flake concentration	1.00	0.020	12	18	+			+	+	+				
7/8	flake concentration	2.24	0.051	10	17, 18	+	+[a]		+		+	+		+	
9	hearth	0.46	0.050	33	33, 36	+			+			+			
10	cobble aggregation	2.00	0.160	20	25, 26	+									
11	charcoal stain	0.47	0.024	10	22	+									
12	tool/flake concentration	6.28	0.326	5	22-25, 28-31	+			+	+	+		+		
13	tool/flake concentration	7.00	0.308	10	22-24, 28-31	+		+	+		+	+			+
14	tool/flake concentration	1.00	0.087	13	17, 18	+	+[b]		+		+	+		+	
15	flake concentration	0.10	0.009	3	16	+									
16	soil feature	0.32	0.022	10	44	+			+						
17	soil feature	0.32	0.006	12	44	+									
18	soil feature	0.42	0.025	12	44	+									
19	cobble/tool aggregation	1.00	0.060	25	16	+			+						
20	cobble concentration	0.40	0.044	20	23	+			+					+	
21	flake concentration	1.95	0.088	13	18, 19	+			+					+	
22	cobble aggregation	0.71	0.035	45	23	+									
23	flake concentration	0.40	0.045	30	17, 18	+	+[a]		+		+			+	
24	cobble aggregation	0.53	0.138	45	17, 18	+			+			+			

[†]All Great Salt Lake Grayware
[a]Rosegate Projectile Point
[b]Cottonwood Projectile Point

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a.



b.

Figure 116. 26Ek3092. a. Feature 9; b. Feature 13.

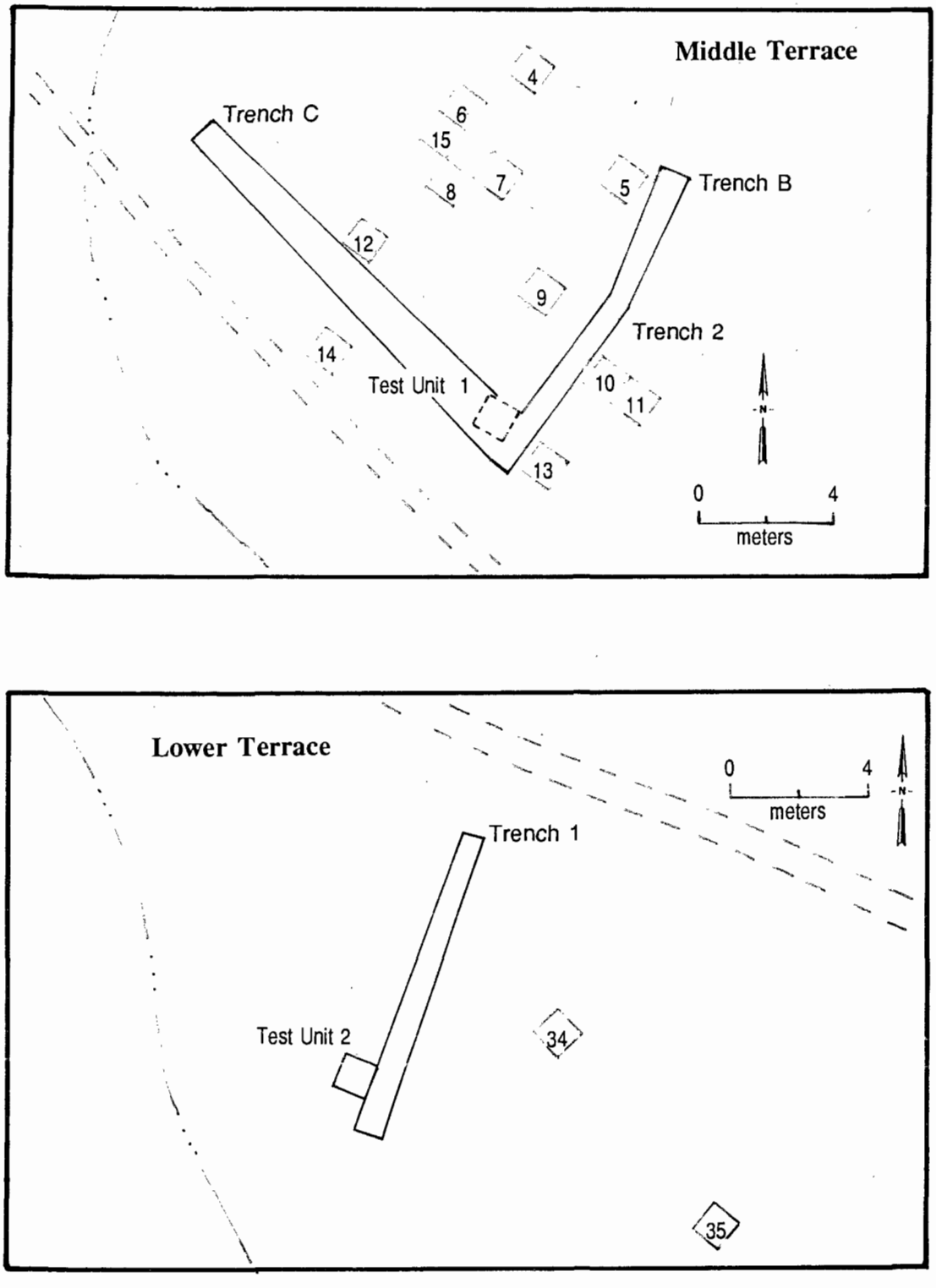


Figure 117. 26Ek3092, excavation units on the Middle Terrace and the Lower Terrace.

Our randomly placed 1 m x 1 m excavation units sampled over 10% of the meadow on the middle terrace. These units intruded deep soils, ranging from 40 cm to 1.1 m below surface. Fire-cracked rock and apparently heat-treated flakes were noted in several units, but no clear features could be discerned. As in our test excavations, all units reported substantial rodent disturbance. Dense flake yields were noted, and a variety of food preparation and processing tools were recovered. We also retrieved an expedient bone tool and a bone bead (Table 128).

Table 128. Summary of Artifacts Collected from Excavation Units in the Middle Terrace at 26Ek3092.

		DEBITAGE		FORMED ARTIFACTS										
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
1 (TS)[a]	0.9	9,525	6,022.4	2	-	17	-	6	-	-	-	-	-	25
2 (TR)	N/A	-	-	-	-	4	-	1	-	-	-	-	-	5
B (TR)	N/A	-	-	-	-	-	-	-	-	-	-	-	-	0
C (TR)	N/A	-	-	-	-	2	-	-	-	-	-	-	-	2
4 (EU)	0.4	941	1,675.2	-	-	5	-	-	-	-	-	-	-	5
5 (EU)	0.6	839	1,843.3	-	-	4	-	1	-	-	-	-	-	5
6 (EU)	0.4	1,906	3,367.2	1	-	17[c]	-	2	-	-	-	2	-	22
7 (EU)	0.9	2,841	3,878.7	2	-	14	-	4	-	2	-	1	-	23
8 (EU)[b]	0.8	8,476	11,237.8	-	2	25[c]	-	10	-	1	-	-	1	39
9 (EU)	0.9	1,461	3,005.6	1	-	7	-	1	-	-	-	2	1	12
10 (EU)[b]	0.5	1,604	1,677.7	-	1	10[c]	-	-	-	1	-	-	-	12
11 (EU)	0.6	725	1,052.6	-	3	5	-	1	-	-	-	-	-	9
12 (EU)	1.1	6,426	9,469.3	1	3	33[c]	-	7	-	1	2	-	-	47
13 (EU)	0.8	1,793	3,078.1	-	1	7[c]	-	6	1	-	-	-	-	15
14 (EU)	0.8	1,286	1,640.5	1	1	15[c]	-	2	-	-	-	-	-	19
15 (EU)	0.6	4,084	7,603.8	1	1	34[c]	1	6	-	-	1	-	-	44
Total	9.3	41,907	55,552.2	9	12	199	1	47	1	5	3	5	2	284

(TS) = Test Excavation Unit
(EU) = Excavation Unit
(TR) = Backhoe Trench

[a]Screened entirely through 1/8 inch mesh
[b]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[c]Includes "possible" bifaces

Most of the mammal remains (including rabbit, hare, marmot, pronghorn, bison, and mountain sheep) came from excavations in the middle terrace. Indeed, the meadow here may have been the refuse "toss" zone for bones prepared in the boulder activity area (cf. Chapter 14).

Several sherds of Shoshone Brownware as well as Desert Side-notched and Cottonwood projectile points, signal use of the meadow after A.D. 1300. A Gatecliff point may have been discarded much earlier (3000–1300 B.C.).

Excavations in the Lower Terrace

We placed Backhoe Trench 1 adjacent the modern streambed in order to characterize the geomorphologic nature of the lowest terrace (cf. Figure 117; cf. description below). Test Excavation Unit 2, off the west edge of Trench 1, penetrated moist meadow soils, and was terminated 70 cm below surface. We excavated two deep units (EUs 34 and 35) to the west of the backhoe trench, uncovering highly bioturbated deposits with associated flake tools, projectile points (Humboldt and Desert series points and unclassifiable fragments), and bifaces (Table 129).

Table 129. Summary of Artifacts Collected from Excavation Units in the Lower Terrace at 26Ek3092.

		DEBITAGE		FORMED ARTIFACTS			
Unit No.	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Bifaces	Flake Tools	Total
1 (TR)	N/A	-	-	1	-	-	1
2 (TS)	0.7	2,271	2,408.0	2	8	3	13
34 (EU)	0.6	739	1,992.5	1	6	2	9
35 (EU)	1.1	773	1,142.7	1	1	-	2
Totals	2.4	3,783	5,543.2	5	15	5	25

(TS) = Test Excavation Unit (EU) = Excavation Unit (TR) = Backhoe Trench

Terrace Stratigraphy

Four major stratigraphic horizons initially were recognized in Backhoe Trenches 1, 2, and 3 (Figure 118). A stratigraphic horizon contains a single stratum or a group of conformable strata that appear to represent an interval in which deposition dominates. In fluvial deposits, horizons essentially define inset terraces.

In 1989 trenches, the stratigraphic profiles not only confirmed the existence of these major depositional episodes, but also revealed additional complexity in the sedimentary record. For example, in Trench A (Figure 119), Units 3 and 4 are contemporaneous with units of Horizon IV, the oldest in the original trenches (Figure 118c), but these also are underlain by Unit 5 which has a truncated upper surface and a higher degree of pebble and cobble weathering. This suggests that Unit 5 may represent an even older sedimentary and pedogenic Horizon V. Molecular weathering ratios of the sediments in Unit 5, however, are not chemically distinct from Horizon IV (Figure 120). Both show a higher degree of leaching as indicated in the iron and aluminum ratios. The base ratio, which notably increases in Unit 3 in Horizon IV, suggests that Unit 3 is part of a truncated calcic soil horizon developed in these gravels, whereas bases decrease below. The higher phosphorus also suggests that Unit 3 may have been part of a stable surface in the past.

Deposits overlying the truncated surface of Units 3 and 5 in Trench A exhibit differences from other previously described deposits as well. These deposits, Units 6, 7, 8, and 9, have a coarser pebble component than their counterparts, although they are in the appropriate stratigraphic position to be equivalent to typical loamy Horizon III deposits elsewhere on the site. Horizon II (Unit 2), although of the same silty texture, is notably thicker than in other trenches. As with all other trenches at this site, except Trench 1, Horizon I is not present in Trench A. Finally, mantling the Trench A profile, there is the modern A horizon present over the entire surface of the site.

Trenches B and C best characterize the sediments that comprise the second highest (middle) terrace surface above the modern stream channel. Their profiles are typical of the stratigraphy encountered in most excavation units. Trench C (Figure 121) has a stratigraphic record identical to Trench B (equivalent to Trench 2 in Figure 118b) with a strongly weathered gravel Horizon IV, notable for its highly irregular surface relief, a result of extensive erosion and gullying; a Horizon III of strongly bioturbated, silty clay loam with a slightly cemented carbonate basal zone; Horizon II, a pebbly silt loam; and Horizon A, the typical silt loam surface layer. Horizons A, II, and possibly III, are also part of a poorly developed soil profile that probably has unrecognized aggradational surfaces within it. Chemically, a progressive leaching can be seen in the silty Units 1 through 3 (Figure 122). Unit 2a, however, may reflect the existence of a former stable surface. This is suggested by the slightly greater degree of iron leaching and the notable increase in phosphorus. This, however, also may be an effect of strong bioturbation.

Trench D, the eastern-most, provided a view not only of sediments from alluvial activity and the four main stratigraphic episodes, but also part of the colluvial slope above (Figure 123). It has a profile similar to those in Trenches B and C, with a lowermost gravel and cobble unit overlain by silt units. There is a difference, however, in the larger amount of clays present in the silts in Trench D. This may be a function of clays being mixed with the silts by slopewash. The very clay-rich Unit 6, present upslope, is probably the source. This reddish clay has a distinct fine columnar structure that indicates some stability on the hillslope; however, it also appears to be reworked to some degree with common incorporated colluvial gravel. Unit 6 appears the least reworked where it directly overlies Unit 5 at the extreme northeastern end of the trench. The stratigraphic position of Unit 6 here suggests soil development on the surface of an older terrace. Molecular weathering ratio plots for these sediments show an interesting trend beginning with Unit 4 (Figure 124). At this point the aluminum ratio shows decreased clay formation while iron indicates increased oxidation. Also, the phosphorus percentage increases.

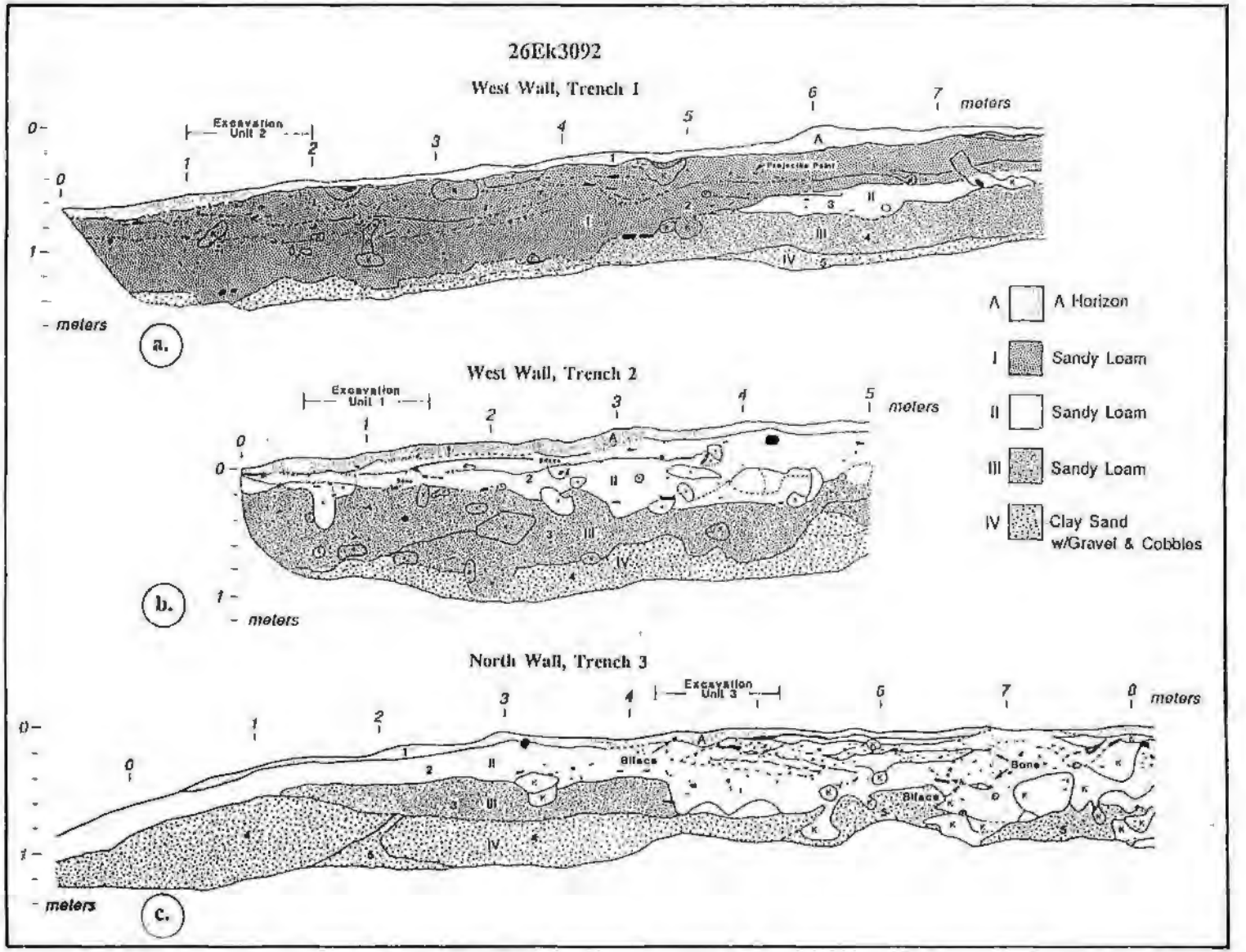


Figure 118. 26Ek3092. Stratigraphic profiles of Trenches 1, 2, and 3, excavated during 1988 Testing. a. West wall, Trench 1; b. West wall, Trench 2; c. North wall, Trench 3.

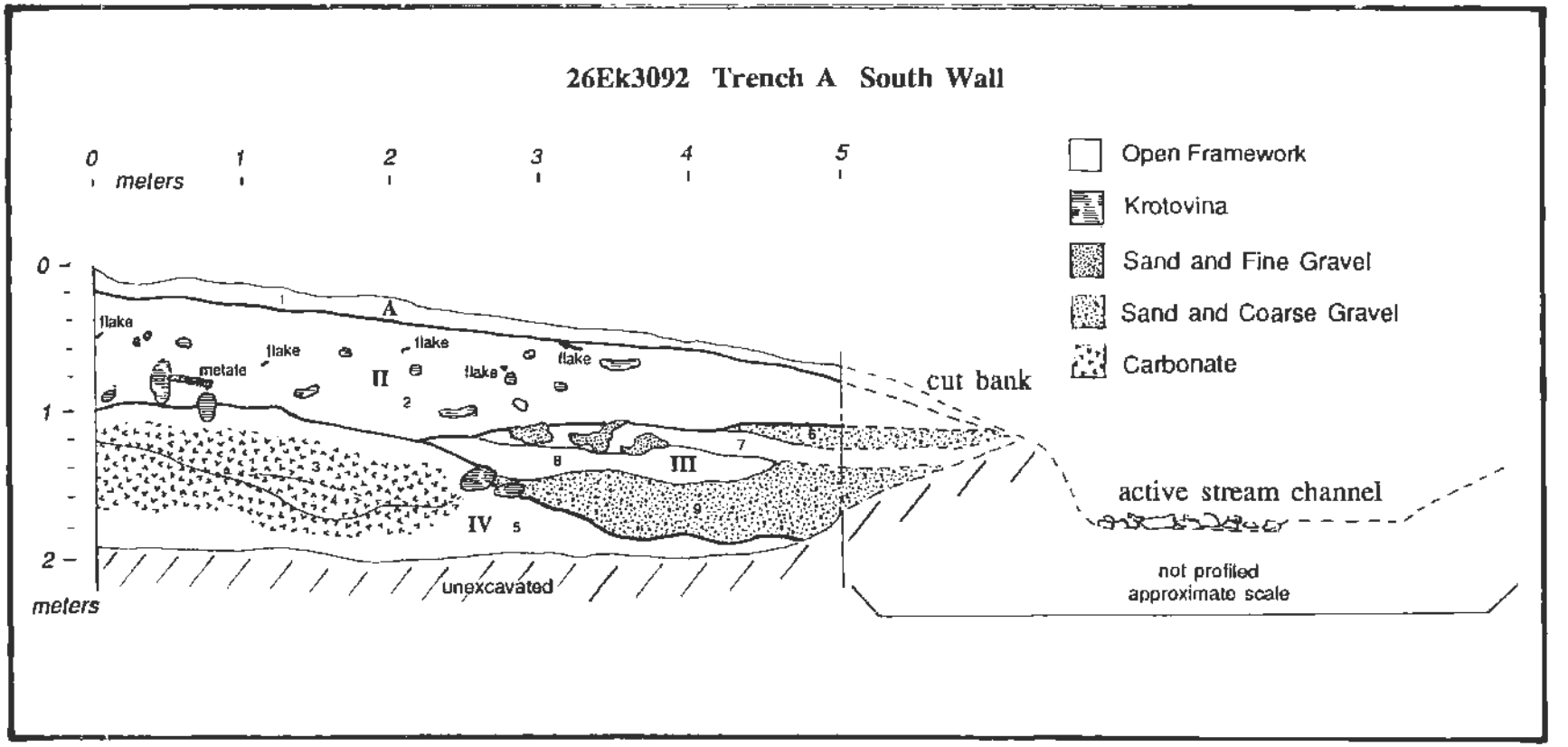
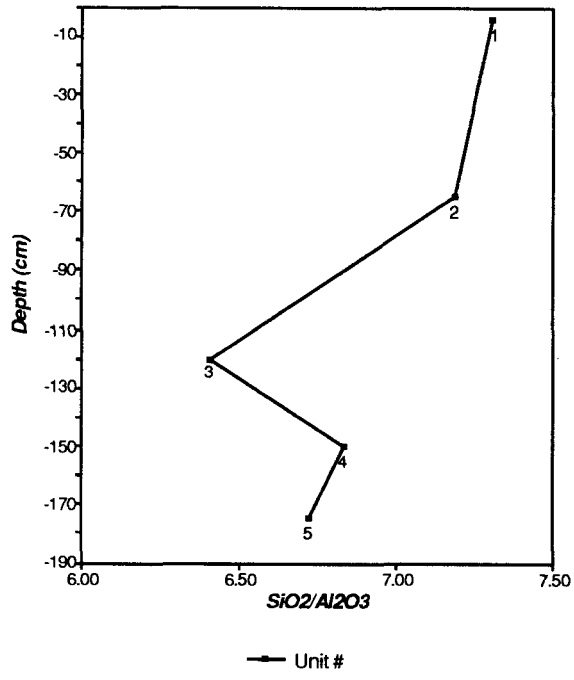


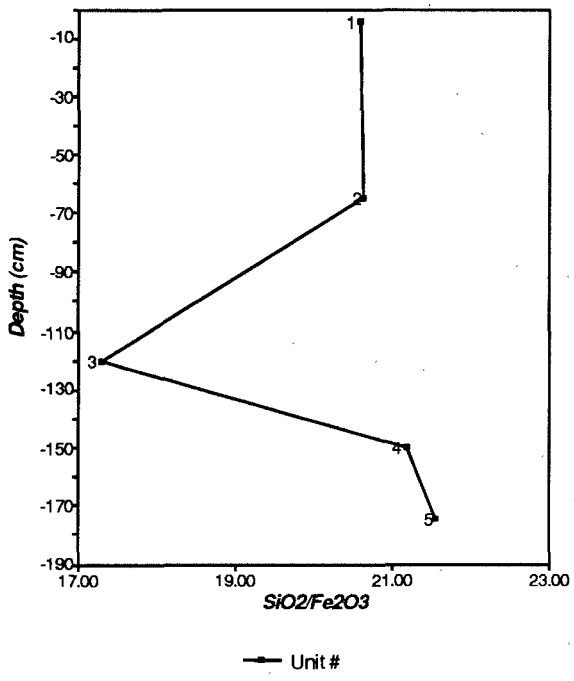
Figure 119. Description of stratigraphic units, Trench A, 26Ek3092.

Figure 119. Description of stratigraphic units, south wall of Trench A, 26Ek3092.

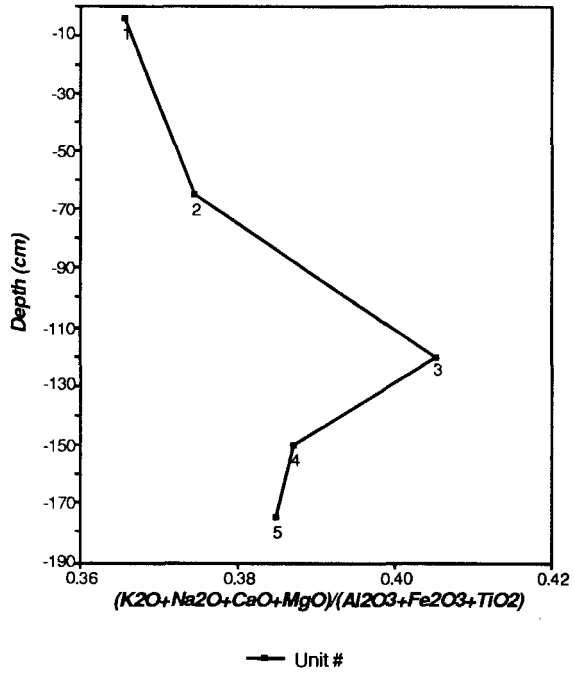
Horizon	Stratum	Description
A	1	Grayish brown (10YR 5/2) dry; silt loam; loose to weak, fine to granular to fine platy; abundant fine, common medium roots; common fine to medium subangular to subrounded pebbles; boundary gradual to clear and smooth.
II	2	Dark brown (10YR 3/3) dry silt loam; mottling of dark yellowish brown (10YR 4/6) dry; as sandy patches in lowest 10–15 cm of unit; loose to weak fine granular to weak fine subangular blocky; common fine to medium roots and pores, common burrows; common fine to medium subangular to subrounded pebbles, rare fine opalite flakes; boundary abrupt and irregular.
IV	3	Yellowish red to dark reddish brown (5YR 4/6 to 3/4) moist; silty clay; weak fine angular blocky; rare fine to medium roots and pores; rare fine rounded pebbles in upper parts grading to medium to coarse gravels downward; moderate acid reaction on carbonate veins and pebble coating in lower half of unit; boundary clear and irregular.
	4	Dark grayish brown (10YR 4/2) moist; with clear mottling of very dark brown (10 YR 2/2), yellowish brown (10YR 5/6) and yellowish red (5YR 5/8) sandy clay, coarsening downward, abundant strongly weathered gravels; weakly columnar; moderate acid reaction on carbonate veins and pebble coatings; boundary clear and irregular.
	5	Dark yellowish brown (10YR 4/4) moist; with mottling as in Unit 4; clayey sand with abundant fine to coarse subangular to subrounded gravels and cobbles commonly strongly weathered, primarily matrix supported; strong acid reaction on well-developed carbonate accumulation that reaches down into the top 40 cm of this unit; boundary unexposed.
III	6d	Dark brown (7.5YR 4/4 dry) clayey sand matrix clast supported fine to medium subangular to subrounded gravels, rare fine subangular cobbles; boundary abrupt wavy.
	7	Gravels similar to Unit 6 with silts similar to Unit 2; extensively burrowed and disturbed.
	8	Similar to Unit 7, but with slightly more gravels.
	9	Strong brown to dark brown (7.5YR 5/6 to 4/4) clayey sand with gravels similar to Unit 5 except they are less weathered and generally coarser.



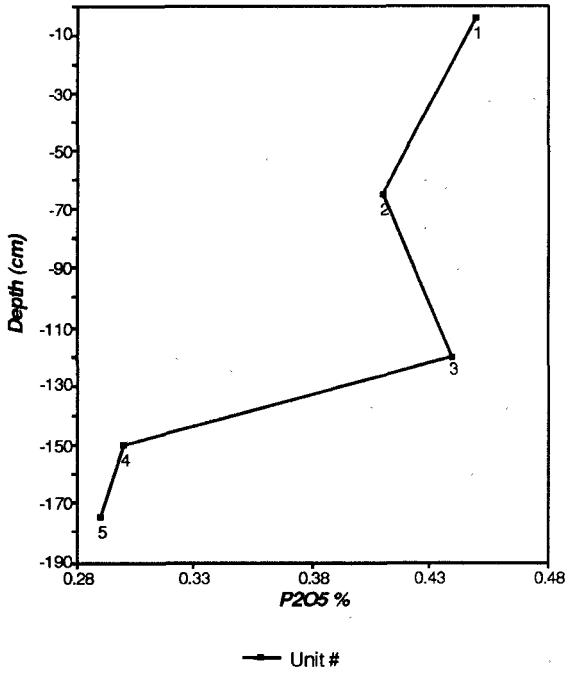
a.



b.



c.



d.

Figure 120. Molecular weathering ratios for 26Ek3092, Trench A, profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

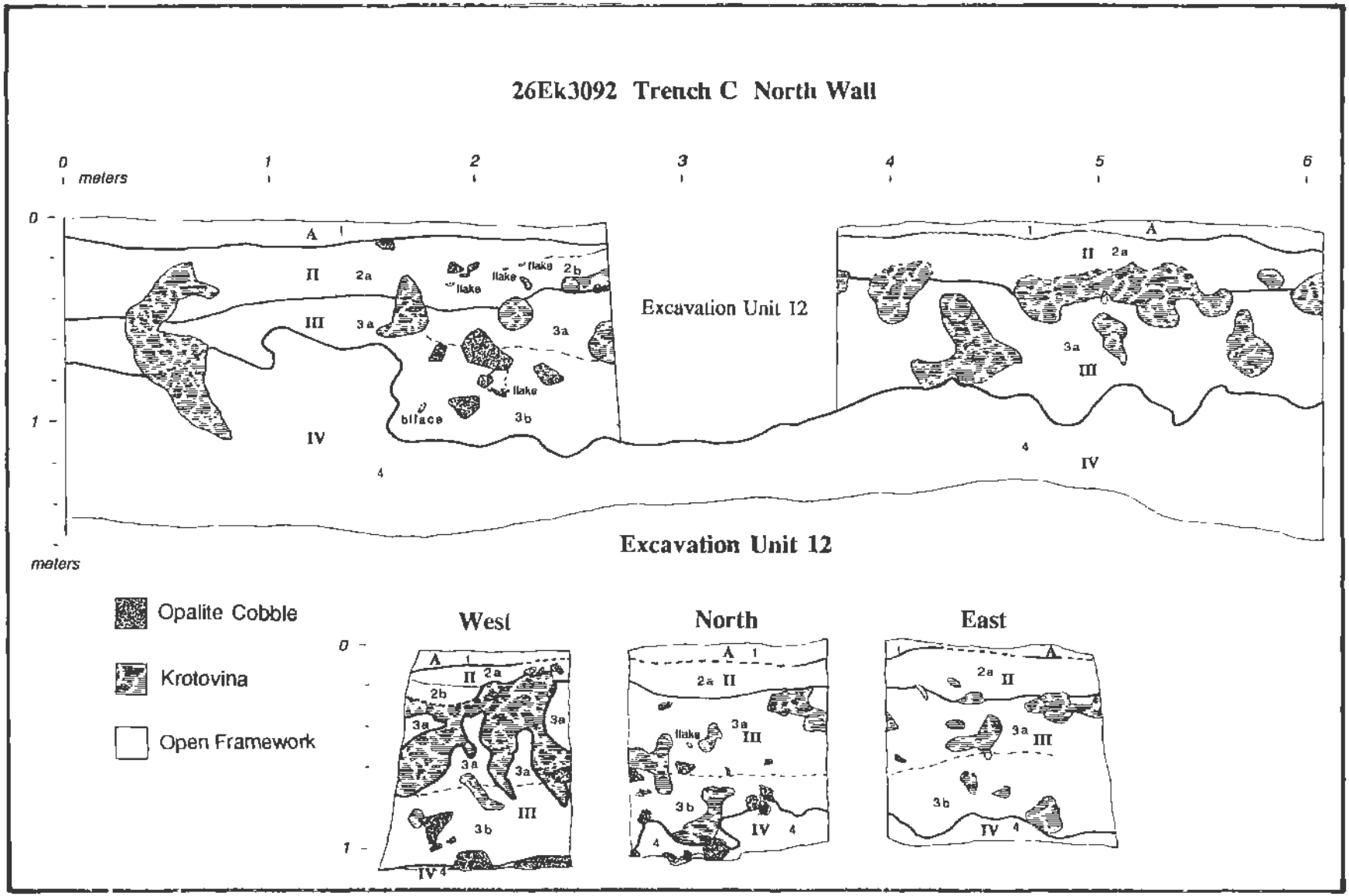
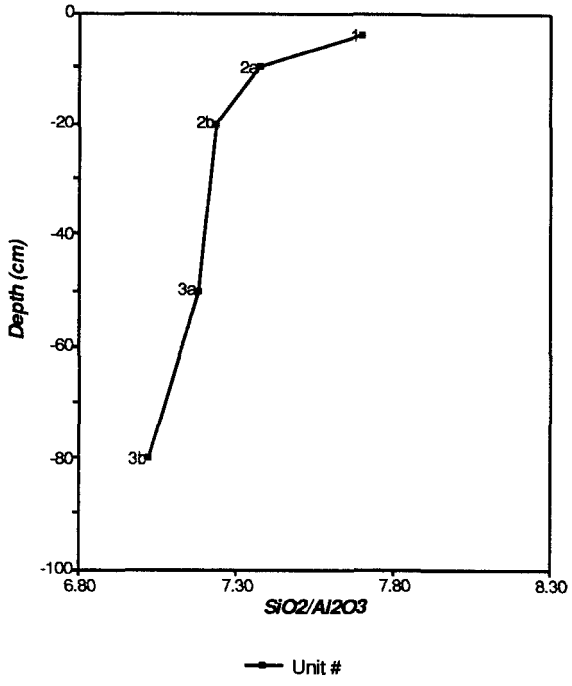


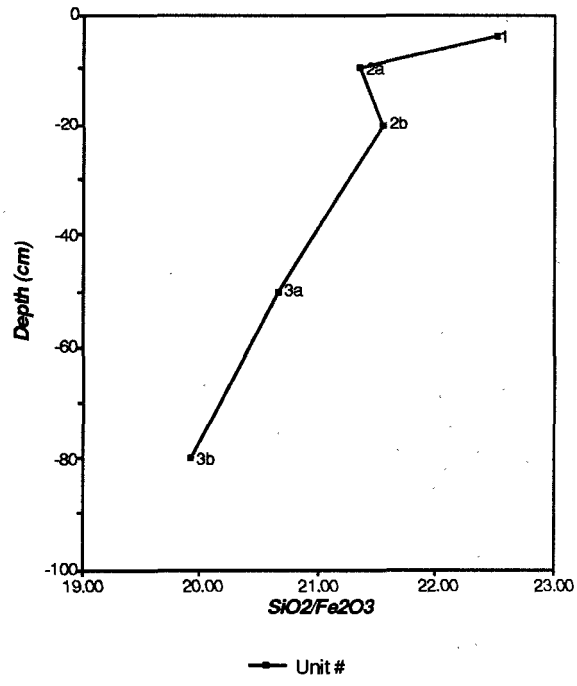
Figure 121. Description of stratigraphic units, Trench C, 26Ek3092.

Figure 121. Description of stratigraphic units, north wall of Trench C, 26Ek3092.

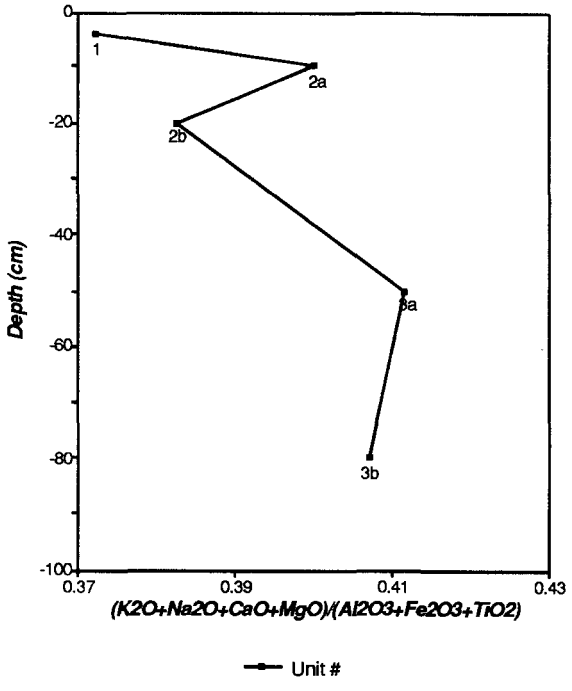
Horizon	Stratum	Description
A	1	Dark brown to very dark brown (10YR 3/3 to 3/2) dry; silt loam; loose to weak fine granular to weak fine platy; abundant fine to medium roots and abundant dry organics at surface; rare randomly distributed fine and medium opalite flakes and rare commonly subhorizontal opalite flakes along bottom of unit at boundary; boundary clear and smooth.
II	2a	Dark brown (10YR 3/3) dry; silt loam; loose to weak medium subangular blocky; common medium subangular to subrounded pebbles; abundant fine to medium roots, common krotovina; rare commonly subhorizontal fine to medium opalite flakes; flakes suggest additional unrecognizable boundaries within this unit; boundary diffuse to clear and irregular.
	2b	Dark grayish brown (10YR 4/2) dry; silt loam; moderately hard, no apparent structure; common fine to medium roots; distinct fine rounded pebble and fine flake lenses along lower boundary with Unit 2c.
	2c	Very dark grayish brown to very dark brown (10YR 3/2 to 2/2) dry; silt loam; loose to moderately compact, no apparent structure; common fine subangular pebbles; common fine roots; rare fine to medium opalite flakes; abundant charcoal flecks; this unit is possibly part of a krotovina.
III	3a	Very dark grayish brown to very dark brown (10YR 3/2 to 3/3) dry; silty clay loam to silt loam; loose to weak fine subangular blocky; common fine to medium subangular to subrounded pebbles; common fine roots, abundant krotovina; boundary with Unit 4 abrupt and irregular, boundary with Unit 3b clear and smooth.
	3b	Same as Unit 3 except sediment is weakly cemented with carbonate, slightly stronger carbonate accumulation is apparent on the upper surfaces of the larger stones in this unit, weak acid reaction; boundary abrupt and irregular.
IV	4	Strong brown to dark brown (7.5YR 5/6, 4/6, 4/4) dry; clast supported to matrix supported, matrix is hard, fine to coarse subrounded sand with clay, and fine subangular to subrounded pebbles to subangular to subrounded cobbles up to 20 cm, poorly defined coarsening of clasts downward in unit; the surface of this unit appears to have been highly eroded and also possibly burrowed in places.



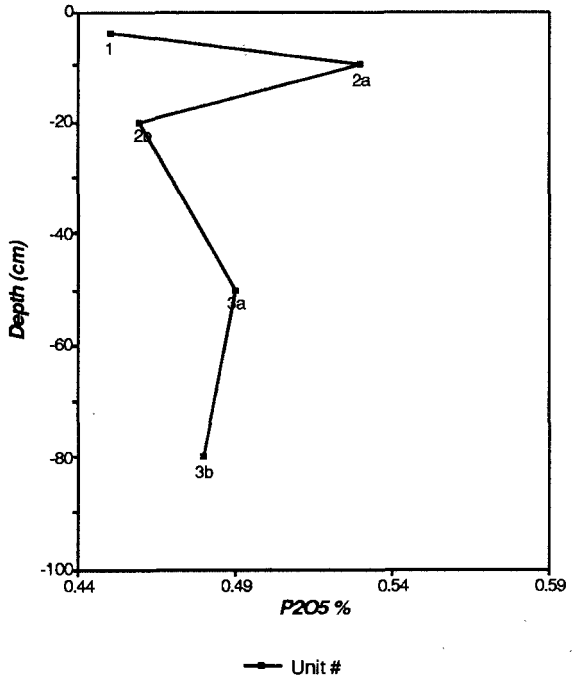
a.



b.



c.



d.

Figure 122. Molecular weathering ratios for 26Ek3092, Trench C, profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

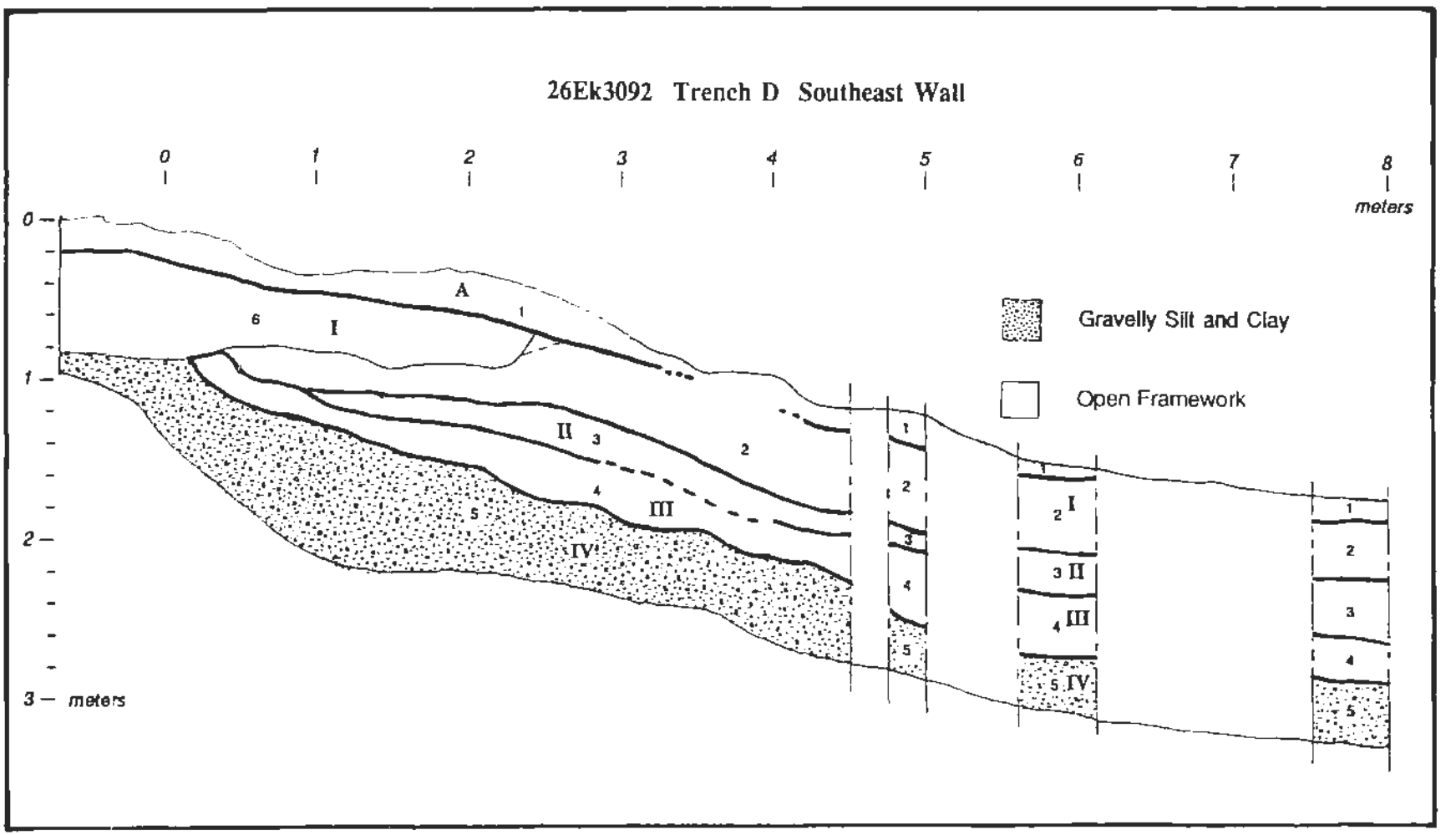
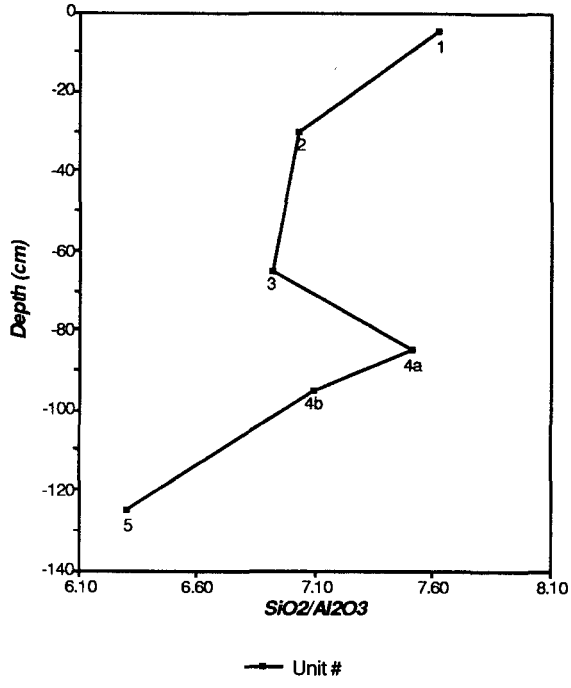


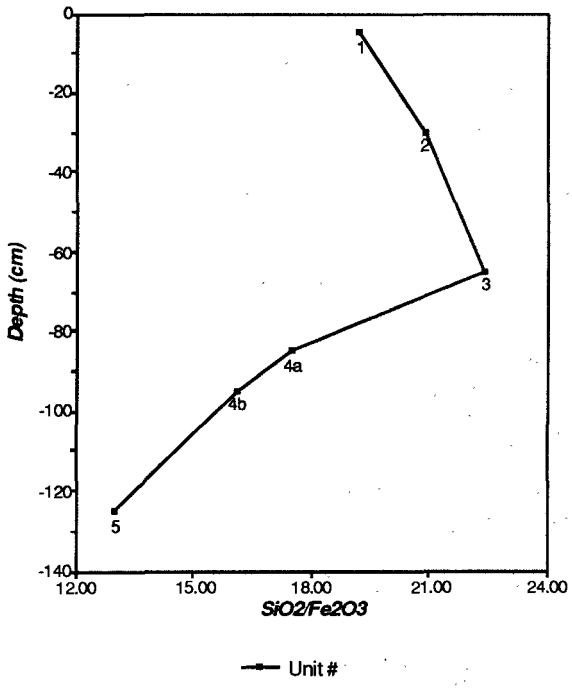
Figure 123. Description of stratigraphic units, Trench D, 26Ek3092.

Figure 123. Description of stratigraphic units, southeast wall of Trench D, 26Ek3092.

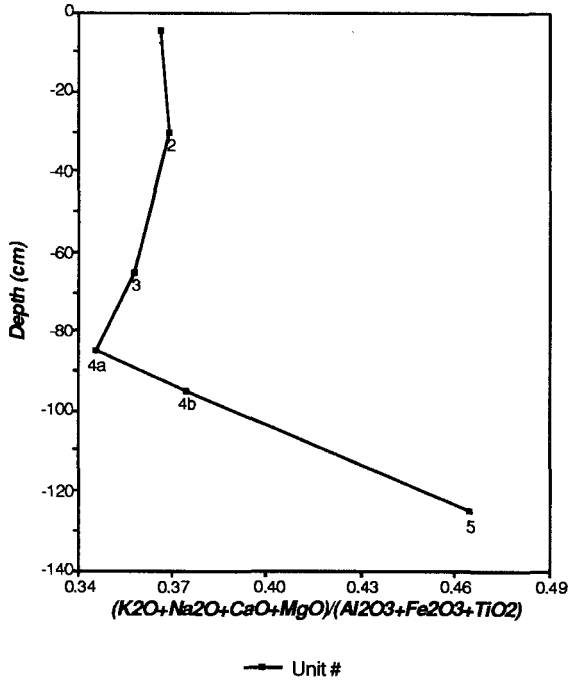
Horizon	Stratum	Description
A	1	Grayish brown (10YR 5/2) dry; silt loam; loose to weak fine granular to weak fine platy; common fine to medium subangular to subrounded pebbles; abundant fine and common medium roots; boundary clear and wavy over Unit 2, abrupt and irregular over Unit 6.
II	2	Dark yellowish brown (10YR 4/2) slightly moist; silty clay; weak fine subangular blocky; rare to common fine to medium subangular to subrounded pebbles; common fine roots and pores; common clay skins on ped surfaces; boundary clear and smooth.
	2b	Dark brown (10YR 3/3) moist; silty clay loam; loose to moderate fine granular to moderate fine subangular blocky; common fine to medium subangular to subrounded pebbles; abundant fine roots and pores; common clay skins on ped surfaces; boundary clear and smooth.
III	3a	Dark brown (10YR 4/3) moist; weakly mottled dark yellowish brown (10YR 4/4) moist; silty clay loam; weak to moderate fine subangular blocky; common fine to medium subangular blocky subangular to subrounded pebbles; poor clay skins on ped surfaces; contact clear and smooth.
IV	4	Dark brown (10YR 3/4) moist; silty clay loam; loose to weak fine subangular blocky; abundant to common fine to medium subangular to subrounded pebbles; common fine roots and pores; boundary abrupt and irregular.
V?	5	Strong brown (7.5YR 5/6 to 4/6) moist; matrix supported; clasts coarsening downward from fine subangular to subrounded pebbles to angular to rounded cobbles up to 30cm, matrix of clay to fine sand; poor to moderate carbonate accumulation as veins, pebble coatings and incipient angular nodules in clayey matrix; upper surface of this unit appears to be erosional; boundary unexposed.
	6	Strong brown (7.5YR 4/6) moist; sandy clay; strong medium prismatic peds; common fine to medium subangular sand; clays appear to be reworked from upslope, especially in the southwestern-most part of this unit; moderate to strong acid reaction on carbonate accumulation occurring on ped faces and as incipient nodules near lower boundary of this unit; boundary abrupt and slightly irregular.



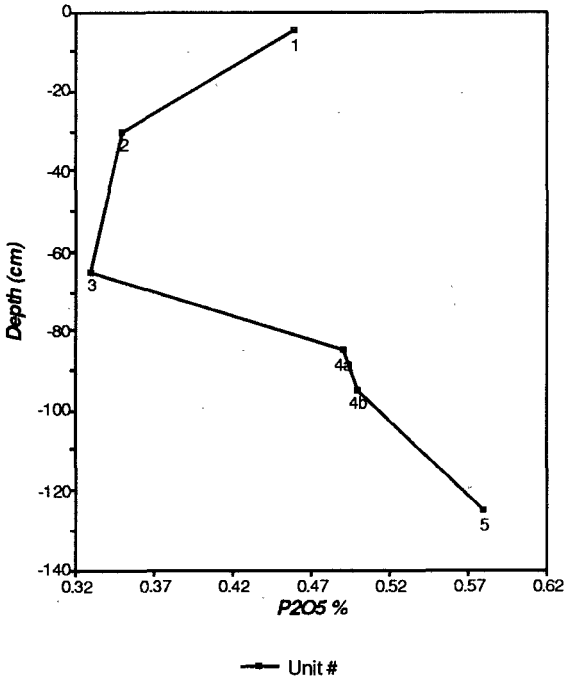
a.



b.



c.



d.

Figure 124. Molecular weathering ratios for 26Ek3092, Trench D, profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

This suggests a former soil surface at this level. This may be equivalent to the Horizon IV surface noted in Trench A, thus implying that Unit 5 in Trench D is indeed part of the hypothesized Horizon V. The strong weathering of pebbles in Unit 5 and the degree of carbonate deposition also indicate a relatively old age.

Excavation Unit 35 (Figure 125) provided a good example of sediments on the lowest, most recent stream terrace adjacent to the modern alluvial channel. The profile was similar to Trench 1 except for an isolated pebble lens with silty clay matrix. This excavation, like Trench 1, also has loamy sediments of Horizon A. Horizons II and III also are present. The weathered gravels of Horizon IV were not encountered. Molecular weathering ratios for sediments in this excavation show an interesting change in trends beginning with Unit 4 (Figure 126). There appears to be increased leaching and phosphorus content starting here. This may be the product of former surface weathering in these sediments, or of bioturbation.

In summary, trench profiles at 26Ek3092 illustrate a history of alternating episodes of stream activity, slopewash, and stable surfaces. Horizons V and IV consist of weathered alluvial gravel and pebble deposits, probably of Pleistocene age. Erosion has truncated both horizons. The more recent irregular surface on Horizon IV gravels possibly occurred during a mid-Holocene erosional cycle that stripped Mazama ash from the area, as no evidence of it was found at the site. Horizons III, II, and I are part of later Holocene depositional episodes in which finer grained materials of alluvial, colluvial, and eolian origin predominated. The low terrace features recognized in the surface topography at the site are constructed of these finer sediments.

Summary

26Ek3092 contributes importantly to our understanding of residentiality peripheral to the Quarries. Activity area surfaces, residential features, refuse zones, food remains, and intense reduction loci shed light on both subsistence and technological energetics (cf. Chapters 10, 14, and 26). This Basalt Canyon terrace system was a singularly attractive place for short-term settlement. The co-occurrence of edible plants (both here and within easy reach on Bitterroot Ridge), potable water, and good game habitat is rare in the Tosawihi uplands (cf. Chapter 25). This quality made 26Ek3092 a particularly desireable resting place, and its proximity to the Quarries one of the more convenient campsites for groups who required an extended stay (high-quality toolstone sources are within relatively easy walking distance).

The place afforded multiple opportunities, including places for food gathering, food processing, food preparation, raw material heat treatment, tool manufacture, and maintenance. Many of these activities centered around a notable piece of "site furniture," the massive boulder situated on the upper terrace. The boulder activity area attracted intensive use, probably over several millennia. Indeed, this site is one of the few in our study area exhibiting such persistent spatial structure.

Seventy-three percent (n=16) of the classifiable projectile points date to Rosegate times and later, suggesting increased activity after 1250 B.P. This accords well with data from other sites around the Tosawihi Quarries which indicate Late Archaic intensification of use (cf. Chapter 19). More locally, the Fremont sherds and late projectile points recovered at 26Ek3092 fall within the radiocarbon date range recorded in the extraction pit at 26Ek3208. This temporal element, and the appearance in the debitage collection of jasper-like opalite, suggest a functional relationship between this campsite and quarrying at 26Ek3084 and 26Ek3208 (Intermountain Research 1988b:53).

26Ek3092 is one of the few places at Tosawihi that contain deep sedimentary deposits exhibiting multiple depositional forces. Extensive erosion and gullying, and alternating episodes of stream activity, slopewash, and stability have produced a complex sedimentary record, informative of past geomorphologic regimes.

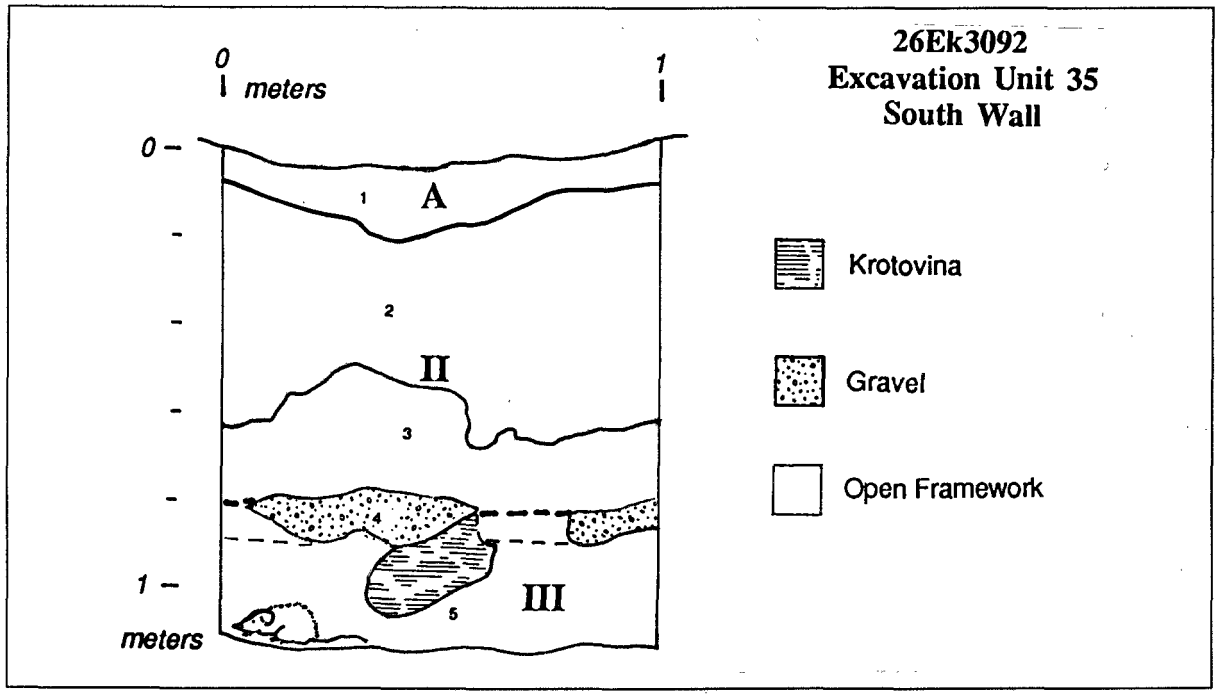
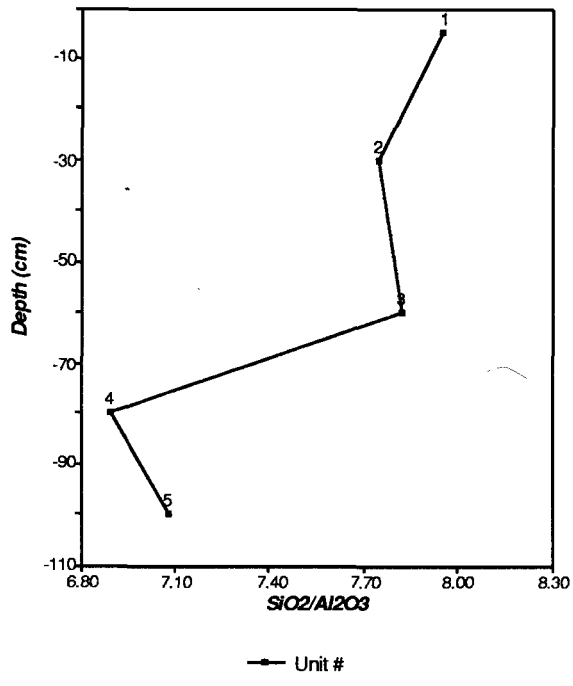
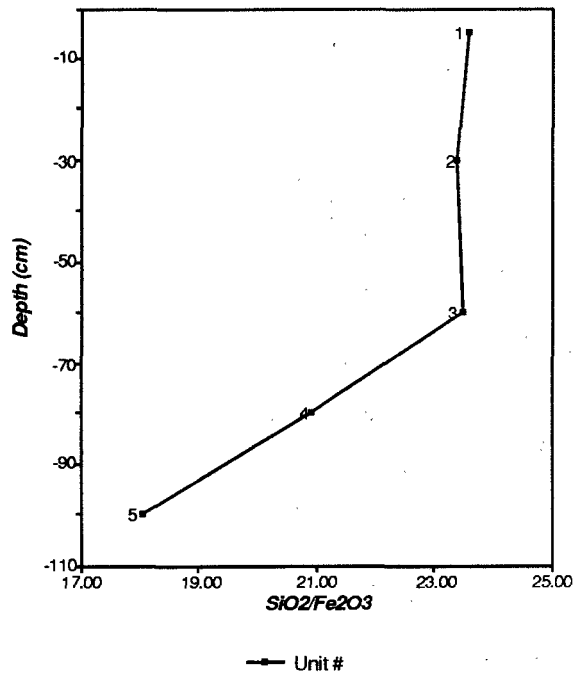


Figure 125. Description of stratigraphic units, Excavation Unit 35, 26Ek3092.

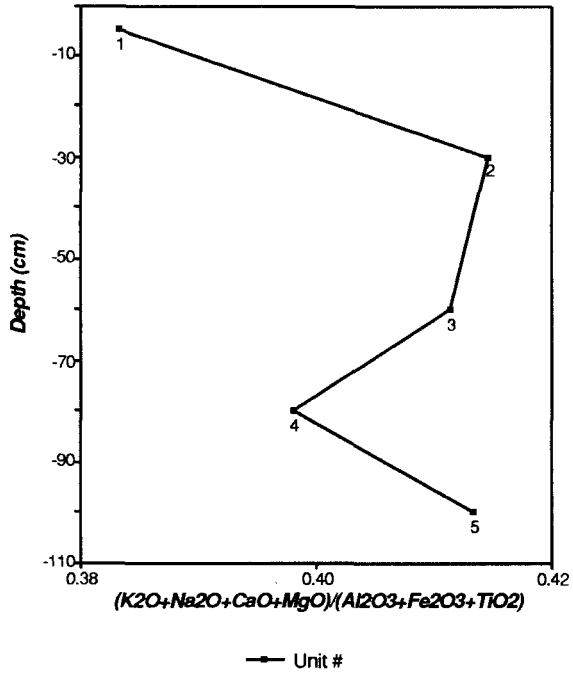
Horizon	Stratum	Description
A	1	Grayish brown (10YR 5/2) dry; silt loam; loose to weak, fine granular to fine platy; common fine to medium subangular to subrounded pebbles; common fine roots; boundary clear and smooth.
II	2	Dark grayish brown (10YR 4/2) dry; silty clay loam; weak to moderately strong, medium subangular blocky; common fine to medium subangular to subrounded pebbles; abundant fine roots and pores with common earthworm castings; moderate acid reaction on carbonate veins and pebble coatings; boundary abrupt and irregular.
	3	Very dark grayish brown (10YR 3/2) dry; silty clay loam; loose to weak medium subangular blocky; common fine to medium subangular to subrounded pebbles; abundant fine roots and pores, common earthworm castings, common rodent burrows; rare to common poor clay skins in pores; very weak acid reaction; boundary abrupt and irregular.
III	4	Strong brown (7.5YR 4/6) moist; clast supported fine to medium subangular pebbles in a matrix of silty clay; abundant burrows disrupting unit; boundary abrupt and irregular.
	5	Strong brown (7.5 YR 4/6) moist; sandy clay with rare to common medium subangular to subrounded pebbles; very weak subangular blocky; common fine roots; boundary unexposed.



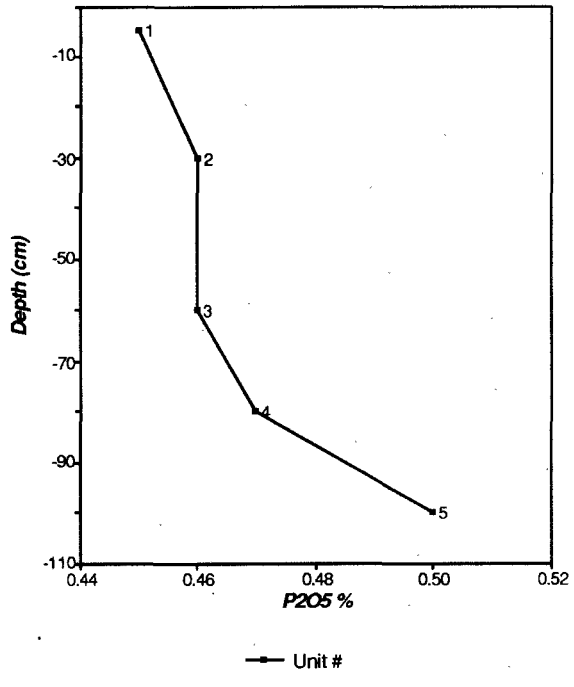
a.



b.



c.



d.

Figure 126. Molecular weathering ratios for 26Ek3092, Excavation Unit 35, profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

26Ek3093

Reduction complex 26Ek3093, situated on the extreme southeast edge of a knoll in the Bitterroot Ridge Complex, encompasses a sparse debitage scatter (covering over 1,800 m^2) surrounding six discrete reduction features (Figure 127). We intensively sampled Feature 4 with a 7 m x 7 m block of contiguous, 2 cm deep surface scrapes (Figure 127). This enabled complete collection of all surface artifacts in the feature, and exposed an irregular ashy stain upon which we placed a 1 m x .5 m excavation unit. This phenomenon appears to be a small, unlined hearth—now considerably deflated by exposure—around which small-scale tool maintenance and processing took place (Budy 1989:222).

Our surface collections (from both feature and nonfeature contexts) yielded opalite and (rare) obsidian debitage, two projectile points, six point preforms, 38 bifaces, two cores, a multi-purpose chopping tool, a pointed flake tool, and retouched flakes (cf. Budy 1989). A Large Side-notched projectile point, which typically predates A.D. 1300 (Thomas 1981), was found in Feature 5, a large, two-lobed debitage scatter lying on a relatively steep slope below Feature 4.

The multi-purpose assemblage and probable hearth indicate a diverse, possibly domestic, activity at this site.

26Ek3095

On the north and east-facing slopes of Basalt Canyon lie 25 feature clusters comprising reduction/residential complex 26Ek3095. Here, prehistoric activity converged on a narrow bench, leaving distinct concentrations of debitage and formed tools, and relatively large numbers of millingstones (Figure 128). Bedrock rests very close to the surface; cultural deposits are, as a consequence, vertically limited. Nevertheless, the distinctive horizontal array of surface features here informs about prehistoric activity organization, and the diversity of millingstones and reduction debitage suggests a variety of prehistoric subsistence and tool production pursuits.

Vegetation presently is dominated by big sagebrush and lupine, but before grazing, this thinly-mantled ridgetop should have been an attractive place for gathering edible tubers. No permanent water sources surface nearby, but ephemeral pools sometimes collect in the lower reaches of Basalt Canyon.

The 25 features consist of fairly discrete activity zones. These include four loci containing profuse lithic debris and plant processing equipment, one large eroded tool scatter, one cache of bifaces, and 19 lithic reduction areas. Material types encountered in reduction features are dominated by opalite (99.7%), with trace frequencies of obsidian, basalt, quartzite, and rhyolite.

Excavation Methods and Rationale

Because bedrock restricts the depth of soils and the potential for buried cultural remains seemed limited, we focused our efforts on identifying surface artifact configurations, conducting limited subsurface testing only in certain features and depositional contexts. Six feature concentrations (Features 6, 10, 15, 19, 22, and 24) were deemed representative of feature variability across the site (small lithic scatters, tool aggregations, millingstone clusters, and biface caches), and were sampled by systematic surface scrapes and subsurface excavations. Surrounding surface artifacts were plotted and collected. The remaining 19 features were inventoried, mapped, and collected of formed artifacts.

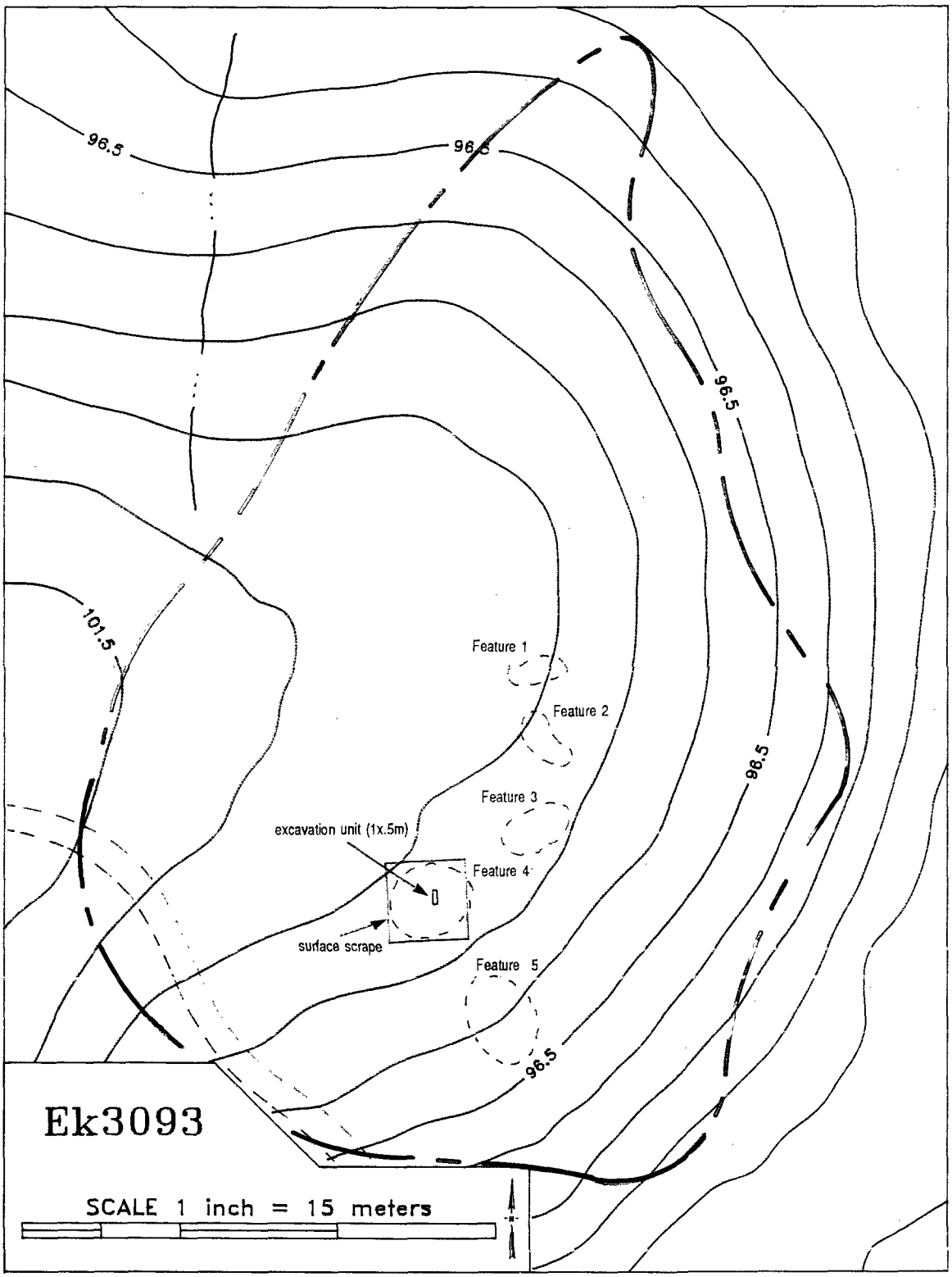


Figure 127. 26Ek3093 site map.

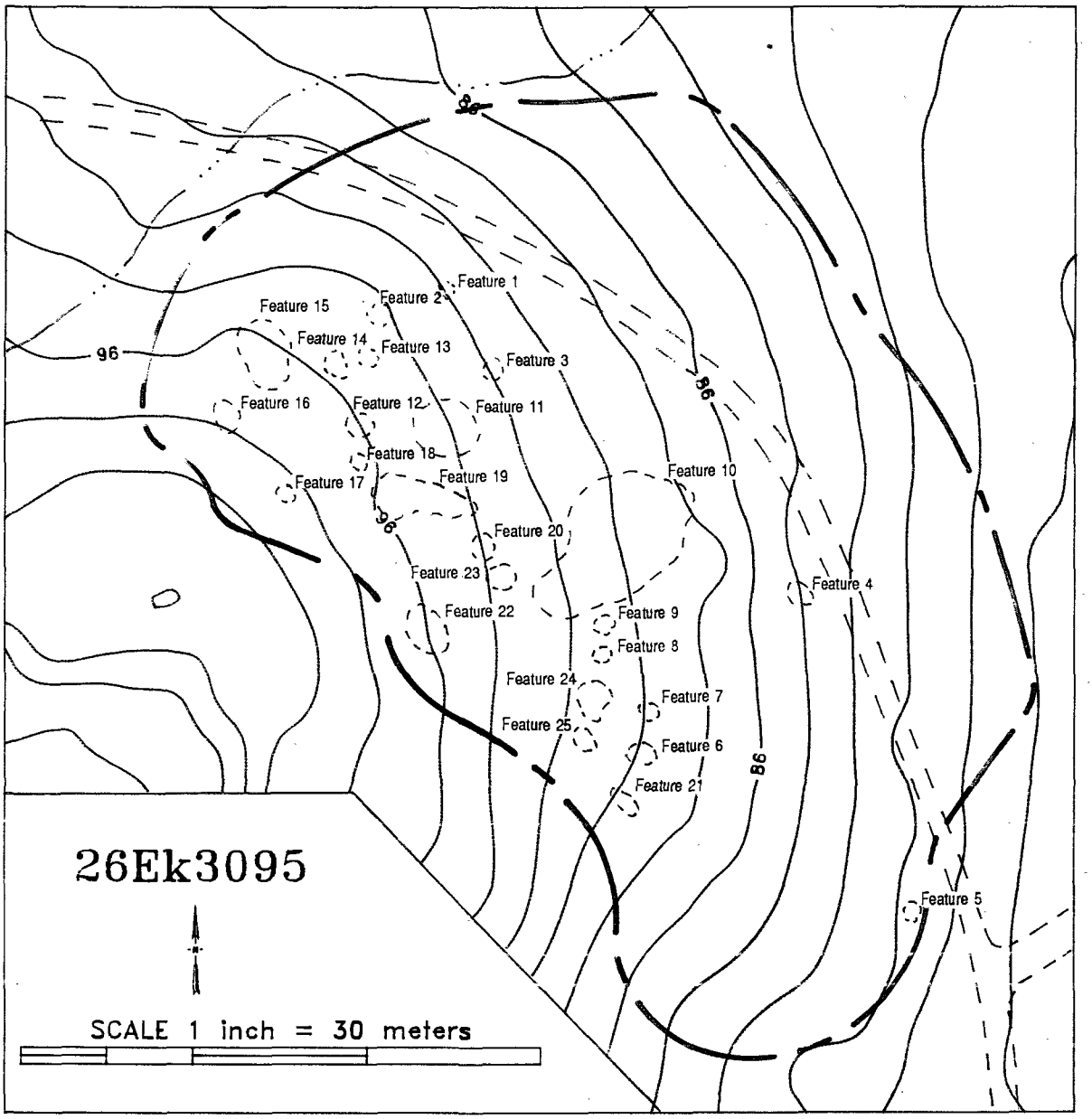


Figure 128. 26Ek3095 site map.

Nonfeature Contexts

The site was surveyed intensively for diagnostic artifacts beyond the boundaries of defined features. Dozens of formed artifacts were mapped and collected in extra-feature areas during testing and data recovery. We recovered numerous bifaces (73), several scrapers and retouched flakes (4), metate fragments (3) and a pestle, Rosegate (2) and Gatecliff (2) projectile points, a hammerstone, a scratched stone, a chopper, and a core. No additional collection strategies were employed in non-feature areas.

Inventoried Features

The features inventoried, but not excavated further, consist of lithic reduction stations (Features 1–5, 7–9, 11–14, 16–18, 20, 21, and 23) and an apparently functionally complex locus (Feature 25). The reduction stations tend to be rather small, averaging less than 24 m^2. Indeed, ten of these may represent the remains of single lithic reduction episodes, being restricted to less than 11 m^2 in area. The assemblages are dominated by debitage and bifaces, with infrequent cores, percussion tools, modified chunks, and flake tools (Table 130). Time markers include Cottonwood, Elko, and Gatecliff points.

Table 130. Summary of Formed Artifacts Collected from Inventoried Features at 26Ek3095.

Feature	Area (m^2)	Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Total
1	5	-	-	-	-	-	-	-	0
2	7	-	-	4	-	-	-	-	4
3	7	-	-	6	1	-	-	-	7
4	7	-	-	1	-	-	-	-	1
5	48	-	-	10	1	-	1	-	12
7	28	1	-	7[a]	-	-	-	-	8
8	10	-	-	3	-	-	-	-	3
9	11	1	-	5	1	-	-	-	7
11	24	1	1	6	2	-	1	-	11
12	11	-	-	4	-	-	-	-	4
13	54	-	-	10	-	-	1	-	11
14	20	1	-	-	-	1	2	-	4
16	42	2	1	3	1	-	-	-	7
17	24	-	-	1	-	-	-	-	1
20	50	-	-	7	1	-	-	-	8
21	3	-	-	1	-	-	-	-	1
23	5	-	-	1	-	-	-	-	1
25	9	-	-	2	1	-	-	1	4
Totals		6	2	71	8	1	5	1	94

[a]Includes one "possible" biface

Feature 25 consists of a small cluster of metate fragments and several specialized tools, incorporated into a dense scatter of reduction debris. The presence of plant processing equipment and the spatially-restricted nature of the lithic scatter imply a short-term residential stay in conjunction with a tool production episode.

Feature 6

This 78 m^2 reduction feature was selected at random from our sample of reduction loci for focused data recovery. We excavated ten 1 m x 1 m units in this moderately dense debris scatter of mostly good-quality pink and white opalite. Six units were placed at two meter intervals along the long axis and parallel to the slope. Four more units were offset 1 m from this transect, two to each side, to sample the breadth of the feature. Rare obsidian debitage, primarily Stage 3 (n=12) and Stage 4 (n=4) bifaces, a modified chunk, a scraper, two retouched flakes, and a Gatecliff projectile point were recovered from the shallow deposits (Table 131). While the recovered bifaces indicate mid to late stage production, the debitage assemblage reflects the entire continuum of biface reduction (Appendix C, Table 1; W. Bloomer, personal communication).

Table 131. Summary of Artifacts Collected from Feature 6, 26Ek3095.

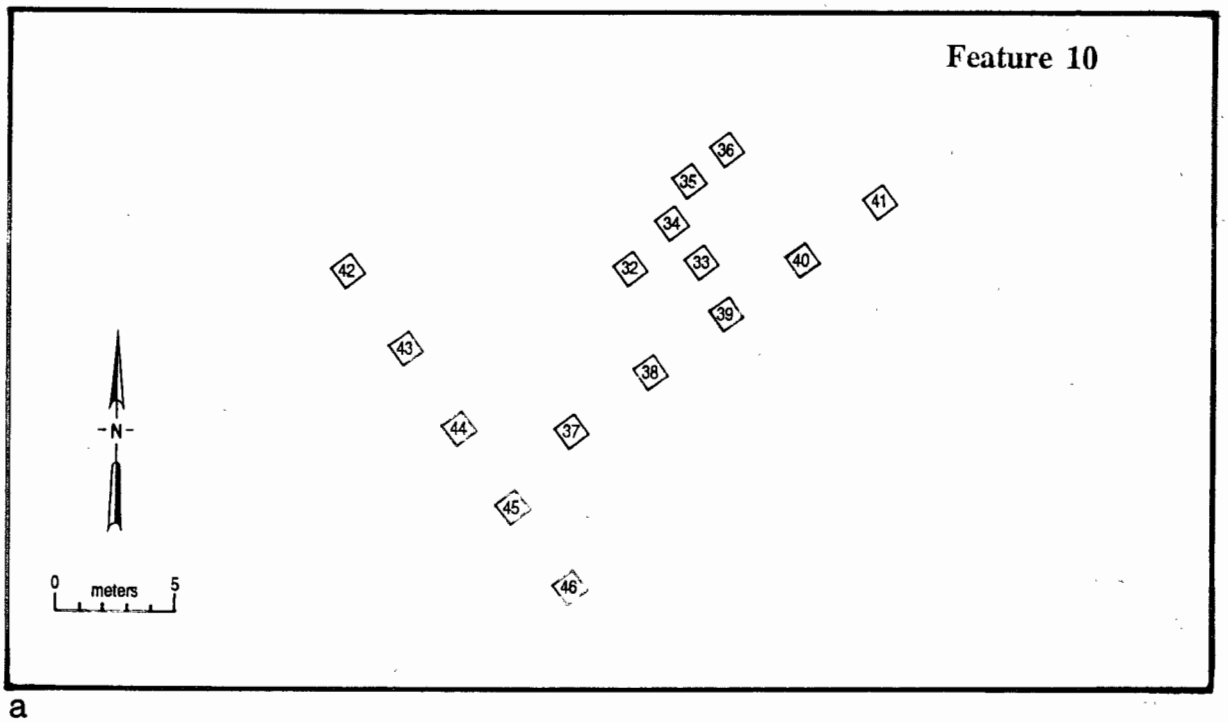
		DEBITAGE		FORMED ARTIFACTS				
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Bifaces	Flake Tools	Modif. Chunks	Total
47 (EU)	0.10	431	405.3	-	-	-	-	0
48 (EU)	0.20	1,481	1,634.6	-	6[a]	-	-	6
49 (EU)	0.10	817	743.1	-	1	1	-	2
50 (EU)	0.10	458	503.6	-	2	1	-	3
51 (EU)	0.10	369	404.1	-	1	1	-	2
52 (EU)	0.10	87	148.4	1	-	-	-	1
53 (EU)	0.10	109	76.3	-	-	-	-	0
54 (EU)	0.10	344	208.1	-	1	-	-	1
55 (EU)	0.10	106	55.2	-	-	-	-	0
56 (EU)	0.20	543	454.8	-	-	-	-	0
Surface	N/A	2	2.9	-	9	-	1	10
Totals	1.2	4,747	4,636.4	1	20	3	1	25

(EU) = Excavation Unit
[a]Includes one "possible" biface

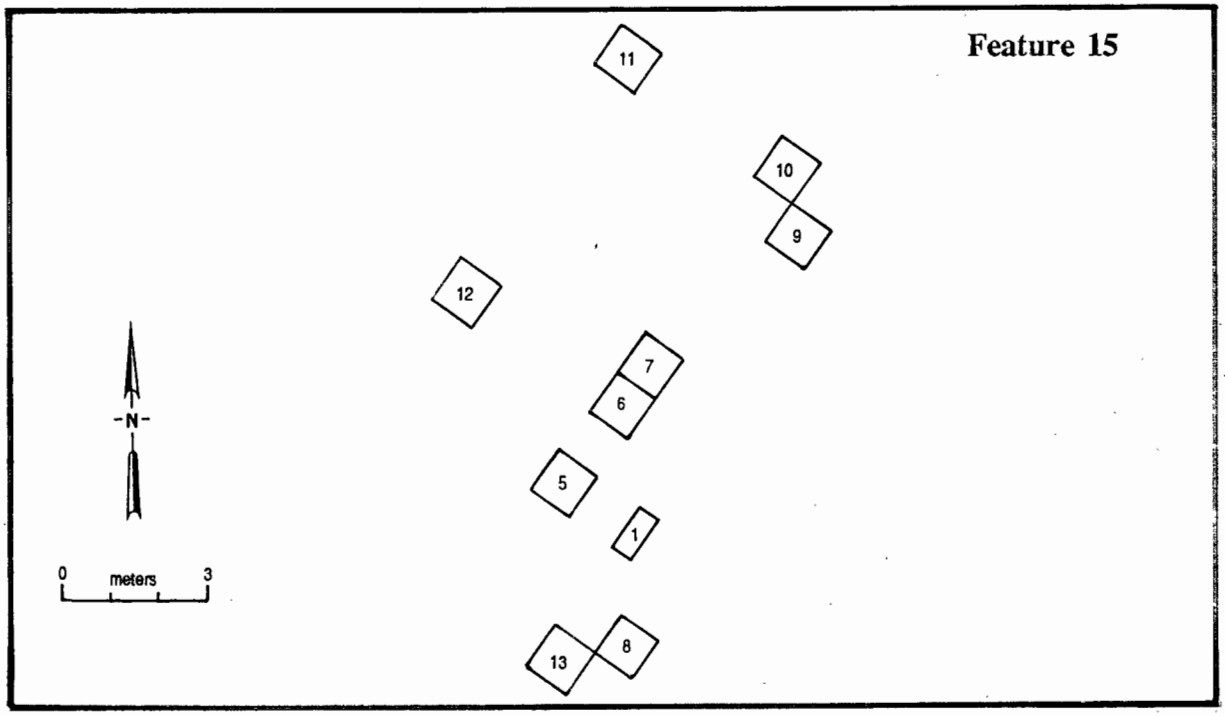
Feature 10

Feature 10 is the largest feature at the site (cf. Figure 128). This eroded scatter is sparsely littered with opalite and rarer obsidian debitage, but is marked by two lithic concentrations and abundant formed artifacts, including projectile points, preforms, numerous bifaces (dominated by Stage 3 and 4 forms), retouched flakes and pointed flake tools, and a single mano (Figure 129a).

We placed a transect of 12 regularly spaced, 25 cm x 25 cm surface scrapes parallel to the slope and through the densest tool array, and excavated five 1 m x 1 m units (EUs 37-41) leading off the north side of the transect (cf. Figure 129a). We also investigated the small bench above the scatter with a series of five units placed perpendicular to the slope, aimed at locating potential buried features that might have served as the source for the downslope array of tools. These units (EUs 42-46) provided smaller debitage yields than the downslope units; no subsurface features were encountered (Table 132). We sampled the reduction concentrations in the northern, downslope portion of the feature with EUs 32-36, recovering higher densities of debitage than from other units. This is accounted for by the use of finer screen mesh in 50 cm x 50 cm control quadrants, and by inevitable slopewash of surface artifacts.



a



b

Figure 129. 26Ek3095. a. Feature 10 plan; b. Feature 15 plan.

Table 132. Summary of Artifacts Collected from Feature 10, 26Ek3095.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
1 (SF)	0.00125	4	4.1	-	-	-	-	-	-	0
2 (SF)	0.00125	7	4.9	-	-	-	-	-	-	0
3 (SF)	0.00125	8	16.6	-	-	-	-	-	-	0
4 (SF)	0.00125	6	4.6	-	-	-	-	-	-	0
5 (SF)	0.00125	9	4.7	-	-	-	-	-	-	0
6 (SF)	0.00125	1	0.3	-	-	-	-	-	-	0
7 (SF)	0.00125	9	8.2	-	-	-	-	-	-	0
8 (SF)	0.00125	3	0.9	-	-	-	-	-	-	0
9 (SF)	0.00125	15	13.7	-	-	-	1	-	-	1
10 (SF)	0.00125	8	6.3	-	-	-	-	-	-	0
11 (SF)	0.00125	7	7.3	-	-	1	-	-	-	1
12 (SF)	0.00125	3	0.7	-	-	-	-	-	-	0
32 (EU)	0.10000	343	575.2	-	-	3	-	-	-	3
33 (EU)[a]	0.20000	1,013	1,478.5	-	1	5	-	-	-	6
34 (EU)	0.20000	672	723.9	-	-	-	-	-	-	0
35 (EU)[a]	0.20000	1,326	2,318.6	-	-	2	-	-	-	2
36 (EU)	0.20000	177	195.9	-	-	-	-	-	-	0
37 (EU)	0.20000	214	295.4	-	1	3	-	-	-	4
38 (EU)	0.20000	181	178.1	-	-	-	1	1	-	2
39 (EU)	0.10000	375	322.7	-	-	2[b]	-	-	-	2
40 (EU)	0.20000	596	431.2	-	-	-	2	-	-	2
41 (EU)	0.10000	69	50.9	-	-	1	-	-	-	1
42 (EU)	0.20000	46	33.4	-	-	-	1	-	-	1
43 (EU)	0.20000	180	315.9	-	-	3[b]	-	-	-	3
44 (EU)	0.30000	465	526.6	-	-	4	-	-	-	4
45 (EU)	0.30000	351	414.3	1	1	8	2	-	-	12
46 (EU)	0.20000	426	612.5	-	-	2[b]	-	-	-	2
Surface	N/A	23	344.0	6	5	52	7	-	1	71
Totals	2.9150	6,537	8,889.4	7	8	86	14	1	1	117

(SF) = Surface Scrape
(EU) = Excavation Unit

[a]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[b]Includes one "possible" biface

The highest density and widest variety of tools were recovered during intensive surface inventory. During excavation, platy tabular basalt bedrock usually was encountered within 20 cm. No subsurface features were observed, hence we conclude that Feature 10 is primarily a surface manifestation and not a secondarily deposited tool feature. We recovered several classifiable projectile points from the Desert and Elko series, suggesting occupation between 1300 B.C. and historic times.

Feature 15

Feature 15 resides on a flat bench at the northwest margin of the site (cf. Figure 128). The material remains of both seed-processing and biface reduction activities are represented abundantly, suggesting a residential component. Characterized by a cluster of metate fragments (comprising at least four different millingstones) and other specialized tools, in at least two moderately dense concentrations of biface reduction debris, the feature spans 48 m^2. A variety of materials compose the debitage, including pink and white opalite and lesser amounts of obsidian.

We centered a 3 m x 4 m surface scrape sample block and a shallow 1 m x .5 m excavation unit on the cluster of groundstone fragments (cf. Figure 129b). We then excavated

nine additional 1 m x 1 m units, six placed randomly inside the surface concentration to sample the region of the metate cluster and the surrounding flake scatter, and three (also randomly placed) at the perimeter of the feature.

Though we detected no subsurface residential features, our recovery of multiple groundstone fragments and a variety of formed artifacts including Cottonwood (2) and Rosegate (1) projectile points, a point preform, numerous Stage 3 and 4 bifaces (Appendix C, Table 1), several retouched flakes, a hammerstone, a core, and a heavily used sandstone shaft abrader lends credence to our initial assumption of short-term residential use (Table 133).

Table 133. Summary of Artifacts Collected from Feature 15, 26Ek3095.

		DEBITAGE		FORMED ARTIFACTS								
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Perc./ Cobble Tools	Ground Stone	Other/ Exotic	Total
1 (SF)	0.02	131	118.5	-	-	1	-	-	-	-	-	1
2 (SF)	0.02	154	259.3	-	-	3	-	-	-	-	-	3
3 (SF)	0.02	265	278.5	-	-	-	-	-	-	1	-	1
4 (SF)	0.02	293	346.1	-	-	3	-	-	-	-	-	3
5 (SF)	0.02	95	78.4	-	-	-	1	-	-	-	1	2
6 (SF)	0.02	904	659.8	-	-	1	-	-	-	-	-	1
7 (SF)	0.02	709	660.0	-	-	1	-	-	-	-	-	1
8 (SF)	0.02	436	316.1	-	-	1	-	-	-	-	-	1
9 (SF)	0.02	651	581.8	-	-	2	-	2	-	1	-	5
10 (SF)	0.02	465	574.3	-	-	3	-	-	-	-	-	3
11 (SF)	0.02	203	121.8	-	-	-	-	-	-	-	-	0
12/1 (TS)[a]	0.11	912	461.0	1	1	5	-	1	-	1	-	9
5 (EU)	0.18	551	471.6	1	-	4[c]	-	-	-	-	-	5
6 (EU)	0.28	696	1,283.9	1	-	5	-	-	-	-	-	6
7 (EU)	0.28	799	779.5	1	-	7	-	-	-	-	-	8
8 (EU)	0.20	115	99.4	-	-	2	-	-	-	-	-	2
9 (EU)[b]	0.20	270	278.9	1	-	3	-	-	-	-	-	4
10 (EU)	0.20	142	148.0	-	-	4	-	1	-	-	-	5
11 (EU)	0.20	59	36.2	-	-	1	-	-	-	-	-	1
12 (EU)[b]	0.20	228	167.9	-	-	2[c]	-	-	-	-	-	2
13 (EU)	0.20	42	37.2	-	-	-	1	-	-	-	-	1
Surface	N/A	-	-	-	-	9	-	1	1	1	-	12
Totals	2.27	8,120	7,758.2	5	1	57	2	5	1	4	1	76

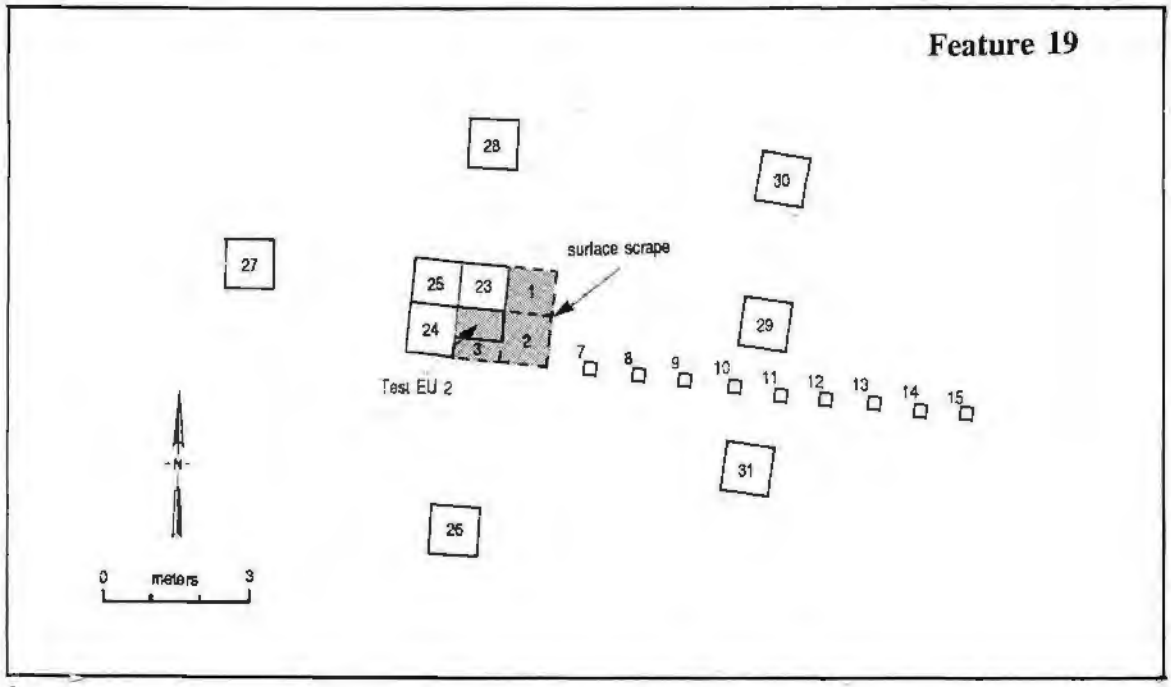
(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Screened through 1/8 inch mesh
[b]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[c]Includes one "possible" biface

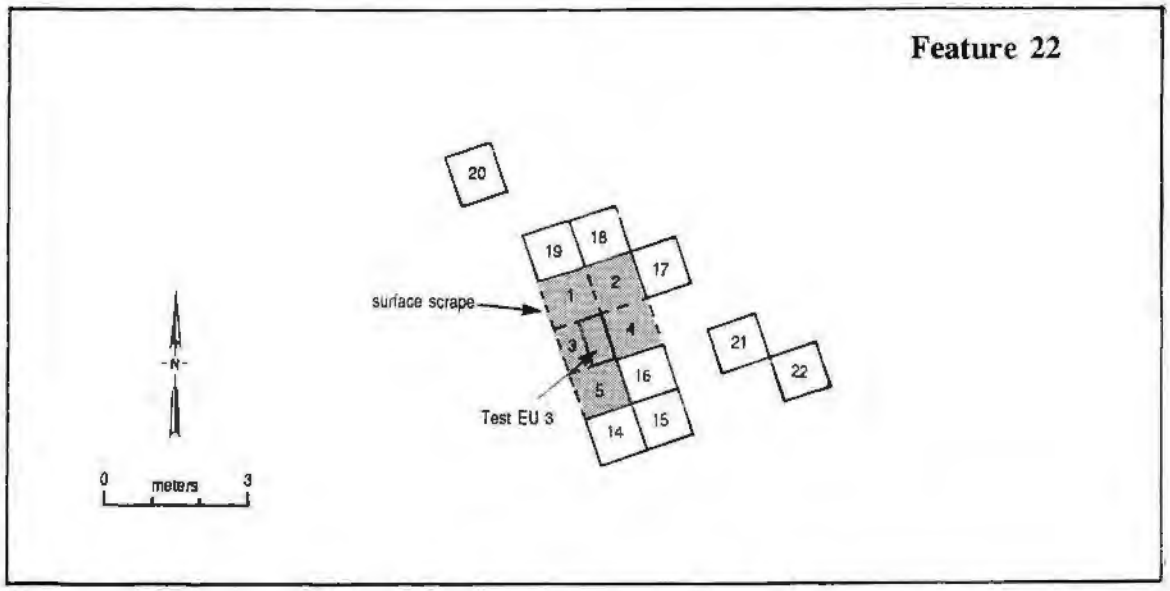
Feature 19

In the west-central portion of the slope, Feature 19 covers 75 square meters and incorporates two discrete lithic concentrations (cf. Figure 128; Figure 130a). A small cluster of metate fragments, a probable hearth, formed tools, and occasional obsidian and basalt flakes highlight the dense scatter of opalite reduction debris that extends downslope from the groundstone cluster. The presence of plant processing equipment and heavily used maintenance tools centered around the hearth suggests a short-term residential character for this portion of the feature. The lithic concentration, with an associated fragmentary projectile point, contains evidence of toolstone reduction only; bifaces and debitage are more widely dispersed suggesting longer exposure of the tool surface than that observed at the hearth (Budy 1989:232).

During testing, we conducted surface inventory and collections, and sampled separately the two loci of debitage (Figure 130a). One 2 m x 3 m block of surface scrapes and a 1 m x .5 m



b



a

Figure 130. 26Ek3095. a. Feature 19 plan; b. Feature 22 plan.

test excavation unit were centered on the hearth/groundstone cluster in Locus 1, and nine 25 cm x 25 cm surface scrapes were located at one meter intervals along the slope through Locus 2. In addition to several metate fragments, a large quantity of debitage, several flake tools, hammerstones, a core, a shaft abrader, a preform, numerous bifaces (mostly Stage 3 and 4), and projectile points (Desert series and an unclassifiable fragment) characterize the assemblages.

In 1989, we returned to Feature 19 to continue subsurface excavations in both loci. At the exposed hearth in the center of Locus 1, and below three earlier surface scrapes, we excavated three new units (EUs 26–28), with one 1/8 inch control, to a depth of 30 cm; we placed three additional units (EUs 23–25) just beyond the perimeter. Lastly, we cross-cut Locus 2 with three excavation units (EUs 29–31) intersecting its midline. Opalite, obsidian, and basalt debitage, Desert Side-notched and fragmentary projectile points, primarily mid- to late stage bifaces, scrapers and other flake tools, a hammerstone, an abrader, and four ground tuff beads were recovered (Table 134). Technological analysis of the debitage from Locus 1 (EUs 24 and 29) posited a relatively late stage biface reduction profile and a heat-treatment rate of over 15% (cf. Chapter 10). Over 35% of the bifaces also were heat-treated (Appendix C, Table 1).

Table 134. Summary of Artifacts Collected from Feature 19, 26Ek3095.

		DEBITAGE		FORMED ARTIFACTS								
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Perc./ Cobble Tools	Ground Stone	Other/ Exotic	Total
1 (SF)	0.02000	783	1,242.7	-	-	2	-	-	-	-	1	3
2 (SF)	0.02000	722	953.4	-	1	-	-	-	-	1	1	3
3 (SF)	0.02000	1,012	1,007.7	-	-	1	1	-	-	-	-	2
4/2 (TS)[a]	0.19500	3,926	2,769.1	1	-	7	1	3	1	-	-	13
5 (SF)	0.02000	638	503.3	-	-	1	-	-	-	-	-	1
6 (SF)	0.02000	450	295.2	-	-	2	-	-	1	-	-	3
7 (SF)	0.00125	45	67.5	-	-	-	-	-	-	-	-	0
8 (SF)	0.00125	56	46.8	-	-	-	-	-	-	-	-	0
9 (SF)	0.00125	76	262.1	-	-	1	-	-	-	-	-	1
10 (SF)	0.00125	66	102.7	-	-	-	-	-	-	-	-	0
11 (SF)	0.00125	86	203.2	-	-	-	-	-	-	-	-	0
12 (SF)	0.00125	43	24.3	-	-	-	-	-	-	-	-	0
13 (SF)	0.00125	40	47.4	-	-	-	-	-	-	-	-	0
14 (SF)	0.00125	28	41.6	-	-	-	-	-	-	-	-	0
15 (SF)	0.00125	1	0.1	-	-	-	-	-	-	-	-	0
23 (EU)	0.28000	1,418	1,433.4	-	-	5	-	1	-	-	-	6
24 (EU)[b]	0.28000	5,761	4,618.7	-	-	11[c]	-	2	-	-	5	18
25 (EU)	0.28000	2,127	2,626.4	-	-	7	-	1	-	-	-	8
26 (EU)	0.20000	71	48.2	-	-	1	-	-	-	-	-	1
27 (EU)[b]	0.20000	75	69.0	-	-	-	-	-	-	-	-	0
28 (EU)	0.20000	150	137.6	-	-	-	-	-	-	-	-	0
29 (EU)[b]	0.20000	2,313	1,494.2	3	-	2	-	-	-	-	-	5
30 (EU)	0.20000	501	655.6	2	-	2	-	-	-	-	-	4
31 (EU)	0.20000	79	53.9	-	-	1	-	-	-	-	-	1
Surface	N/A	7	13.6	1	-	11	1	2	1	1	-	17
Totals	2.34625	20,474	18,717.7	7	1	54	3	9	3	2	7	86

(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Screened through 1/8 inch mesh
[b]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[c]Includes one "possible" biface

Feature 22

This small (approximately 20 m^2) feature incorporates a cluster of fragments from a single basalt metate and other specialized tools in a dense scatter of opalite and obsidian reduction debris (cf. Figure 130b).

To explore its vertical extent and characterize functional diversity, we aligned a 2 m x 4 m surface collection grid along the narrow bench that supported the metate fragments, crosscutting the encircling lithic concentration. We recovered numerous bifaces and a substantial quantity of debitage. We then placed a 1 m x .5 m excavation unit in the obsidian reduction area, encountering bedrock at 30 cm. The cultural materials clustered in the upper 10 cm, with few small opalite flakes appearing deeper. Tests recovered opalite debitage, several dozen obsidian and rare basalt flakes, biface fragments, and a pointed flake tool.

Data recovery was planned to explore further the possible residentiality of this feature. We placed nine additional excavation units (with three 1/8 inch controls) to sample subsurface deposits in the metate cluster area, the surrounding scatter, and the perimeter of the feature. These yielded yet more bifaces (dominated by mid- to late stage types; cf. Appendix C, Table 1), flake tools, and several beads and bead preforms.

The density and diversity of debitage, food-processing and maintenance tools, and ornaments recovered from Feature 22 suggest multiple domestic and toolstone reduction activities (Table 135).

Table 135. Summary of Artifacts Collected from Feature 22, 26Ek3095.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces	Flake Tools	Ground Stone	Other/ Exotic	Total
1 (SF)	0.02	978	1,349.1	4	-	-	-	4
2 (SF)	0.02	1,327	954.8	2	-	-	-	2
3/3 (TS)[a]	0.16	4,719	3,135.6	11	1	-	-	12
4 (SF)	0.02	1,833	1,543.0	3	-	1	-	4
5 (SF)	0.02	347	502.6	2	-	-	-	2
6 (SF)	0.02	1,201	1,378.8	8	-	-	-	8
7 (SF)	0.02	51	34.1	2	-	-	-	2
8 (SF)	0.02	551	867.1	3	-	-	-	3
14 (EU)	0.28	384	550.2	4	-	-	-	4
15 (EU)	0.28	1,221	1,570.9	4[c]	-	-	-	4
16 (EU)	0.28	2,223	2,584.6	7	1	-	3	11
17 (EU)	0.30	546	357.5	2	-	-	2	4
18 (EU)[b]	0.30	1,801	1,249.3	6	1	-	-	7
19 (EU)	0.30	770	703.6	7	-	-	2	9
20 (EU)	0.20	125	110.2	3	-	-	2	5
21 (EU)[b]	0.30	798	735.1	1	-	-	-	1
22 (EU)	0.20	75	50.1	-	-	-	-	0
Surface	N/A	-	-	4	-	-	-	4
Totals	2.74	18,950	17,676.6	73	3	1	9	86

(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Screened through 1/8 inch mesh
[b]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[c]Includes two "possible" bifaces

Feature 24

Resting on a narrow bench at the south end of the site, Feature 24 is a biface cache surrounded by a scatter of lithic reduction debris (cf. Chapter 6 and Appendix C, Table 2). The feature was selected for detailed investigation in order to gather data on caching behavior peripheral to the Tosawihi Quarries (cf. Chapter 26).

The cache, one of only five such features found in the Tosawihi study area, is interesting for its association with considerable assemblage variety. The observed surface manifestations

included a four m^2 aggregation of greyish-white opalite flakes, several biface fragments, and a flawless, entire, late stage 3 biface. We placed a 1 m x 1 m test excavation unit in the feature, encountering bedrock at 20 cm; we retrieved 11 bifaces (one refitted), mostly later-stage implements fashioned from identical grey-speckled opalite almost certainly originating from a single source. They range from a very large, thick leaf-shaped specimen to a thin, lanceolate form with an incipient haft (Intermountain Research 1988b:66); their technological attributes are described in Chapter 6. We also retrieved over 5000 opalite flakes, mostly products of later stage biface reduction, a notched flake tool, and a modified opalite chunk.

We returned in 1989 to expose the feature fully. We excavated 15 1 m x 1 m units adjacent the test unit, with one 1/8 inch control unit; we recovered dozens of additional bifaces (largely Stage 3 and 4), many retouched flakes and flake tools, a Desert Side-notched point and several point fragments, two preforms, and a core (Table 136). Debitage was dominated by opalite flakes, with small amounts of obsidian.

Table 136. Summary of Artifacts Collected from Feature 24, 26Ek3095.

		DEBITAGE		FORMED ARTIFACTS						
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Total
1/4 (TS)[a]	0.20	5,002	3,332.3	-	-	12	-	1	1	14
57 (EU)	0.10	59	95.8	-	-	-	-	-	-	0
58 (EU)	0.10	351	297.5	-	-	-	-	-	-	0
59 (EU)	0.10	883	916.3	-	-	1	-	-	-	1
60 (EU)	0.10	673	454.4	-	-	1	-	1	-	2
61 (EU)	0.20	2,233	2,700.4	-	1	8	-	-	-	9
62 (EU)	0.10	93	53.1	-	-	-	-	-	-	0
63 (EU)	0.10	1,437	1,105.1	-	-	-	-	-	-	0
64 (EU)	0.10	1,978	1,275.9	2	1	-	-	3	-	6
65 (EU)	0.10	2,010	1,740.2	1	-	3	-	4	-	8
66 (EU)	0.10	773	601.2	-	-	5	-	-	-	5
67 (EU)[b]	0.10	2,905	2,001.3	1	-	3[c]	-	-	-	4
68 (EU)	0.10	316	192.3	-	-	-	-	-	-	0
69 (EU)	0.10	1,979	2,003.5	1	-	6	-	2	-	9
70 (EU)	0.10	1,613	1,419.9	-	-	3	1	1	-	5
71 (EU)	0.10	1,336	777.1	-	-	4	-	1	-	5
Surface	N/A	1	4.6	-	-	-	-	-	-	0
Totals	1.8	23,642	18,970.9	5	2	46	1	13	1	68

(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Screened through 1/8 inch mesh
[b]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[c]Includes one "possible" biface

Summary

The opportunities (commodious work space, seasonal root crops, favorable wildlife habitat, and close-at-hand water) afforded on Bitterroot Ridge have been exploited for perhaps 5000 years. The discrete distribution and variable character of the 25 features at this locale provide ample evidence of a complex occupational history. Feature types range from limited-purpose reduction scatters to tool aggregations to multipurpose clusters of domestic artifacts and facilities.

In both feature and non-feature contexts, tool diversity signals a wide variety of support tasks—tool production and maintenance, and food gathering and processing—as well as relatively late stage biface production, possibly conducted during quarrying forays. Clusters of millingstones, reduction debris, various formed tools, and at least one hearth imply diverse residential activities, probably played out over multiple seasons. Several of these features—the

smallest and most discrete ones—may represent single, short-term campsites, possibly occupied by both men and women.

The diversity of raw materials in the lithic assemblage (including obsidian from several sources [Appendix N]) suggests that visitors ranged from a broad area and were engaged in lithic production and maintenance, beyond mere reduction of Tosawihi opalite.

26Ek3096

Reduction complex 26Ek3096 (14,250 m^2) consists of a light-density (fewer than 100 items per m^2), ridge-top lithic scatter (Budy 1989:158). Characterized by seven discrete reduction loci (Features 1–7), it lies on the west side of Rodent Valley among outcrops mapped as silicified reworked tuffaceous sediments (Cornucopia 1987; Figure 131). Surface rock appears poorly silicified, and we saw no sign that the site was used as a source of toolstone.

We surveyed the surfaces of these relatively small (all less than 12 m^2) loci for diagnostic tools, and selected Feature 1, a 4 m^2 biface reduction locus, for intensive surface scraping (Budy 1989:158). This operation, which collected the entire feature, yielded four bifaces and relatively slight quantities of debitage (204 items per m^2), suggesting limited biface reduction. No subsurface exercises were conducted.

26Ek3097

Reduction station 26Ek3097, on the moderately steep slopes of Basalt Canyon, is a briefly employed lithic station with no clear feature concentrations. We made no collections because the surface is eroded, and site deposits have been disturbed by road construction (Budy 1989:200–201).

26Ek3099

Discrete artifact concentrations at reduction complex 26Ek3099 (750 m^2) in Basalt Canyon were recorded as biface and core reduction features (Budy 1989:201). All associated artifacts were plotted and collected. These formed artifacts included seven bifaces, a core, a chopper-like tool, and an unclassifiable projectile point. The four features are located on a steep slope, and surface materials appear to have been redistributed by erosion and heavy vehicle movements. We elected, therefore, to undertake no systematic debitage collections.

26Ek3100

At 26Ek3100, a Rodent Valley knoll-top lithic complex covering 5,865 m^2, we documented two functionally-discrete reduction features. Feature 1 appears to have resulted from core reduction, indicated by two cores and a dense (481 items per m^2) scatter of early stage debitage (confirmed by mass analysis; cf. Appendix I). We collected the concentration entirely by scraping two 1 m x 1 m units (Budy 1989:158). Feature 2 consists of a restricted (1 m^2) surficial deposit of biface thinning flakes, none of which was collected.

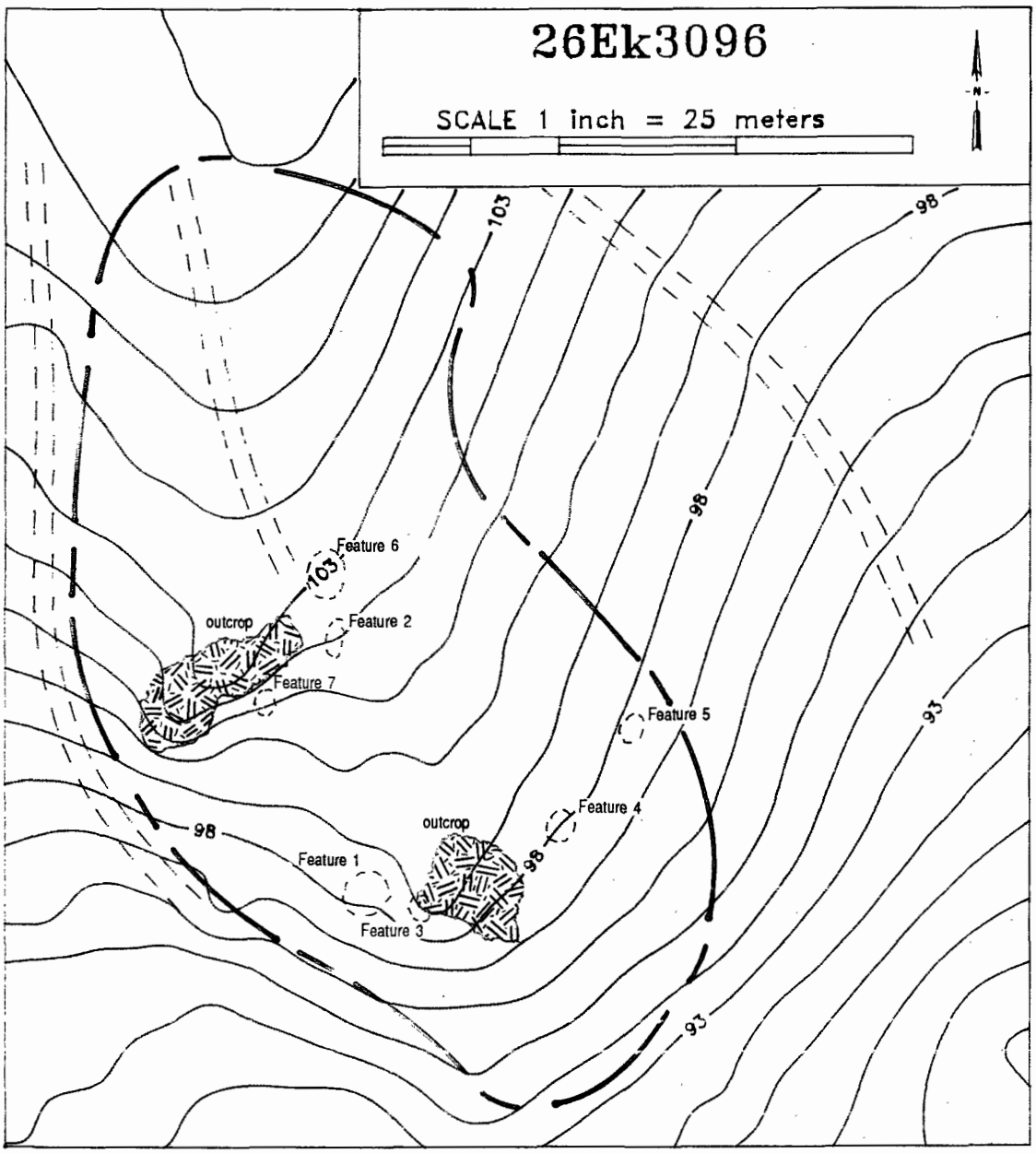


Figure 131. 26Ek3096 site map.

26Ek3101

On a saddle at the southwestern margin of Rodent Valley, reduction complex 26Ek3101 is characterized by a large, diffuse lithic scatter ranging over 11,250 m^2. The site has been disturbed by rodent activity and modern grass seeding. Surface scrapes (two 1 m x 1 m units) and a 1 m x 1 m subsurface excavation unit in a nonfeature area at the center of the saddle yielded 21, chiefly middle-stage, bifaces (Appendix C, Table 1), three flake tools, opalite and obsidian debitage (2,210 flakes), a modified chunk, a chopping/scraping tool, and a Great Basin Stemmed projectile point. A single backhoe trench, exposing about 80 cm of highly bioturbated silty loam overlying an ancient paleosol, failed to reveal any cultural stratigraphy.

26Ek3102

26Ek3102, a 2400 m^2 reduction complex resting on the toe of a ridge in eastern Rodent Valley, hosts five small, light density lithic reduction features. Only one feature was surface scraped (shovel skimmed over 8 square meters to a depth of 2 cm), while all others were surface collected (Budy 1989:162). The suite of formed tools collected across feature and extra-feature areas is dominated by middle-stage bifaces (complemented by a single flake tool and a modified chunk). A Rosegate series projectile point signals use of the area during Late Archaic times.

26Ek3106

A reduction complex with six well-preserved debitage concentrations, 26Ek3106 (5,175 m^2) lies on the east slope of a ridge overlooking Boundary Ravine (Figure 132). Two concentrations (Features 1 and 4/5; 6 m^2 and 36 m^2, respectively) were sampled by complete surface collection, shovel scraping to 2 cm depth, and limited subsurface excavation. These exercises yielded mostly early-stage biface production debris (Appendix I). Feature 1 was dominated by middle stage bifaces, with a single flake tool and a dense concentration of debitage, while Feature 4/5 yielded middle stage bifaces (Appendix C, Table 1), two flake tools, two percussion tools, and two cores. Projectile points recovered during excavation include Desert Series specimens. Surface scrapes at Feature 4/5 revealed a small, centrally-located hearth, composed of fire-cracked rocks and a burned millingstone fragment, suggesting plant processing and short-term domestic use of the site.

We subjected a charcoal sample from the hearth to radiocarbon assessment, obtaining a date of 300 ± 70 B.P. (Beta-26827) that indicates occupation during the latter part of the Late Archaic (ca. A.D. 1650). Relatively recent occupation is supported by the unusual spatial integrity of lithic features; such discrete distribution stems, perhaps, from the limited time they have been exposed to the surface (Budy 1989:163).

26Ek3107

Reduction complex 26Ek3107 consists of a debitage scatter, comprised of five lithic concentrations, blanketing 6,750 m^2 along the west slope of the Rodent Valley ridge that supports 26Ek3106 (Budy 1989:166). The surface of Feature 1 (4m^2), a spatially-discrete biface production and core reduction station atop a soil mound, was collected completely. Feature deposits were exposed by a backhoe trench, but we detected no distinct cultural stratigraphy.

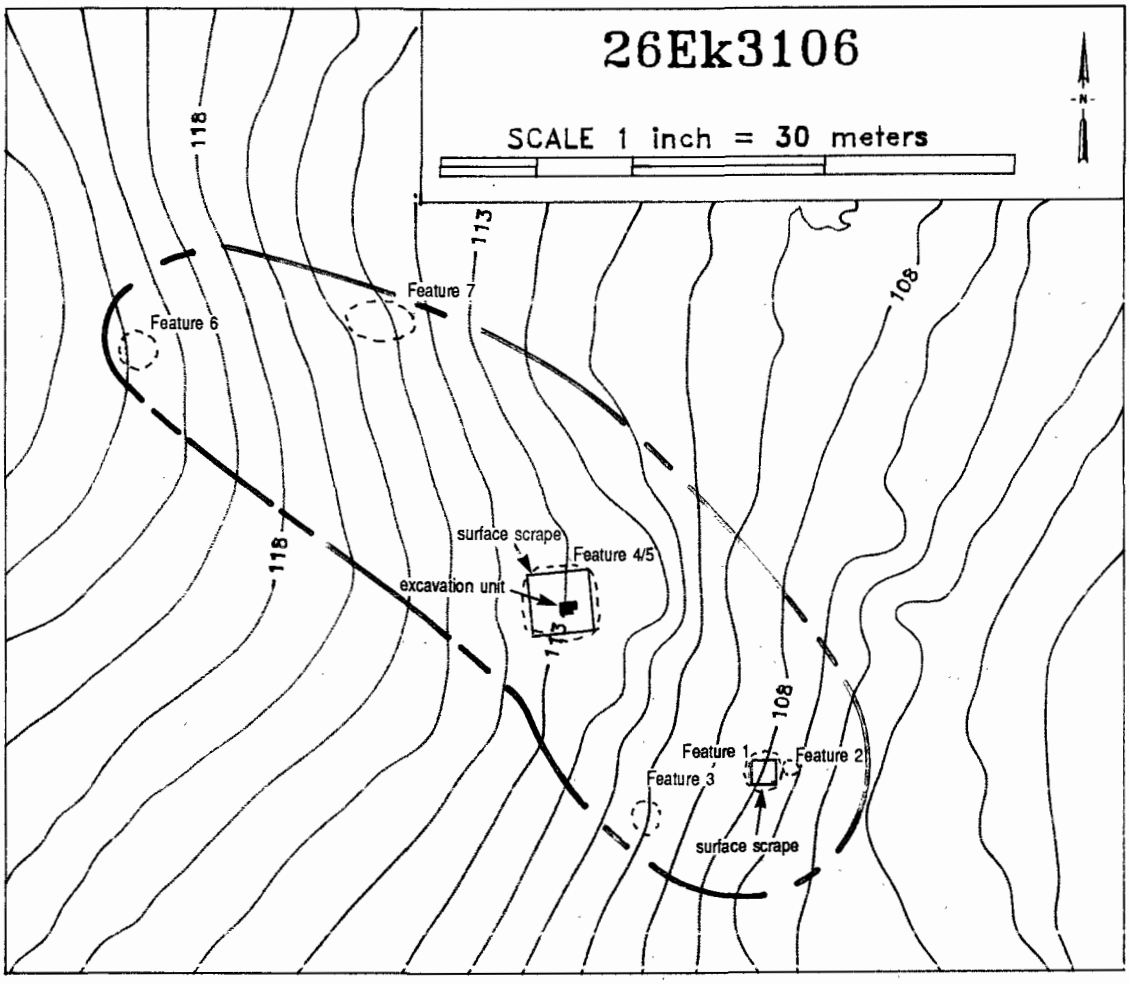


Figure 132. 26Ek3106 site map.

A series of 25 cm x 25 cm x 10 cm subsurface excavations intersected nonfeature areas, and yielded early stage biface reduction debitage of opalite and jasper (Appendix I). The recovery of a Great Basin Stemmed point base near Feature 5 suggests early (pre-Archaic) use of this location.

26Ek3114, 26Ek3115, and 26Ek3116

Three small reduction stations in the Bitterroot Ridge complex, each covering less than 200 m^2, contain single lithic concentrations. They occupy elevated positions above the Basalt Canyon and Antelope Creek drainages, and may have served as game trail overlooks and short-term biface production stations (Budy 1989:224).

Each reduction station was inventoried, mapped, and its surface collected. We also sampled features (over 60–100% of their surfaces) with systematic surface scrapes. 26Ek3114 and 26Ek3115 yielded early, middle, and late stage bifaces (Appendix C, Table 1) and flake tools and a scratched stone. 26Ek3116 contained a wide array of flake tools, projectile points, preforms, and middle and late stage bifaces, suggesting butchering/hide processing activities (Budy 1989:224). Late Archaic use is indicated by Desert Side-notched projectile points retrieved from 26Ek3114 and 26Ek3116.

26Ek3149

26Ek3149 (2,500 m^2) rests on the rocky eastern slope of Basalt Canyon, above its confluence with Little Antelope Creek (cf. Figure 100). The most intensive evidence of use occurs on the upper, western edge of the site, where two debitage features have been crosscut by a road, and along a series of narrow bedrock benches near the center of the site (Figure 133). Lateral artifact patterns do not appear to have been affected significantly by slopewash. Discrete artifact concentrations were recorded as Features 1–3, and associated artifacts were plotted and collected. Subsequently, we collected a representative sample feature (Feature 2, 1m x 4 m) for debitage classification and distributional studies. As well, a 1 m x .5 m unit was placed at the lower edge of the site, in recent canyon-bottom alluvium.

Collections included middle and late stage bifaces, a mano and metate, retouched or notched flakes, a chopping tool, and fragmentary projectile points (Table 137). This assemblage diversity and the presence of seed-processing equipment leads us to posit use as a campsite and reduction station.

Table 137. Summary of Artifacts Collected from 26Ek3149.

Feature	Area (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	Proj. Points	Bifaces	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
-	-	192	315.9	1	8	2	1	2	14
1	43	-	-	-	1	-	-	-	1
2	3	276	245.4	2	3	2	-	-	7
3	4	-	-	-	-	-	-	-	0
Total		468	561.3	3	12	4	1	2	22

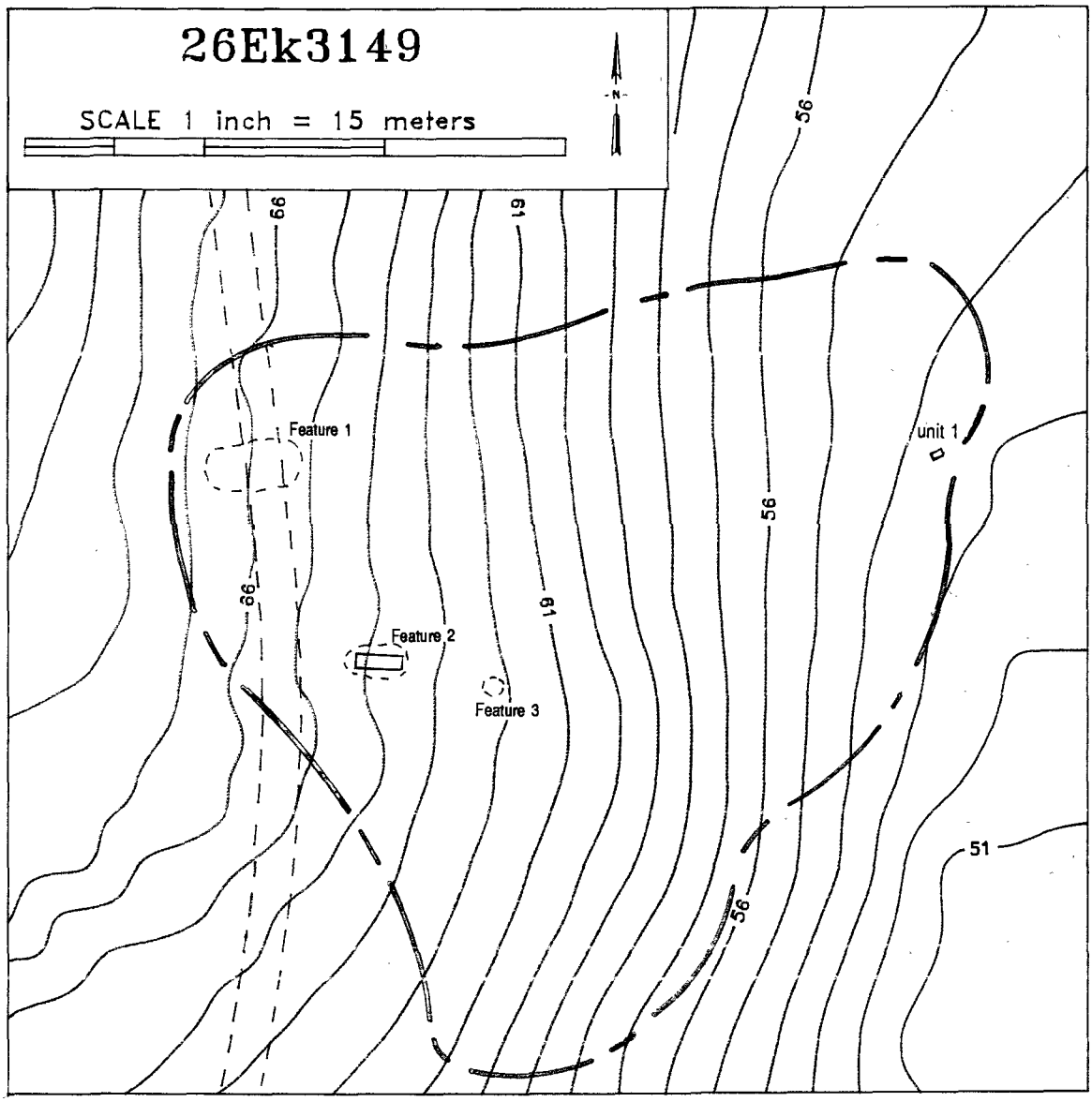


Figure 133. 26Ek3149 site map.

26Ek3160

26Ek3160, one of the largest sites recorded in the Tosawihi region, 46,000 m^2, is located on a broad, V-shaped ridge, bounded by seasonal drainages emptying into Little Antelope Creek (cf. Figure 100). The site rests on shallow, colluvial soils, and is peppered with big and low sagebrush and sparse grasses.

The ridge hosts diverse features, probably deposited over many occupational episodes, representing a wide variety of reduction and subsistence activities. They may represent repeatedly occupied reduction staging centers that also served as short-term campsites. The crest of the ridge is littered nearly continuously with debitage, hundreds of formal tools, and 23 artifact clusters defined as surface features (Figure 134). Investigated features variously reflected biface reduction and thinning, plant processing, hearth-focused activities, and ceramic vessel discard.

Excavation Methods and Rationale

Three site use areas (Loci A, B, and C) were identified on the basis of artifact densities and physical setting. Locus A rests at the center of the site, on a gentle slope with deeper soils, and extends over the south side of the ridgecrest. This aggregate consists of a light scatter of opalite debitage and three reduction loci (Features 17, 18, and 23). Locus B occupies the upper, western edge of the ridgecrest, and contains four reduction areas (Features 19–22) and a light to moderate density scatter of off-white opalite debitage and tools. Locus C incorporates the toe of the ridgeline and many dense, overlapping scatters of debitage and tools. We identified 16 discrete features in Locus C, composed of 11 early and mixed stage biface reduction areas (Features 3–7, 9, and 12–16; Appendix I), four burned reduction features (Features 2, 8, 10, and 11), and one component (Feature 1) containing millingstones and pottery sherds.

After intensive survey for feature identification, mapping, and collection of artifacts, we selected six particularly discrete features representing a diversity of types across each locus for preliminary testing (Features 1, 2, 3, 14, 17, and 20). Initially, only three areas subsurface—Feature 1 and two inter-feature locations in the deeper sediments of Locus A—were explored.

We returned in 1989 to conduct more focused data recovery at Features 1, 12, and 23. We also investigated one of the burned reduction scatters (Feature 11) and probed the deeper deposits in Locus A and Locus C.

Nonfeature Contexts

Cultural materials abound beyond the borders of the 23 defined features eroding off the ridgecrest onto the slopes below. Background lithic debris is continuous, and hundreds of isolated formed tools litter the ground. We collected from inter-feature areas a remarkable array, surpassing the number of isolates seen on any other site in the project area (525 items). Cultural remains were both focused and dispersed, signifying reoccupation as well as visits of relatively short duration.

We placed two 1 m x 1 m test excavation units in nonfeature contexts in Locus A (Figure 135). In Unit 2, a surprising depth of 60 cm was attained and 470 pieces of debitage and seven formed artifacts, including a rhyolite mano, were retrieved (Table 138). Unit 4, a control unit in which one 50 cm x 50 cm quadrant was screened through 1/8 inch mesh, was both shallower (40 cm) and sparser in yield. Each unit was profiled stratigraphically.

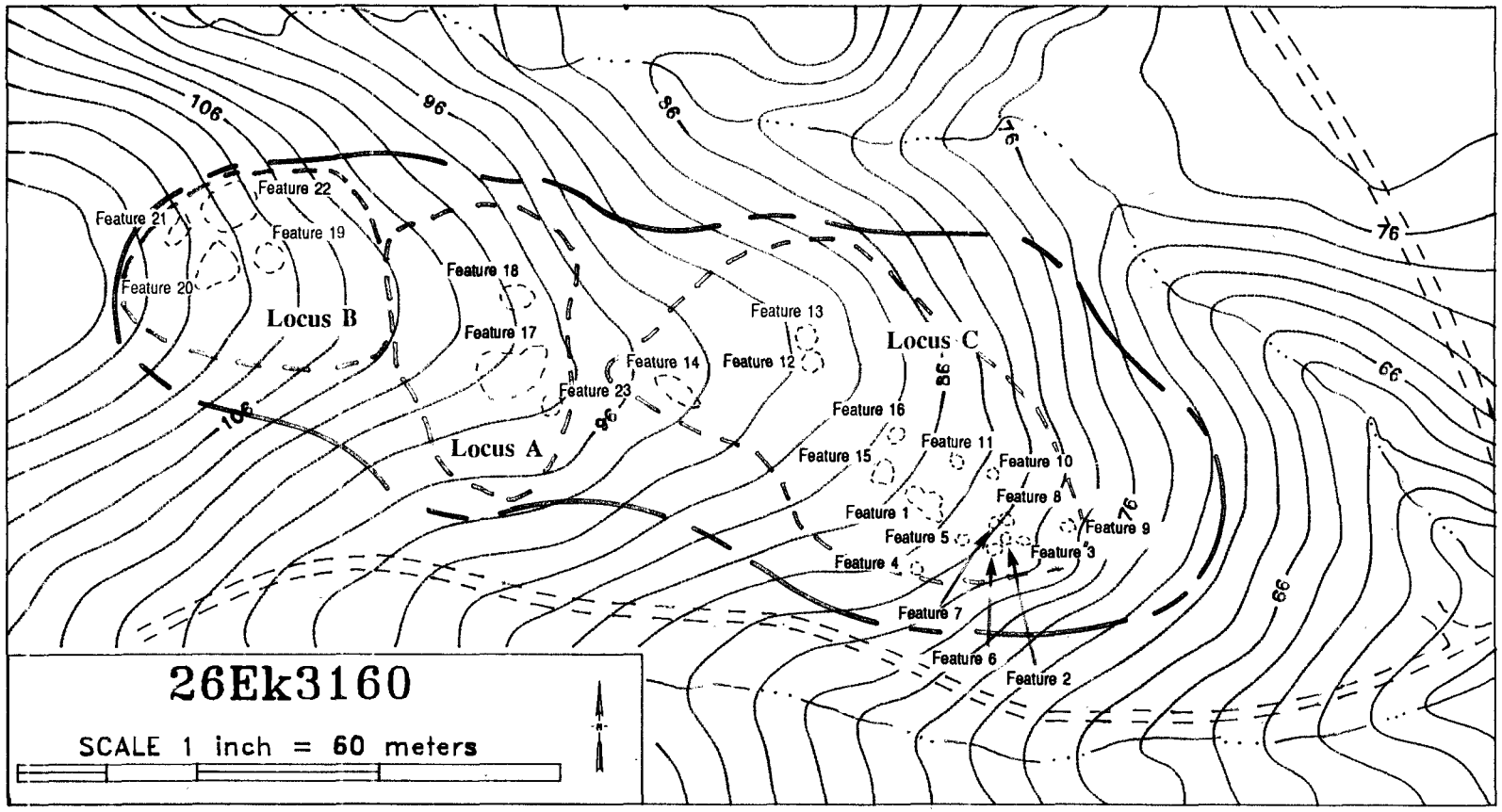


Figure 134. 26Ek3160 site map.

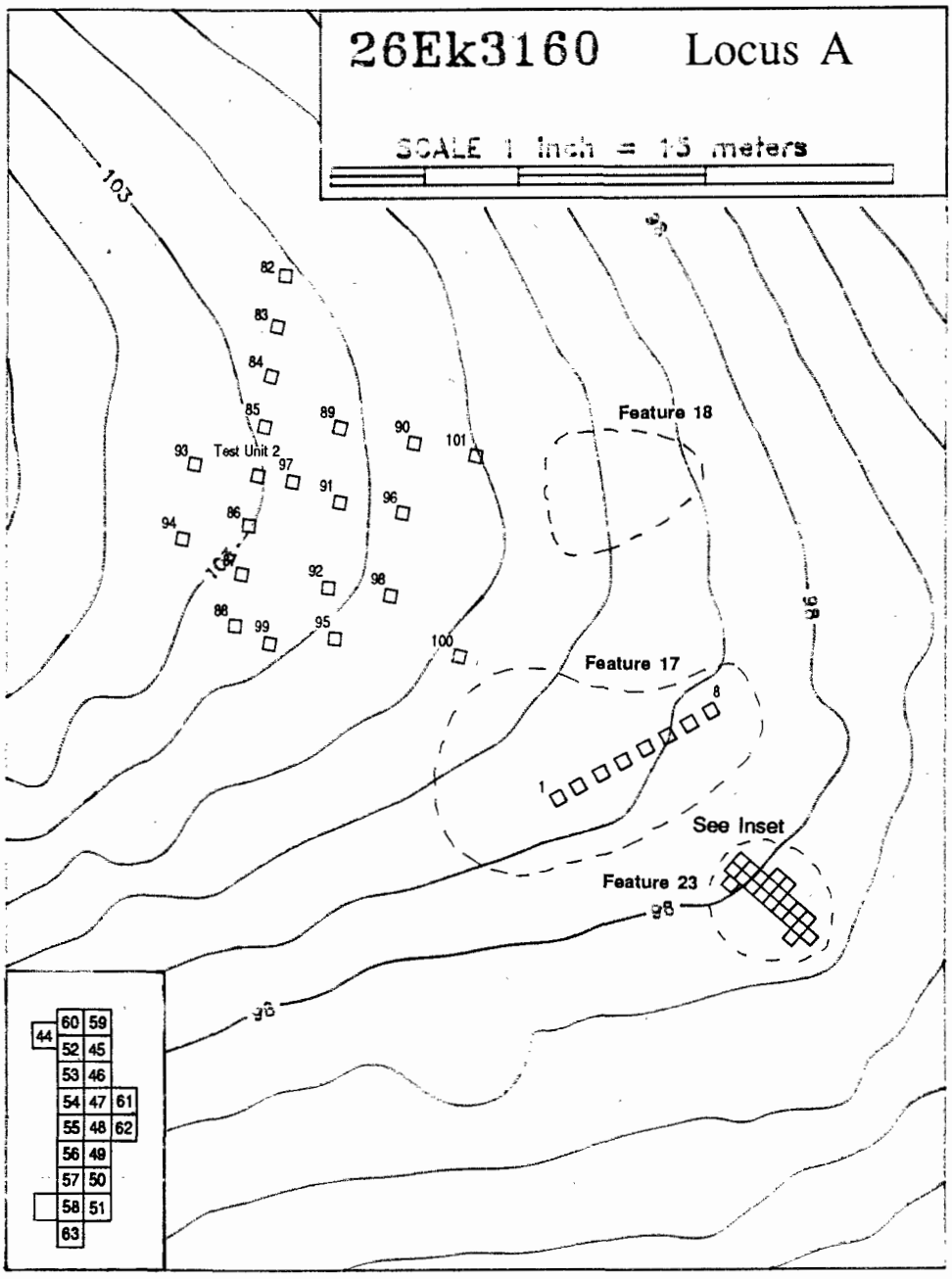


Figure 135. 26Ek3160, excavation units in Locus A.

Table 138. Summary of Artifacts Collected from Non-Feature Contexts in Locus A and All Surfaces at 26Ek3160.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Other/ Exotic	Total
2 (TS)	0.6	454	464.3	-	-	5	-	1	-	-	1	-	7
4 (TS)[a]	0.4	45	31.4	1	-	-	-	-	-	-	-	-	1
82 (EU)	0.3	23	25.8	-	-	-	-	-	-	-	-	-	0
83 (EU)	0.4	157	203.1	-	-	1	-	-	-	-	-	-	1
84 (EU)[a]	0.4	357	680.5	-	-	6[b]	-	-	-	-	-	-	6
85 (EU)	0.6	360	257.7	-	3	2	-	1	-	-	-	-	6
86 (EU)	0.7	701	766.9	2	1	4	-	1	-	-	-	-	8
87 (EU)	0.4	143	158.1	-	-	2	-	1	-	-	-	-	3
88 (EU)	0.3	133	215.0	-	-	2[b]	-	-	-	-	-	-	2
89 (EU)	0.4	193	215.9	-	-	-	-	-	-	-	-	-	0
90 (EU)	0.4	364	354.3	1	-	1	-	-	-	-	-	-	2
91 (EU)	0.3	132	122.3	-	1	1	-	-	-	-	-	-	2
92 (EU)	0.3	88	86.7	-	1	-	-	-	-	-	-	-	1
93 (EU)	0.5	362	333.7	-	-	6	-	1	-	-	-	-	7
94 (EU)	0.5	303	661.3	-	-	4	-	-	-	-	-	-	4
95 (EU)	0.2	36	34.8	-	-	-	-	-	-	-	-	-	0
96 (EU)[a]	0.3	130	179.8	-	-	1	-	-	-	-	-	-	1
97 (EU)	0.4	229	181.2	-	1	3	-	-	-	1	-	-	5
98 (EU)	0.4	38	35.8	-	-	-	-	-	-	-	-	-	0
99 (EU)	0.2	119	124.6	-	-	-	-	-	-	-	-	-	0
100 (EU)	0.2	37	48.3	-	-	2	-	-	-	-	-	-	2
101 (EU)	0.2	108	132.9	-	-	2	-	-	-	-	-	-	2
Surface	N/A	21	66.8	22	10	449[b]	1	27	1	3	11	1	525
Totals	8.4	4,533	5,381.2	26	17	491	1	32	1	4	12	1	585

(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Contains a 50 x 50 1/8 inch mesh control quadrant
[b]Includes "possible" bifaces

The deep deposits around Test Unit 2 were explored further with a block of systematically placed excavation units, achieving equivalent depth in only two units (EUs 85 and 86). We recovered numerous bifaces, flake tools, preforms, projectile points, and a hammerstone from this central portion of the site, indicating long-term and varied tool production and tool use activities (Appendix D).

Time markers from nonfeature contexts chronicle occupation during the pre-Archaic and the entire span of the Archaic. Great Basin Stemmed, Large Side-notched, Humboldt and Gatecliff Split Stem, Elko, Rosegate and Cottonwood series are represented.

Locus A; Features 17, 18 and 23

Features 17 (240 m^2) and 18 (110 m^2) are large flake scatters whose clarity has been compromised somewhat by slopewash or re-use. Feature 17 contains three flake concentrations and a large assemblage of formed artifacts. We sampled the feature with eight surface scrapes at two meter intervals along its long axis (cf. Figure 135), recovering various artifact types including a Rosegate projectile point, mid- to late stage bifaces, preforms, several flake tools, and a core (Table 139). Though bifaces dominate the cultural remains, other functionally diverse tools reflect processing activities as well as lithic production.

Table 139. Summary of Artifacts Collected from Feature 17, 26Ek3160.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Total
1 (SF)	0.02	255	163.1	-	-	3	-	-	3
2 (SF)	0.02	188	156.3	-	-	-	-	1	1
3 (SF)	0.02	328	253.7	1	-	-	-	-	1
4 (SF)	0.02	460	384.3	-	-	-	-	-	0
5 (SF)	0.02	437	260.9	-	-	-	-	-	0
6 (SF)	0.02	394	321.8	-	-	1	-	-	1
7 (SF)	0.02	188	149.4	-	-	-	-	-	0
8 (SF)	0.02	188	129.6	-	-	-	-	-	0
Surface	N/A	-	-	1	1	11	1	1	15
Totals	.16	2,438	1,819.1	2	1	15	1	2	21

(SF) = Surface Scrape

Feature 18 was inventoried for formed artifacts, yielding a single opalite biface.

Feature 23 contains a more diverse assemblage, apparently the remains of a series of food preparation and tool production activities in a campsite context (cf. Figure 135). Dispersed within a light density (30 items per m^2) debitage scatter are numerous specialized tools. A mortar, 20 projectile points, 19 point preforms, pointed flake tools, scrapers and retouched flakes, and dozens of mostly mid- to late stage bifaces were recovered from the surface and in subsurface excavations (Table 140).

Table 140. Summary of Artifacts Collected from Feature 23, 26Ek3160.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Ground Stone	Total
45 (SF)	0.02	162	295.4	-	3	7[b]	1	-	11
46 (SF)	0.02	236	295.7	-	-	4	-	-	4
47 (SF)	0.02	240	247.2	-	-	2	3	-	5
48 (SF)	0.02	151	209.2	-	-	2	3	-	5
49 (SF)	0.02	125	100.4	2	-	2	-	-	4
50 (SF)	0.02	95	114.7	-	-	-	-	-	0
51 (SF)	0.02	100	82.9	-	-	1	-	-	1
53 (SF)	0.02	72	98.3	2	-	-	-	-	2
54 (SF)	0.02	115	227.7	-	-	3	1	-	4
56 (SF)	0.02	191	193.2	1	-	2	1	-	4
57 (SF)	0.02	83	87.7	-	-	-	-	-	0
58 (SF)	0.02	127	108.5	-	-	4	-	-	4
59 (SF)	0.02	184	171.3	-	1	-	1	-	2
61 (SF)	0.02	117	78.3	-	1	1	-	-	2
62 (SF)	0.02	134	145.4	1	1	2	-	-	4
63 (SF)	0.02	78	83.4	-	-	-	-	-	0
64 (SF)	0.02	82	79.3	-	-	-	-	-	0
44 (EU)	0.30	796	1,016.6	6	3	11	5	-	25
52 (EU)[a]	0.30	618	781.5	5	4	7[b]	1	-	17
55 (EU)	0.20	355	383.7	-	2	4	4	-	10
60 (EU)	0.30	484	955.9	3	1	6	2	-	12
Surface	N/A	-	-	-	3	9	1	1	14
Totals	1.44	4,545	5,756.3	20	19	67	23	1	130

(SF) = Surface Scrape
(EU) = Excavation Unit
[a]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[b]Includes "possible" bifaces

We scraped 21 1 m x 1 m surface units to sample the bulk of visible remains, and then placed 4 excavation units in tool-rich areas. A subsurface cobble accumulation with carbon-stained matrix (Feature 24) was encountered in Units 44, 52, and 60. No artifacts were associated clearly; a functional ascription of "hearth" remains indefinite. No carbonized seeds were retrieved, nor was a radiocarbon date returned. Projectile points included Elko and Desert series specimens, as well as a dozen unidentifiable fragments.

Locus B Features (Features 19–22)

Most features in Locus B are large, ranging from 76 to 185 m^2, and have suffered considerable downslope movement and bioturbation (Budy 1989:241–243). Surface collections at Features 19 and 20 yielded processing tools and milling equipment (a mortar and a metate, respectively), suggesting that they may be short-term campsites (Table 141). Features 21 and 22 are reduction loci where we collected several bifaces, a modified chunk of opalite, and a scraper. Features 19, 21 and 22 were not sampled beyond collection of surface artifacts.

Feature 20 yielded controlled surface collections. No subsurface excavation was conducted due to the shallow soils in this part of the locus. We placed five 1 m x 1 m surface scrapes at two meter intervals parallel to the slope, and recovered a diverse flaked tools, in and a metate. This assemblage suggests a suite of food preparation and processing activities beyond mere lithic production. A single projectile point was not classifiable.

Table 141. Summary of Artifacts Collected from Locus B Features, 26Ek3160.

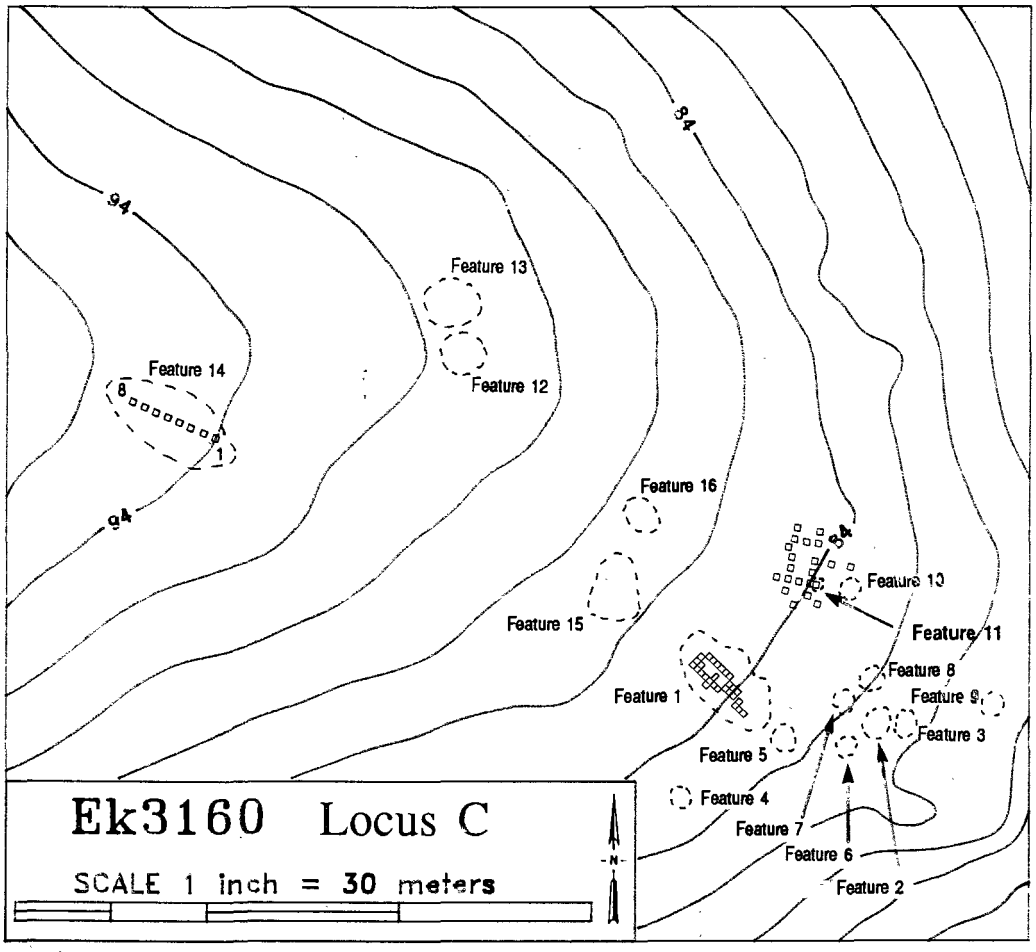
			DEBITAGE		FORMED ARTIFACTS						
Feature	Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Perc./ Modif. Chunks	Ground Stone	Total
19	Surface	N/A	-	-	-	-	6	1	-	1	8
20	1 (SF)	0.02	125	104.8	-	-	-	-	-	-	0
20	2 (SF)	0.02	142	165.7	-	-	-	-	-	-	0
20	3 (SF)	0.02	140	224.4	-	-	-	-	-	-	0
20	4 (SF)	0.02	258	326.4	-	1	1	-	-	-	2
20	5 (SF)	0.02	228	241.6	-	-	1	-	-	-	1
20	Surface	N/A	-	-	1	1	6	-	-	1	9
21	Surface	N/A	-	-	-	-	3	-	1	-	4
22	Surface	N/A	-	-	-	-	4	1	-	-	5
Totals		0.10	893	1,062.9	1	2	21	2	1	2	29

(SF) = Surface Scrape

Locus C Features (Features 1–16)

Feature 1

Feature 1 is unique at 26Ek3160. It is large (135 m^2) and complex, containing two discrete debitage concentrations and a scatter of Shoshone Brownware pottery (Figure 136). With a surface and subsurface assemblage containing seed-processing equipment (manos and a metate), a variety of flake tools (scrapers, notched/denticulate and pointed tools, and retouched flakes), hammerstones, a scraper plane, a tabular basalt shovel, a shaft abrader, obsidian and other exotic debitage, numerous mid- to late stage bifaces, and several Late Archaic projectile points (Desert Side-Notched, Cottonwood, Rosegate), the feature exhibits a functional diversity not seen elsewhere on the site.



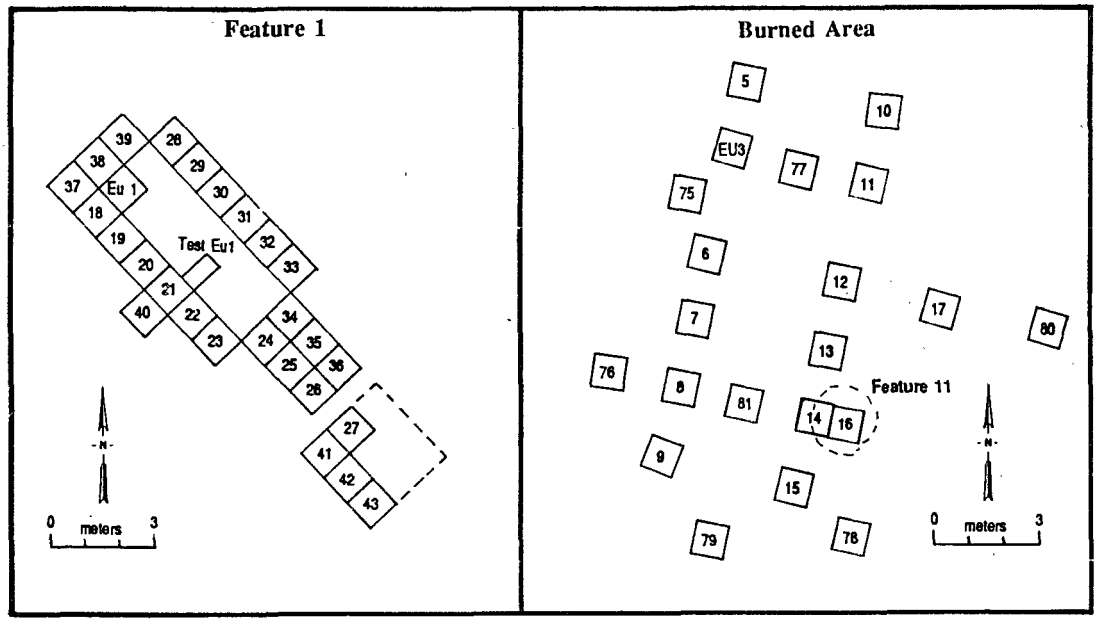


Figure 136. 26Ek3160, excavation units in Locus C.

We scraped a 2 m x 6 m block, centered in the westernmost (upslope) reduction area of the feature, and excavated a 1 m x .5 m unit in the center of the surface scrape block, encountering bedrock at 20 cm. We also placed five 1 x 1 m scrape units approximately five meters downslope to collect a scatter of 39 Shoshone Brownware ceramic sherds, apparently the remnants of a single pot drop.

In 1989, we expanded our exposure with 26 additional surface scrape units, connecting the two reduction loci, and then continued subsurface excavations in four prior scrape locations (EUs 1, 21, 24, and 31). We discovered several intensive reduction areas, more pottery (for a total of 61 sherds), a variety of flake tools, and opalite and obsidian debitage (Table 142). We failed to expose any subsurface hearths or other features.

Table 142. Summary of Artifacts Collected from Feature 1, 26Ek3160.

		DEBITAGE		FORMED ARTIFACTS									
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
1 (SF)	0.02	1,138	1,023.7	-	-	5	-	-	1	-	-	-	6
2 (SF)	0.02	263	170.1	1	1	-	-	-	-	-	-	-	2
3 (SF)	0.02	1,708	1,319.5	2	-	6	-	-	-	-	-	-	8
4 (SF)	0.02	587	398.3	-	-	1	-	-	-	-	-	-	1
5 (SF)	0.02	1,167	911.9	1	-	6	1	-	1	1	-	-	10
6 (SF)	0.02	722	488.6	-	-	1	-	-	-	-	-	-	1
8 (SF)	0.02	556	733.2	-	-	4	-	-	-	-	-	-	4
9 (SF)	0.02	742	1,744.8	1	-	1	-	-	-	-	-	-	2
10 (SF)	0.02	677	1,517.1	-	-	1	3	-	-	-	-	-	4
11 (SF)	0.02	349	465.1	-	-	1	1	-	-	-	-	-	2
12 (SF)	0.02	551	663.0	-	-	-	-	-	-	-	-	-	0
13 (SF)	0.02	116	87.0	-	-	-	-	-	-	-	17	-	17
14 (SF)	0.02	82	75.6	-	-	-	-	-	-	-	8	-	8
15 (SF)	0.02	207	169.3	-	-	-	-	-	-	-	3	-	3
16 (SF)	0.02	139	147.5	-	-	-	-	-	-	-	4	-	4
17 (SF)	0.02	89	78.2	-	-	1	-	-	-	-	7	-	8
18 (SF)	0.02	462	393.8	-	1	2	-	-	-	-	-	-	3
19 (SF)	0.02	616	588.4	-	1	2	-	-	-	1	-	-	4
20 (SF)	0.02	685	1,162.3	-	-	2	-	-	-	-	-	-	2
22 (SF)	0.02	629	808.0	-	-	3	1	-	-	-	-	-	4
23 (SF)	0.02	301	382.7	-	-	2[b]	-	-	-	-	-	-	2
25 (SF)	0.02	207	219.6	-	-	1	-	-	-	-	-	-	1
26 (SF)	0.02	178	144.2	-	-	-	-	-	-	-	-	-	0
27 (SF)	0.02	104	221.2	-	-	-	-	-	-	-	12	-	12
28 (SF)	0.02	63	41.7	-	-	-	-	-	-	-	-	-	0
29 (SF)	0.02	118	193.1	-	-	-	-	-	-	-	-	-	0
30 (SF)	0.02	151	122.6	-	-	4	-	-	-	-	-	-	4
32 (SF)	0.02	161	118.4	1	-	-	-	-	-	-	-	-	1
33 (SF)	0.02	219	192.3	-	-	1	-	-	-	-	-	-	1
34 (SF)	0.02	153	129.3	-	-	-	-	-	-	-	-	-	0
35 (SF)	0.02	88	92.6	-	-	-	-	-	-	-	-	-	0
36 (SF)	0.02	141	170.6	-	-	1	-	-	-	-	-	-	1
37 (SF)	0.02	363	376.0	-	-	-	-	-	-	-	-	-	0
38 (SF)	0.02	254	224.3	-	-	-	-	-	-	-	-	-	0
39 (SF)	0.02	89	77.7	-	-	-	-	-	-	-	-	-	0
40 (SF)	0.02	612	813.6	-	-	2	-	-	-	-	-	-	2
41 (SF)	0.02	130	138.7	-	-	-	-	-	-	-	-	-	0
42 (SF)	0.02	163	186.7	-	-	-	-	-	-	-	5	-	5
43 (SF)	0.02	141	162.4	-	1	-	-	-	-	-	-	-	1
7/1 (TS)[a]	0.11	1,301	3,296.0	-	-	7	1	1	2	-	-	-	11
1 (EU)	0.18	880	620.5	-	-	2	1	-	-	-	-	-	3
21 (EU)	0.20	1,896	6,274.3	-	-	12[b]	2	-	-	-	-	-	14
24 (EU)[a]	0.20	464	378.3	-	-	-	3	-	-	-	-	-	3
31 (EU)	0.20	198	198.2	-	-	4	-	-	-	-	-	-	4
Surface	N/A	6	13.0	-	-	13[b]	-	-	1	1	5	1	21
Totals	1.67	19,866	27,733.4	6	4	85	13	1	5	3	61	1	179

(SF) = Surface Scrape
(TS) = Test Unit
(EU) = Excavation Unit

[a]Contains a 50 x 50 cm 1/8 inch mesh control portion
[b]Includes one "possible" biface

Features 2–16

We submitted eight of the Locus C reduction stations to limited surface inventory and collection (Features 4–8, 13, 15–16; Table 143). Features 2 and 3 (adjacent 6–9 m^2 areas of moderate density debitage on the downslope, eastern edge of Locus C) and Feature 14 (140 m^2) at the west end of the locus were selected for intensive surface collection. At Features 2 and 3, we scraped a 2 m x 2 m grid and 2 m x 4 m grid, respectively, thereby recovering approximately 80% of the contents of the features (Table 143).

Table 143. Summary of Artifacts Collected from Inventoried and Tested Features in Locus C, 26Ek3160.

			DEBITAGE		FORMED ARTIFACTS						
Feature	Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Cobble Tools	Perc./ Other/ Exotic	Total
2	1 (SF)	0.02	240	227.8	-	1	-	-	-	-	1
2	2 (SF)	0.02	263	148.4	-	-	-	-	-	-	0
2	3 (SF)	0.02	360	281.9	-	-	1	-	-	-	1
2	4 (SF)	0.02	287	185.0	-	-	-	-	-	-	0
2	Surface	N/A	-	-	-	-	1	-	-	-	1
3	1 (SF)	0.02	280	649.8	-	-	-	-	-	-	0
3	2 (SF)	0.02	341	710.7	-	-	-	-	-	-	0
3	3 (SF)	0.02	403	1,042.0	-	-	-	-	-	-	0
3	4 (SF)	0.02	451	756.4	-	-	1	-	-	-	1
3	5 (SF)	0.02	327	660.8	-	-	-	-	-	-	0
3	6 (SF)	0.02	224	409.1	-	-	-	-	-	-	0
3	7 (SF)	0.02	100	186.8	-	-	-	-	-	-	0
3	8 (SF)	0.02	124	207.0	-	-	-	-	-	-	0
4	Surface	N/A	-	-	-	-	6	2	-	-	8
5	Surface	N/A	-	-	-	-	2	-	-	-	2
6	Surface	N/A	-	-	-	1	1	-	-	-	2
7	Surface	N/A	-	-	-	-	4	-	1	-	5
8	Surface	N/A	-	-	-	-	1	-	-	-	1
13	Surface	N/A	1	1.7	-	1	2	-	-	-	3
14	1 (SF)	0.02	38	31.9	-	-	1	-	-	-	1
14	2 (SF)	0.02	190	121.2	1	-	1	-	-	-	2
14	3 (SF)	0.02	394	244.6	-	-	-	-	-	-	0
14	4 (SF)	0.02	772	545.2	-	-	-	-	-	-	0
14	5 (SF)	0.02	337	306.9	-	-	-	-	-	-	0
14	6 (SF)	0.02	426	401.8	-	-	-	-	-	-	0
14	7 (SF)	0.02	391	369.2	-	-	-	-	-	-	0
14	8 (SF)	0.02	316	257.2	-	1	1	-	-	-	2
14	Surface	N/A	2	0.8	-	-	7	-	-	-	7
15	Surface	N/A	-	-	-	-	1	-	-	1	2
16	Surface	N/A	-	-	-	-	1	-	-	-	1
Totals		0.70	6,267	7,746.2	1	4	31	2	1	1	40

(SF) = Surface Scrape
(EU) = Excavation Unit

Features 9 and 10 (respectively, 54 m^2 and 3 m^2) were recorded and biface thinning flakes and core reduction were observed. We collected no artifacts.

A discontinuous line of surface scrapes parallel to the slope at Feature 14 yielded debitage samples, a preform, several bifaces, and a fragmentary projectile point (Table 143).

It was apparent that Features 2, 8, 10, and 11 had been exposed to some unknown source of fire, and, indeed, our collections at Feature 2 yielded quantities of blackened, crazed, and fractured debitage. In a non-feature, moderate density area in the eastern portion of Locus C, we excavated a shallow 1 m x 1 m unit (Unit 3) on the north edge of the burned area (cf. Figure 136), and recovered burned materials to a depth of 20 cm. We could discern no direct evidence of intentional heat-treatment of lithics in this locale, however, and concluded that burning was post-depositional (cf. Chapter 10).

Exploring for a buried heat-treating facility, we placed 20 shallow excavation units (typically confined to a single 10 cm level) at 1–2 m intervals across the area marked by burned opalite (cf. Figure 136; Table 144). Two of these units (EUs 14 and 16) fell within Reduction Feature 11. In EU 16, we exposed subsurface Feature 25, composed of a small (35 cm x 35 cm) concentration of fire-altered opalite chunks and flakes, fire-cracked cobbles, and charcoal. The function of this feature remains unclear in the context of the larger, post-depositional burn.

Table 144. Summary of Artifacts Collected from Burned Feature Cluster in Locus C, 26Ek3160.

		DEBITAGE		FORMED ARTIFACTS						
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Total
3 (TS)[a]	0.2	670	538.5	-	-	7	-	-	-	7
5 (EU)	0.1	146	157.6	-	-	1	-	-	-	1
6 (EU)	0.1	224	269.5	-	-	-	1	-	-	1
7 (EU)	0.1	147	176.2	-	-	-	1	-	-	1
8 (EU)	0.1	71	66.1	-	-	-	-	-	-	0
9 (EU)	0.1	34	21.0	-	-	-	-	-	-	0
10 (EU)	0.1	43	48.8	-	-	-	-	-	-	0
11 (EU)	0.1	184	155.0	-	-	1	-	-	-	1
12 (EU)	0.1	68	94.8	-	-	1	-	-	-	1
13 (EU)	0.1	157	174.1	-	-	-	-	-	-	0
14 (EU)	0.2	183	697.2	-	1	1	-	-	-	2
15 (EU)	0.1	55	82.9	-	-	-	-	-	-	0
16 (EU)	0.1	1,174	3,811.3	-	-	5	-	1	-	6
17 (EU)	0.1	82	276.3	-	-	1	-	-	1	2
75 (EU)	0.2	1,344	1,589.7	1	-	4[b]	-	-	-	5
76 (EU)	0.1	91	70.7	-	-	-	-	-	-	0
77 (EU)	0.1	146	274.9	-	-	-	-	-	-	0
78 (EU)	0.1	36	34.5	-	-	-	2	-	-	2
79 (EU)	0.1	28	50.4	-	-	-	-	-	-	0
80 (EU)	0.1	84	125.3	-	-	-	-	-	-	0
81 (EU)	0.1	134	207.4	-	-	-	-	-	-	0
Totals	2.4	5,101	8,922.2	1	1	21	4	1	1	29

(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[b]Includes a "possible" biface

At Feature 12, a relatively small (64 m^2) reduction station in the north-central portion of Locus C, we collected a projectile point fragment and other formed artifacts (a pointed flake tool, two preforms, and 8 bifaces) during initial inventory. Because of the density of tools in this scatter, and because a millingstone (collected as a nonfeature isolate) lay just beyond its boundaries, we decided that additional data recovery was warranted. We scraped a linear transect of ten 1 m x 1 m units, and excavated one of the high density scrapes (Unit 69) down an additional 28 cm. Primarily mid- to late stage bifaces and a variety of flake tools were retrieved (Table 145; Appendix C, Table 1). We observed no subsurface features.

Table 145. Summary of Artifacts Collected from Feature 12, 26Ek3160.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Total
65 (SF)	0.02	50	32.2	-	-	2	-	2
66 (SF)	0.02	88	74.7	-	-	-	-	0
67 (SF)	0.02	157	184.7	-	-	-	-	0
68 (SF)	0.02	379	561.4	-	-	2	-	2
70 (SF)	0.02	377	317.2	-	-	2	1	3
71 (SF)	0.02	187	181.1	-	-	-	-	0
72 (SF)	0.02	265	195.8	-	-	3	1	4
73 (SF)	0.02	207	179.2	-	-	-	-	0
74 (SF)	0.02	243	252.2	-	-	-	1	1
69 (EU)	0.30	1,437	2,271.8	-	1	7	1	9
Surface	N/A	1	1.8	1	2	8	1	12
Totals	*0.48*	*3,391*	*4,252.1*	*1*	*3*	*24*	*5*	*33*

(SF) = Surface Scrape
(EU) = Excavation Unit

Summary

26Ek3160, the largest site examined on the Western Periphery, exhibits multiple feature types and a diverse assemblage including pottery, seed-milling equipment, and a wide variety of processing tools. Reduction of opalite imported from elsewhere in the Tosawihi study area left the most visible record. Its occurrence within the context of other, subsistence-related, activities, however, adds an important dimension to our understanding of the behavior of groups procuring toolstone at Tosawihi; logistical convenience required quarriers to remain long enough that support activities were necessary. Hence, this ridgeline was the scene of repeated, if short-term, residential occupation.

The variable artifact constituents and intensity of use revealed by the 23 features and extensive non-feature areas testify to the site's complex occupational history. The enormous assemblage reflects heat-treatment of bifaces, mid-to-late biface reduction, tool production and maintenance, and food processing and preparation.

The attractiveness of Bitterroot Ridge was long-standing—the distribution of projectile points suggests occupation, at least intermittently, over the last 8000 years. Recovered projectile points both predate and span the entire Archaic period, and substantial vertical deposits allow us to engage in a long-term look at residentiality and tool production at the edge of the Quarries.

26Ek3165

26Ek3165 sits squarely on a broad saddle atop a northwest-trending ridgeline near the southern boundary of the Western Periphery (cf. Figure 100). Like the other reduction/residential sites that share its elevated position on Bitterroot Ridge, 26Ek3165 supports only shallow soils. We recognized, therefore, little opportunity for the preservation of buried cultural materials and so confined most of our investigations to defining the patterning of artifacts on the surface. We identified two remarkably pristine lithic reduction/ residential loci (Features 1 and 2; 10 m^2 and 38 m^2, respectively), and a rather diffuse scatter of tools and lithics (Locus A) in a sparser background array of debitage and isolated artifacts (Figure 137). Cultural materials also have been transported downslope, south of the site, probably by colluvial action.

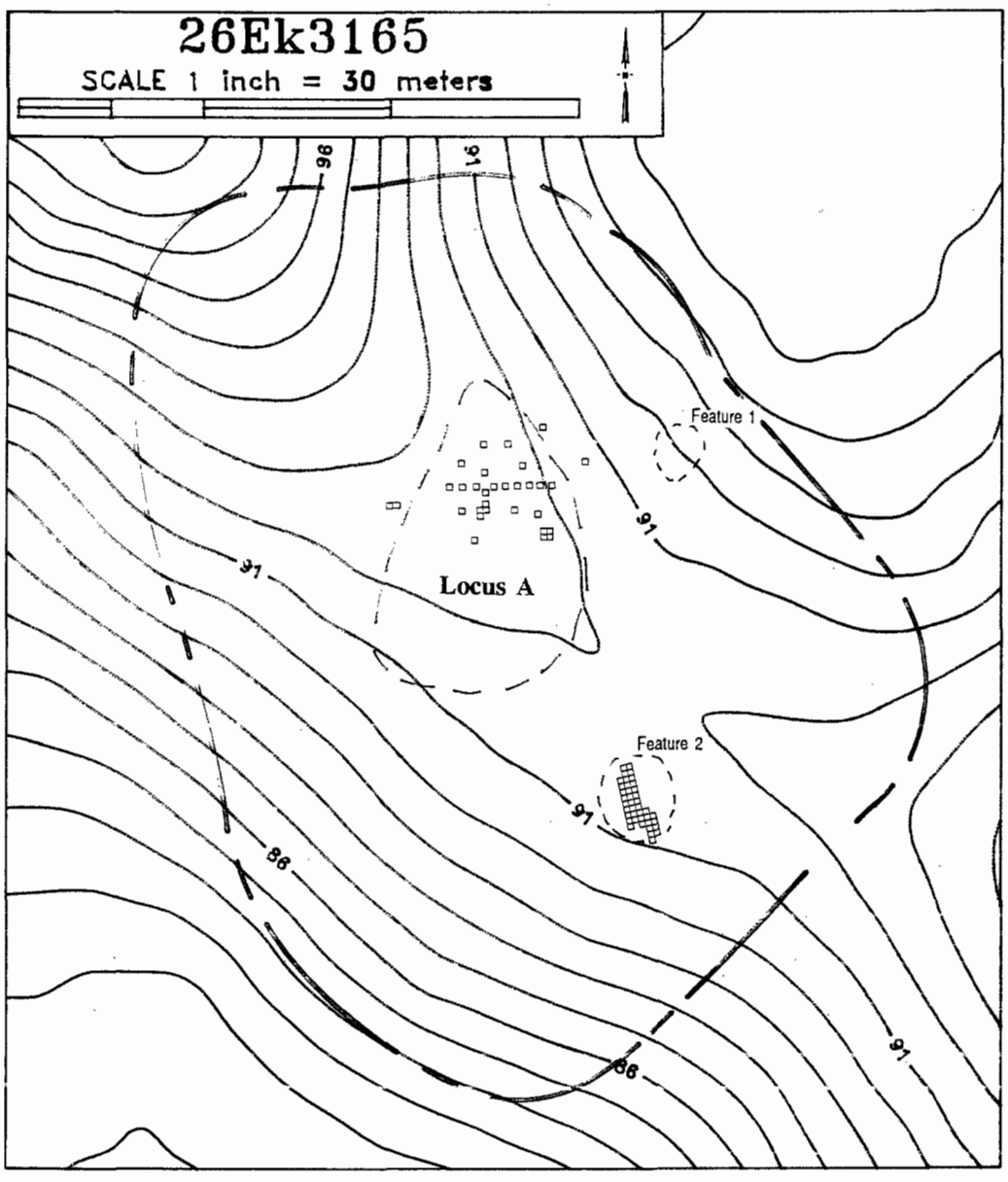


Figure 137. 26Ek3165 site map.

We sampled both features with extensive surface scrapes, and probed the deeper soils in Locus A to check for buried cultural remains. At Feature 2 we also employed subsurface excavations to test for buried residential features.

Nonfeature Contexts

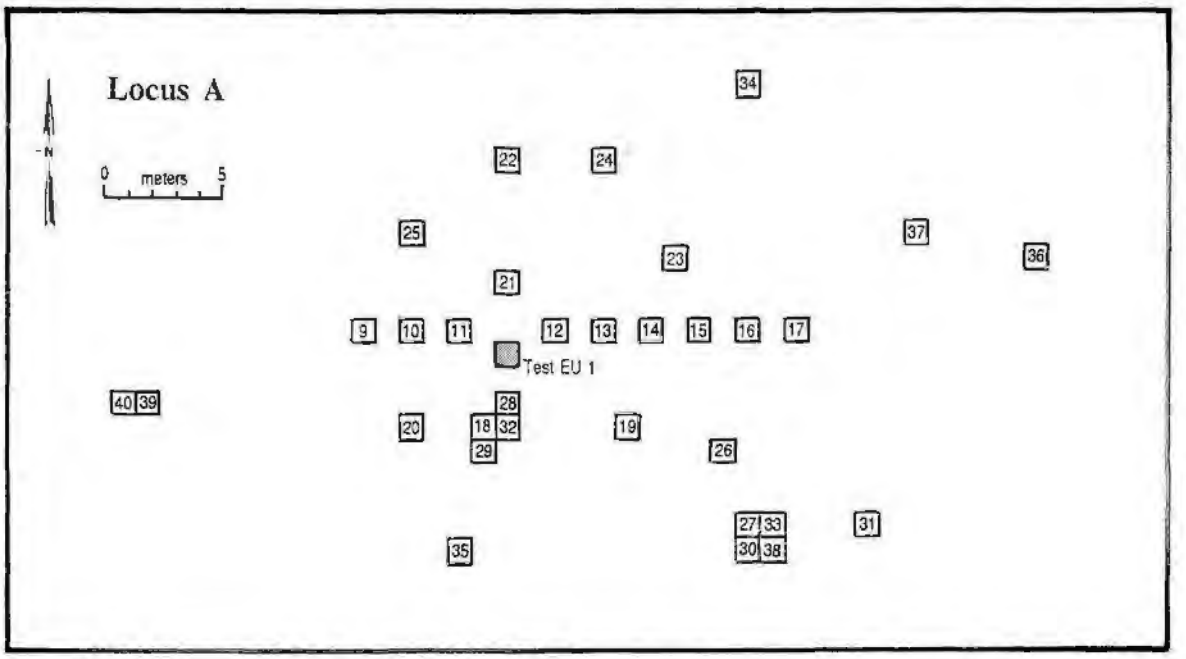
In Locus A, the relatively sparse lithic and tool scatter at the center of the site, we collected surface isolates and excavated a 1 m x 1 m test excavation unit adjacent a partially exposed tabular basalt metate (Figure 138a). Excavating to a depth of 30 cm and screening all deposit through 1/4 inch mesh yielded debitage and formed artifacts (Table 146). To define the assemblage composition and subsurface extent of the concentration more specifically, we then excavated 32 1 m x 1 m units to an average depth of 10 cm. Twenty-two of these units examined vertical deposition in the heart of the locus, and ten additional units sampled the periphery of the scatter. Two units were selected as control units, in which one 50 cm x 50 cm quadrant was screened through 1/8 inch mesh.

A variety of formed tools was retrieved from Locus A and other nonfeature surfaces (Table 146). The assemblage was dominated by bifaces, but functional diversity also was represented by a fragmentary projectile point, preforms, opalite and obsidian retouched flakes, a modified opalite chunk, and two tabular basalt metates. Opalite and rare obsidian and basalt reduction debris was collected, as well.

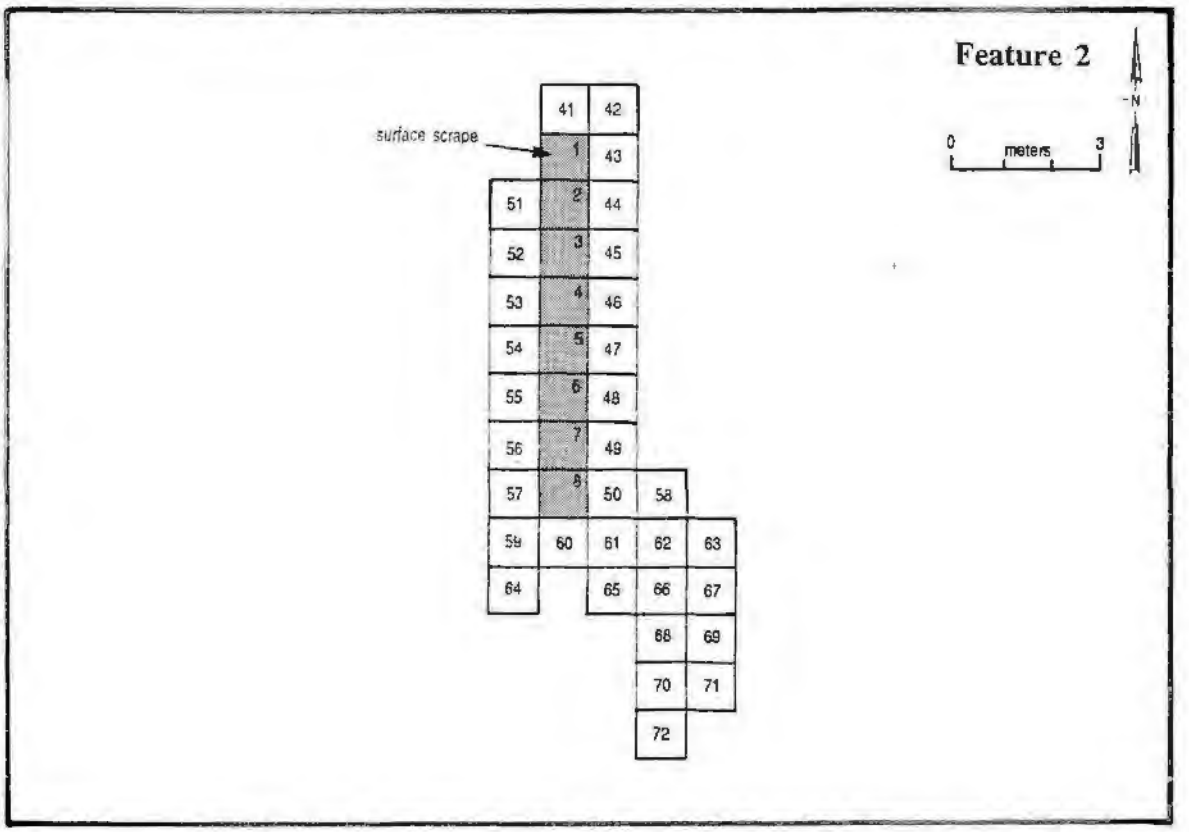
Table 146. Summary of Artifacts Collected from Nonfeature Contexts, 26Ek3165.

		DEBITAGE		FORMED ARTIFACTS						
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Ground Stone	Total
1 (TS)	0.25	135	123.1	-	-	3	-	-	-	3
9 (EU)	0.10	16	17.9	-	-	-	-	-	-	0
10 (EU)	0.10	31	22.8	-	-	-	-	-	-	0
11 (EU)	0.10	19	25.8	-	-	2	-	-	-	2
12 (EU)	0.10	41	35.1	-	-	-	-	-	-	0
13 (EU)	0.10	9	5.1	-	-	-	-	-	-	0
14 (EU)	0.10	10	5.3	-	-	-	-	-	-	0
15 (EU)	0.10	7	27.9	-	-	-	-	-	-	0
16 (EU)	0.10	5	2.8	-	-	-	-	-	-	0
17 (EU)	0.10	15	20.6	-	-	-	-	-	-	0
18 (EU)	0.10	490	569.6	-	-	4	1	-	1	6
19 (EU)	0.10	20	11.5	-	-	-	-	-	-	0
20 (EU)	0.10	27	22.3	-	-	-	-	-	-	0
21 (EU)	0.10	16	13.6	-	-	-	-	-	-	0
22 (EU)	0.10	7	2.9	-	-	-	-	-	-	0
23 (EU)	0.10	6	2.9	-	-	-	-	-	-	0
24 (EU)	0.10	7	6.5	-	-	-	-	-	-	0
25 (EU)	0.10	23	31.8	-	-	-	-	-	-	0
26 (EU)	0.10	7	3.3	-	-	-	-	-	-	0
27 (EU)[a]	0.10	196	175.2	-	-	2	1	-	-	3
28 (EU)	0.10	588	764.7	-	-	2	-	-	-	2
29 (EU)	0.10	194	186.2	-	-	1	1	-	-	2
30 (EU)	0.20	357	252.4	-	-	-	-	-	-	0
31 (EU)	0.10	60	55.4	-	-	1	-	-	-	1
32 (EU)[a]	0.10	1,124	868.5	-	-	1	-	-	-	1
33 (EU)	0.10	90	152.2	-	1	-	-	-	-	1
34 (EU)	0.10	21	18.7	-	-	1	1	-	-	2
35 (EU)	0.10	7	4.5	-	-	-	-	-	-	0
36 (EU)	0.10	215	207.7	-	-	-	-	-	-	0
37 (EU)	0.30	172	143.2	-	-	2	-	-	-	2
38 (EU)	0.10	159	198.1	-	-	2	1	-	-	3
39 (EU)	0.30	146	904.0	-	-	-	-	-	-	0
40 (EU)	0.10	45	93.4	-	-	-	-	-	-	0
Surface	N/A	-	-	1	1	14	-	1	1	18
Totals	3.95	4,265	4,975.0	1	2	35	5	1	2	46

(TS) = Test Excavation Unit
(EU) = Excavation Unit
[a]Contains a 50 x 50 cm 1/8 inch mesh control quadrant



a



b

Figure 138. 26Ek3165. a. Locus A; b. Feature 2.

Feature 1

We surface scraped approximately 75% (eight contiguous 1 m x 1 m units) of Feature 1 to a depth of 2 cm, and we inventoried and collected all formed artifacts from the remaining surface of the feature. An assemblage of opalite debitage (1710 pieces weighing 1561.7 gms), three biface fragments, a pointed flake tool probably used for scraping, and a complete tabular basalt metate suggest that a diverse suite of subsistence-related and processing activities produced the deposits.

Feature 2

Feature 2 is both larger (11 m x 6 m) and more dense than Feature 1. We established a 1 m x 8 m baseline transect through its long axis, and scraped eight contiguous 1 m x 1 m units to a depth of 2 cm (Figure 138b). The entire feature was then inventoried for formed artifacts.

For additional data recovery, aimed explicitly at characterizing the contents and spatial structure of the feature, we scraped 32 1 m x 1 m units (with a 1/8 inch control quadrant in one unit) to 2 cm, immediately surrounding our original surface scrape transect. We then placed three shallow, 1 m x 1 m excavation units in the scraped area in zones of particularly high density. Though no buried features were revealed, we recovered debitage, two unclassifiable projectile point fragments, a preform, several dozen early, middle and late stage bifaces, retouched flakes, pointed and microdenticulate flake tools, and a tabular basalt metate (Table 147).

Table 147. Summary of Artifacts Collected from Feature 2, 26Ek3165.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Ground Stone	Total
1 (SF)	0.02	617	693.0	-	-	1	-	-	1
2 (SF)	0.02	542	597.8	-	-	2	-	-	2
3 (SF)	0.02	115	132.3	-	-	-	1	-	1
4 (SF)	0.02	89	110.9	-	1	-	-	-	1
5 (SF)	0.02	131	244.8	1	-	-	-	-	1
6 (SF)	0.02	208	245.2	-	-	6	-	-	6
7 (SF)	0.02	276	334.3	-	-	-	-	-	0
8 (SF)	0.02	267	432.1	-	-	-	1	-	1
41 (SF)	0.02	69	327.0	-	-	-	-	-	0
42 (SF)	0.02	122	416.1	-	-	-	-	-	0
44 (SF)	0.02	104	91.0	-	-	2	-	-	2
45 (SF)	0.02	58	34.3	-	-	-	-	-	0
46 (SF)	0.02	83	85.5	-	-	-	-	-	0
47 (SF)	0.02	118	155.4	-	-	1	-	-	1
48 (SF)	0.02	137	160.0	1	-	-	-	-	1
49 (SF)	0.02	189	228.2	-	-	-	-	-	0
50 (SF)	0.02	88	113.3	-	-	-	-	-	0
51 (SF)	0.02	132	181.3	-	-	2	-	-	2
53 (SF)	0.02	44	40.6	-	-	-	-	-	0
54 (SF)	0.02	47	49.3	-	-	-	-	-	0
55 (SF)	0.02	104	156.4	-	-	-	-	-	0
56 (SF)	0.02	225	219.9	-	-	-	-	-	0
57 (SF)	0.02	148	336.2	-	-	3[b]	-	-	3
58 (SF)	0.02	62	49.2	-	-	-	-	-	0
59 (SF)	0.02	55	88.7	-	-	-	1	-	1
60 (SF)	0.02	94	117.6	-	-	-	-	-	0
61 (SF)	0.02	107	156.2	-	-	-	-	-	0
62 (SF)	0.02	104	147.3	-	-	3	-	-	3
63 (SF)	0.02	60	74.6	-	-	-	-	-	0
64 (SF)	0.02	48	117.5	-	-	-	-	-	0
65 (SF)	0.02	57	46.2	-	-	-	-	-	0
66 (SF)	0.02	141	237.1	-	-	-	-	-	0
67 (SF)	0.02	108	86.6	-	-	-	-	-	0
68 (SF)	0.02	150	266.1	-	-	-	-	-	0
69 (SF)	0.02	80	102.9	-	-	-	1	-	1
70 (SF)	0.02	131	221.9	-	-	1	-	-	1
71 (SF)	0.02	104	124.2	-	-	-	-	-	0
72 (SF)	0.02	113	115.4	-	-	-	-	-	0
6 (EU)	0.28	1,002	1,248.6	-	-	11	-	-	11
43 (EU)	0.20	410	531.8	-	-	1	-	-	1
52 (EU)[a]	0.20	353	677.9	-	-	2	-	-	2
Surface	N/A	-	-	-	-	2	-	1	3
Totals	1.44	7,092	9,794.7	2	1	37	4	1	45

(SF) = Surface Scrape
(EU) = Excavation Unit

[a]Contains a 50 x 50 cm 1/8 inch mesh control quadrant
[b]Includes one "possible" biface

The high density and diversity of formed artifacts, including milling equipment, suggest both a more discrete and more intense residential use of space at Feature 2 than at Feature 1.

Summary

26Ek3165 provides a strikingly clean glimpse of short-term residence at the rim of the Tosawihi Quarries. The site is relatively small and activity loci are clearly defined. The structure and content of features suggest brief, narrowly-focused occupational histories, incorporating food processing and subsidiary tool production. Metates were found in patterned clusters of tools and debitage, the remains of domestic activity.

The few projectile points and the restricted number and size of the artifact clusters contrast markedly with the extensive remains and repeatedly occupied surfaces at 26Ek3160 to the north. The constricted landform upon which the site rests and its relative isolation from potable water probably contributed to the limited occupation.

26Ek3271

The final Bitterroot Ridge reduction/residential complex, 26Ek3271 (19,500 m^2), lies on the steeply-sloping crest of a narrow, southeast-trending ridgeline and saddle above Basalt Canyon (Figure 139). The ridge was occupied intensively; there are multiple features, thick flake concentrations, and a wide variety of tools distributed along its crest and slopes. These features are not particularly distinct, probably due to recurring occupation and use of the ridgeline for reduction activities (Budy 1989:235). Reduction features occupying the more level ground of the saddle to the east and the bench at the northwestern portion of the site have been grouped into loci (Locus A and Locus C). Locus B, at site center, contains additional features, residing in a dense background of debitage.

A variety of tools (including millingstones) also occur in extra-feature contexts, indicating that activities were often conducted outside spatially-defined use areas. Alternately, the lack of boundary definition in these use areas may indicate greater antiquity and long-term natural transformation processes (cf. Chapter 22).

It appears that the major focus of lithic production was early stage biface reduction (cf. Chapter 10). Over 72% of the 22 features are biface reduction loci (Features 1, 3, 4, 8–11, 13–15, 17, 19–22), ranging in area from five to 250 m^2 (Budy 1989:235). Other features are more complex, with a diversity of maintenance and processing implements and reduction tools not exhibited at simpler biface reduction loci. Feature 12 (a well-defined 60 m^2 concentration of debitage surrounded by a diffuse lithic scatter) and Feature 18 (a 5 m^2 scatter of debitage associated with groundstone and fire-altered cobbles), for instance, reflect use as short-term campsites. They exhibit high tool diversity and/or groundstone in their assemblages (Budy 1989:235).

Testing recovered a wide variety of formed tools and debitage (Table 148). Feature 2, a spatially-limited reduction scatter with groundstone in Locus C, was collected entirely by systematic surface scrapes over its 18 square meters (Budy 1989:237). We recovered opalite and a very small amount of obsidian debitage, a single biface, a flake tool, and a mano. Feature 12 and Feature 18 in Locus B also were scraped to 2 cm over 73% and 40% of their areas, respectively. A 1 m x .5 m excavation unit was then placed in each feature. Yields from Feature 12 contained a large quantity of debitage (including opalite, basalt, and obsidian), projectile points (Rosegate and Humboldt), preforms, largely mid- to late stage bifaces, cores, and a variety

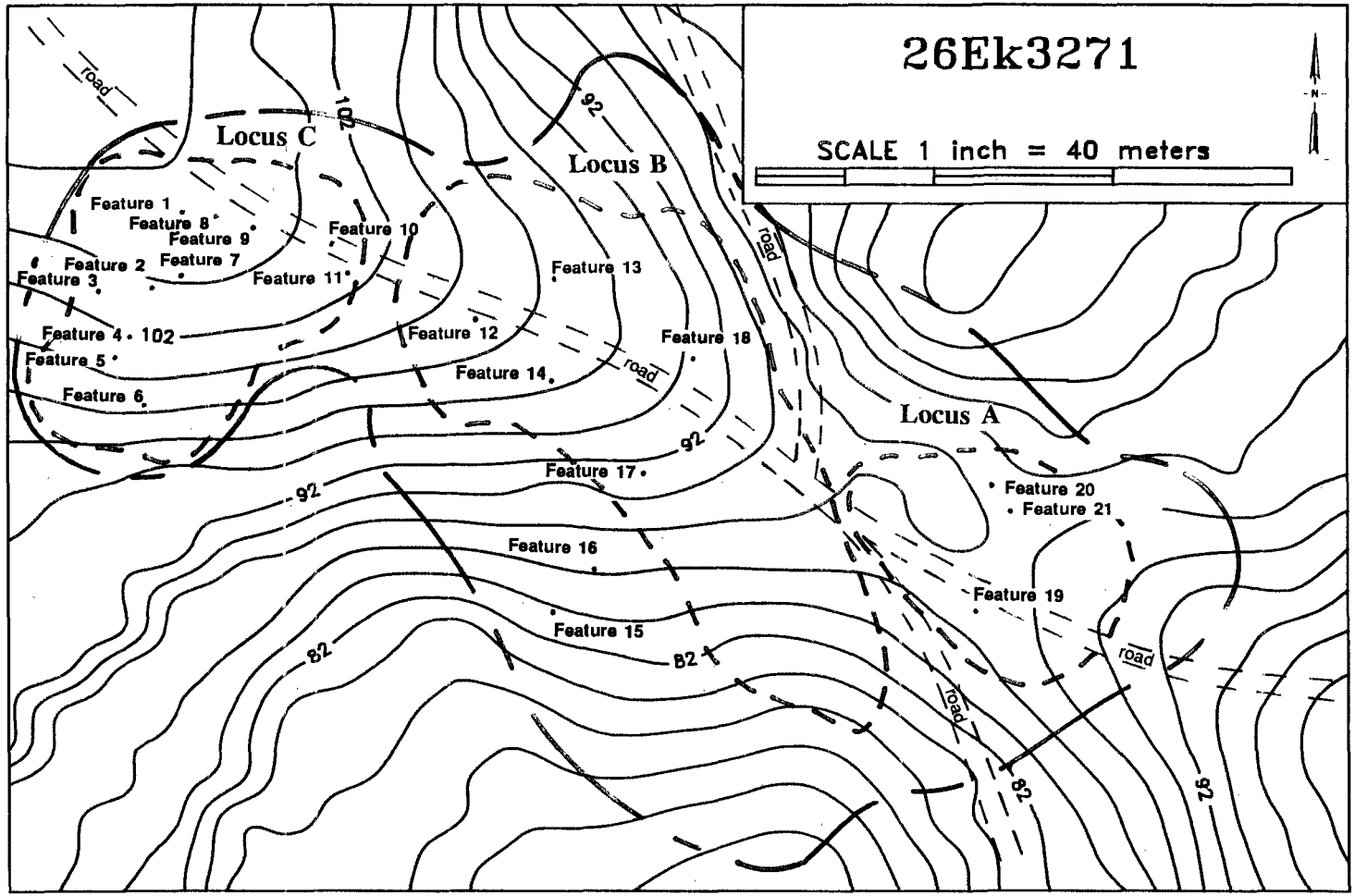


Figure 139. 26Ek3271 site map.

of flake and cobble tools. The assemblage from Feature 18 was considerably less diverse, with a few bifaces and flake tools. However, the recovery of a complete basalt mortar and some fire-cracked rock (though no associated hearth feature came to light) suggests a residential component.

Table 148. Summary of Artifacts Collected from 26Ek3271.

				FORMED ARTIFACTS								
	Area	DEBITAGE		Proj.				Flake	Modif.	Perc./ Cobble	Ground	
Feature	m^2	n	wt. (gm)	Points	Preforms	Bifaces	Cores	Tools	Chunks	Tools	Stone	Total
-	-	4,053	2,951.3	15	3	215[a]	3	12	1	8	4	261
1	32	-	-	-	-	3	-	1	-	-	-	4
2	18	1,218	1,544.6	-	-	1	-	1	-	-	1	3
3	30	-	-	-	2	-	-	4	-	-	-	6
4	20	-	-	-	-	-	-	1	-	-	-	1
5	10	-	-	-	-	1	-	-	-	1	-	2
6	77	-	-	-	-	6	-	-	-	1	-	7
7	56	-	-	-	-	-	-	-	-	-	-	0
8	20	-	-	-	-	3	-	2	-	-	-	5
9	250	-	-	-	-	-	-	-	-	-	-	0
10	15	-	-	-	-	2	-	-	-	-	-	2
11	80	-	-	1	1	7	-	-	-	-	-	9
12	60	37,261	53,373	4	2	67	3	17	-	5	-	98
13	40	1	2.0	1	-	8	-	-	-	-	-	9
14	30	1	0.7	-	2	15	-	1	-	-	-	18
15	25	-	-	-	-	2	-	-	-	-	-	2
16	40	-	-	-	-	-	-	-	-	2	-	2
17	15	-	-	-	-	4	-	-	-	-	-	4
18	5	3,908	2,227.8	-	-	7	-	2	1	-	1	11
19	18	1,095	905.1	-	-	8	-	1	-	1	-	10
20	17	-	-	-	-	7	-	-	-	-	-	7
21	5	5,715	6,520.7	-	-	14	-	2	-	-	-	16
22	20	-	-	1	-	2	-	-	-	-	-	3
Totals		53,252	67,525.2	22	10	372	6	44	2	18	6	480

Features 19 and 21, and several extra-feature areas on the thinly mantled eastern periphery of the site, were explored for additional campsite use via limited surface scrapes and several 1 m x 1 m or 1 m x .5 m excavation units (cf. Budy 1989:237). We discovered no subsurface hearths or food preparation areas.

In summary, 26Ek3271 exhibits the high feature and assemblage diversity (with mid-stage bifaces dominating) characteristic of other large residential sites in the Bitterroot Ridge Complex.

Chronology

The Western Periphery has a long and complex occupation history (Figure 140). Projectile points, our chief time markers in this area, are distributed widely and both predate and span the entire Archaic period.

The earliest exploitation of the area (perhaps from 8000 B.C.) is signalled by Great Basin Stemmed point fragments or preforms recovered from 26Ek3208 on Red Hill, from 26Ek3101 and 26Ek3107 in Rodent Valley, from residence 26Ek3160 and from the Basalt Canyon terrace deposits of 26Ek3092. Large Side-notched points, dating sometime between 5000 B.C. and A.D. 1300, were recovered from Bitterroot Ridge, at 26Ek3093, 26Ek3160, and 26Ek3271.

An obsidian Gatecliff Split Stem point collected at 26Ek3092 indicates use of Basalt Canyon between 3000 and 1300 B.C. Occupation on Bitterroot Ridge during this time also is

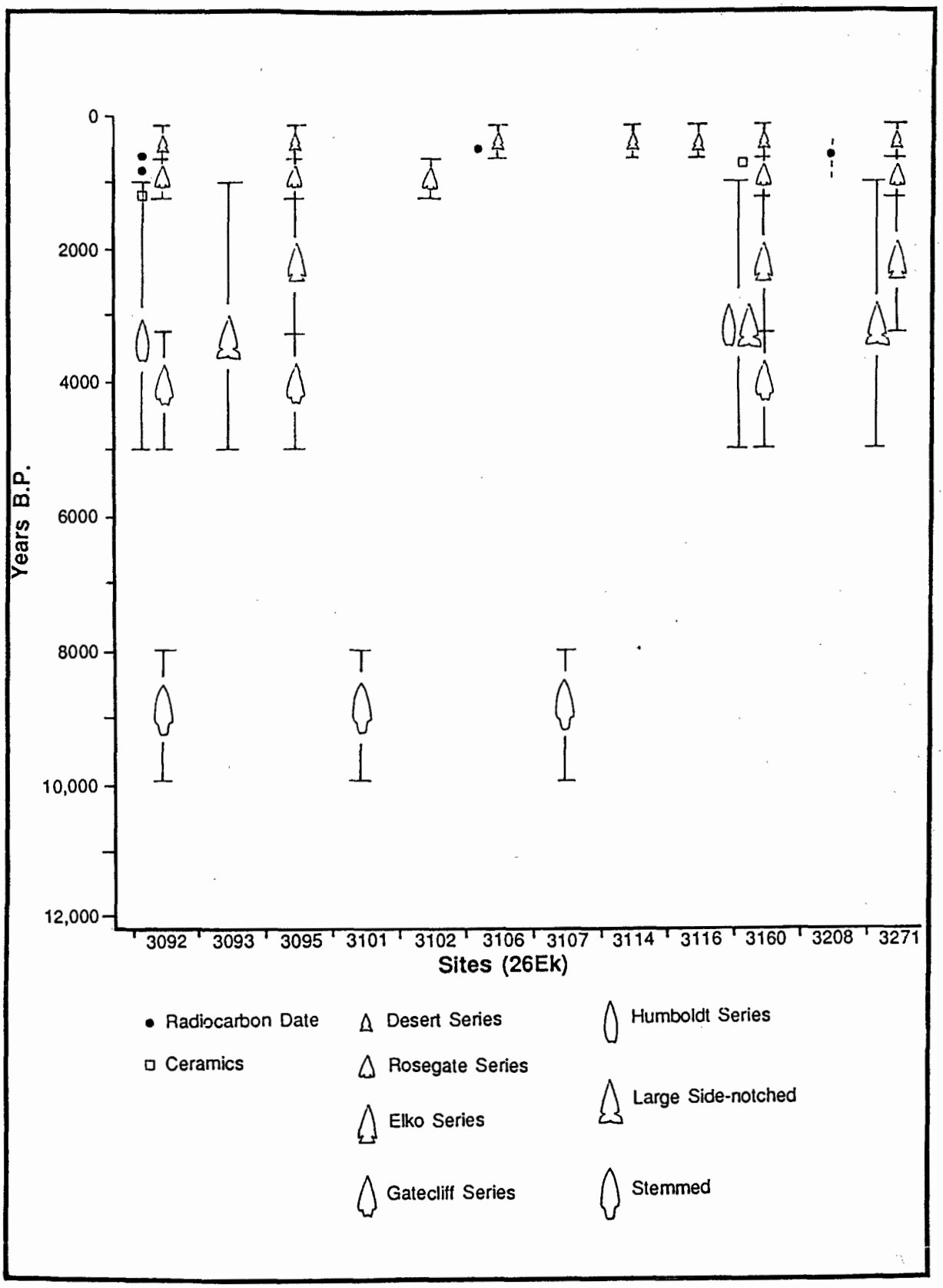


Figure 140. Chronology at investigated sites in the Western Periphery.

documented by Gatecliff points at residential complexes 26Ek3095 and 26Ek3160. Humboldt Concave Base points, retrieved from 26Ek3092, 26Ek3160, and 26Ek3271, may have been manufactured between 3000 B.C. and A.D. 700. Elko projectile points, dating between 1300 B.C. and A.D. 700, occur at these residential sites, as well as at 26Ek3095.

Late Archaic time markers (Rosegate points post-dating A.D. 700, and Cottonwood or Desert Side-notched points manufactured after A.D. 1300) also were recovered in these complexes. In addition, Shoshone Brownware pottery fragments from Feature 1 at site 26Ek3160 place reflect Late Archaic activity; this pottery dates between A.D. 1300 and 1850. Desert Side-notched and Cottonwood projectile points occur at several Bitterroot Ridge reduction loci (26Ek3114 and 26Ek3116), as well.

Several chronological indicators from the benches of Rodent Valley, Basalt Canyon, and Red Hill point to Late Archaic exploitation of these regions. A Rosegate point suggests use of reduction complex 26Ek3102, in Rodent Valley, sometime after A.D. 700. Neighboring reduction complex 26Ek3106 provided a radiocarbon date of 300 ± 70 B.P., corroborated by Desert Series time-markers. And Fremont (Great Salt Lake Grayware) and Shoshone Brownware pottery (A.D. 500 to after A.D. 1300), Rosegate, Cottonwood, and Desert Side-Notched projectile points, and two radiocarbon dates (750 ± 70 B.P., 650 ± 50 B.P.) place components at 26Ek3092 squarely in the Late Archaic. Radiocarbon dates from Red Hill (26Ek3208, 26Ek3085) bracket quarry pit deposits between ca. A.D. 1000 and 1500.

Our investigations in the Western Periphery yielded more than 100 classifiable projectile points; over 62% were discarded in the Late Archaic (represented by Rosegate and Desert Series types). The Middle Archaic (signalled by Elko, Humboldt, and Large Side-notched types) and Early Archaic (characterized by Gatecliff points) contributed substantially fewer points—23% and 9%, respectively. Pre-Archaic Stemmed points represent less than 5% of the recovered point population. Intensification of point discard in the Western Periphery during the Middle and Late Archaic periods, a pattern recognized in other regions of the Tosawihi study area as well, may signify increased hunting, increased population size, and/or intensification of use of the quarries area.

Summary

The functionally diverse Western Periphery sites provide a valuable data set for examining prehistoric decision-making in the context of the larger Tosawihi economic system. Debris scatters here are patterned and often remarkably discrete, reflecting a variety of reduction and subsistence activities. Indeed, Western sites illustrate all elements of the Tosawihi Quarries system—quarrying locales, reduction features, campsites, and food processing stations.

How these data can be used to address the interdigitation of subsistence and technological strategies will be discussed in subsequent chapters (cf. Chapters 20, 24, 25, 26). Groups occupying the Western Periphery engaged in large-scale reduction of Tosawihi opalite (access to toolstone sources must have been one of the principal attractions), yet local assemblage contents indicate that hunting and plant gathering also must have been embedded in toolstone procurement and processing forays. Indeed, important subsistence opportunities in the West may well have dictated how quarry scheduling decisions were made (cf. Chapters 20 and 26).

The West provides discrete, often well-dated, lithic reduction features that have allowed us to characterize episode-specific reduction strategies (cf. Chapters 6, 10 and 21). These features represent, generally, a later stage in the continuum of biface reduction than do features in the Eastern Periphery or the Quarries. Stage 3 and 4 bifaces overwhelmingly dominate assemblages in this area.

The Western Periphery is distinguished by its residential character. People camped here, not only because it was a convenient location for biface reduction on the way out of the Quarries, but also because the place provided access to critical, sustaining resources (water, plants, and game) that could be exploited when visits to the Quarries had to be extended beyond a day or two. The co-occurrence of these resources, in fact, must account for the notable frequency with which western ridges and drainages were revisited.

As a result, large residential complexes like the stratified buried site in Basalt Canyon (26Ek3092) and the Bitterroot Ridge sites exhibit particularly complex patterning. Observable site structure (hearth and millingstone activity areas, features clustered around permanent site furniture), highly diverse assemblages, relatively high rates of heat-treatment (suggesting extended stays), and considerable material diversity (indicating broad-scale territorial movements) contribute to the unique importance of the Western Periphery as a window onto the Tosawihi economic sphere.

Chapter 17

ARCHAEOLOGY OF THE EASTERN PERIPHERY

Steve Botkin, Daniel P. Dugas, and Robert G. Elston

The Eastern Periphery occupies ca. 170 acres along the middle reach of Little Antelope Creek (Figure 141). Most of the subarea lies outside, but contiguous, the southeastern quadrant of the Tosawihi Quarry, encompassing the lower portion of the valley drained by Undine Gorge, with a western leg subsuming a narrow, 10 acre swath in the southern extreme of 26Ek3032. It expresses in microcosm virtually the entire range of physical settings and aboriginal behaviors so far observed at Tosawihi.

The topography of the Eastern Periphery is diverse, largely the product of down-cutting by Little Antelope Creek, Undine Gorge, and their tributaries. Only the western half of the area has been mapped geologically; nevertheless, broad trends in bedrock geology can be projected eastward with some confidence. Overall, the area juxtaposes several zones of contrasting relief, geology, and archaeological content.

The southern portion of the area is gently rolling, and incorporates three locally prominent landforms (Ramadan Ridge, Holeplug Ridge, and Corral Fan). Sloping down to the north from a high rhyolite prominence, they are mildly dissected; a series of broad finger ridges and intervening shallow gullies coalesce to form numerous low knolls at the southern margin of Undine Gorge. Much of the bedrock of Ramadan Ridge, Holeplug Ridge, and Corral Fan is undifferentiated tuff. No silicification has been mapped, yet we know that small pockets of opalite occur on Ramadan Ridge, variously along Undine Gorge, and in an isolated pocket near the far eastern margin of Corral Fan. Soils over most of the southern area are shallow, silty to sandy loams derived largely from in-place weathering and eolian deposition. Where tested, they achieve depths of ca. 40 cm, and vary chiefly in the quantities of rhyolite tuff gravels and cobbles they contain. On some knoll tops eolian deposition dominates and loess-like deposits appear to have buried some cultural features.

Further north the landscape assumes a different character; topography is dominated by the sinuous, deeply incised channel of Undine Gorge and the prominent rimrock at the southern edge of Italian Mesa. The mesa itself is comprised of flowbanded rhyolite overlain by undifferentiated sinter and massive replacement silica. Rhyolite forms its lower southern slopes and the southern margin of Undine Gorge. Gradients are steep (in places, precipitous), rising from 5600 feet (1707 m) amsl in the bed of the gorge to 5700 feet (1737 m) amsl in only 200 horizontal feet. Vertical bedrock faces interspersed with narrow rocky ledges and steep talus cones punctuate the escarpment; various points along the rim served as toolstone sources, and several overhangs at the contact between sinter/silica and rhyolite were exploited as rockshelters. Although opalite stream cobbles abound in the bed of the gorge, quartzite cobbles used as hammerstones were its more visible archaeological product.

The western end of the area encompasses terrain intermediate between those described above. Occupying a ten acre strip within the southern jut of the Tosawihi Quarry, it extends from the crest of Lower Holmes Ridge on the west to the western flank of Ramadan Ridge on the east, incorporating a short segment of Little Antelope Creek. Most slopes are quite steep (ca. 20-40%) save for where they are moderated by stream terraces. Where tested, soils proved to be shallow, very gravely sandy colluvium ca. 20 cm deep. Opalite bedrock exposures occur as low ledges on the crest of Holmes Ridge and more sporadically along the stream terraces. Chert stream cobbles in the bed of Little Antelope Creek offer an abundant but apparently little-used supply of toolstone as well.

Water is scarce in the Eastern Periphery. Little Antelope Creek and Undine Gorge channel copious flows during spring snow melt but dry soon thereafter. More reliable water

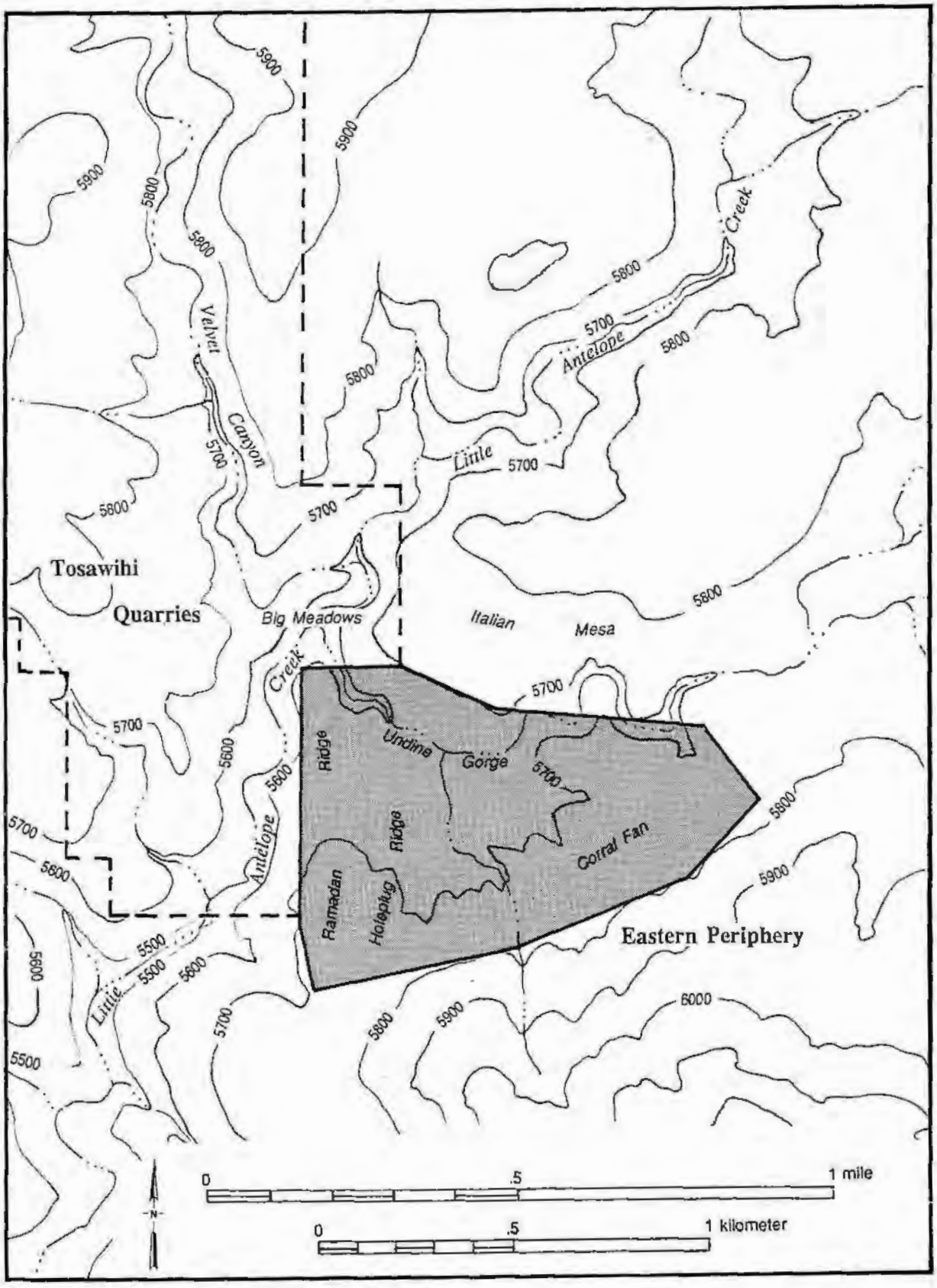


Figure 141. Eastern Periphery project area.

occurs in Big Meadow, some 300 meters north of the project area, where an apparently perennial spring now feeds a stock pond. Aside from its seasonal water, Little Antelope Creek is a link in the most direct foot route between Tosawihi and the Humboldt River; for people traveling this corridor, Ramadan Ridge and the flats immediately north offer the campsites nearest the opalite sources of the Eastern Periphery and the Quarries.

The biosphere of the Eastern Periphery is much like that of the surrounding countryside, and offered no unique attractions. Vegetation consists of an edaphically constrained mosaic where shallow soils along ridgelines host a sparse cover of low sage, rabbitbrush, and phlox, while locally dense stands of tall sage and understory grasses grow in patches of deeper soils on lower ridge slopes. Abundant bitterbrush complements this assemblage at the highest elevations at the eastern extreme of the area. Ground squirrels, badgers, and rabbits are the most commonly encountered mammals; deer and antelope transit seasonally.

At the time of fieldwork the Eastern Periphery remained relatively undisturbed by modern and historic modifications; aboriginal opalite quarrying accounted for the most noticeable human alteration of the place. A dirt road crosses east to west, transecting several sites, and prospects and claim cairns dot many site precincts. Stock grazing and modern wildfires have affected site contents through trampling, crazing of artifacts, and exacerbated erosion. Among non-human agents of disturbance, rodent turbation and slope wash are the most pronounced; subsurface deposits are heavily churned by burrowing animals everywhere save in some impenetrable quarry pit berms consisting almost exclusively of lithic debris. Colluviation undoubtedly has resulted in the translocation of artifacts within general site contexts and appears to account for the characteristic, elongated, slope-mimicking, fan-shaped configuration of many reduction features. Almost everywhere, solifluction lobes sequentially capture, transport, and bury cultural debris, and apparently contribute significantly to the marked seasonal differences in the surface visibility of archaeological remains.

Descriptive Site Summary

The Eastern Periphery encompasses forty-five prehistoric sites and localities. Of these, "sites" (n=37) are archaeological locations recorded during survey of that portion of the area outside the Tosawihi Quarry proper (Raven 1988). "Localities" (n=8) are loci of site 26Ek3032, documented formally during reconnaissance of the Tosawihi Quarry (Elston, Raven, and Budy 1987). Here we use the term "site" generically, to refer to both the localities of 26Ek3032 and the individually enumerated sites. Table 149 and Figure 142 preview the archaeological content of the Eastern Periphery.

Archaeological sites in the Eastern Periphery contain assemblages and features displaying considerable variety in composition and size; they occur in all geographic contexts. At all sites however, remains are derived primarily from extraction and/or processing of opalite. Toolstone related sites include pit, outcrop, and cobble quarries of assorted sizes, discrete concentrations of reduction debris, and numerous rockshelters. As well, several sites contain assemblages reflecting residential use.

For reasons not yet understood, but probably owing in part to the abundance of opalite sources in the Eastern Periphery, and the ephemeral, easily dispersed nature of reduction features, surficial site boundaries there are less clear cut than they are in the West and North. Boundaries in the East tend to be less topographically constrained and often are blurred by a background lithic scatter of variable density. Site boundaries, then, are archaeological constructs enclosing constellations of cultural features grouped on the basis of inferred function, mutual proximity, and/or shared topographic position.

Table 149. Sites and Localities Investigated in the Eastern Periphery.

Site/Locality	Quarry Features n	Non-Quarry Features n	Elevation (ft. amsl)	Site Area (sq. m)
26Ek3170	1	13	5,620	31,000
26Ek3171	3	5	5,670	7,540
26Ek3172	-	6	5,720	2,420
26Ek3173	-	4	5,725	530
26Ek3174	-	2	5,745	590
26Ek3175	-	1	5,700	90
26Ek3177	-	1	5,700	70
26Ek3178	-	4	5,710	910
26Ek3179	-	2	5,645	110
26Ek3180	-	1	5,655	12
26Ek3181	-	1	5,685	235
26Ek3183	-	1	5,680	90
26Ek3184	1	25	5,640	11,309
26Ek3185	-	7	5,660	910
26Ek3186	-	2	5,650	185
26Ek3187	-	1	5,645	40
26Ek3188	-	1	5,660	95
26Ek3189	-	4	5,640	1,320
26Ek3190	-	11	5,630	4,241
26Ek3191[a]	-	1	5,660	6,600
26Ek3192	-	5	5,660	3,190
26Ek3193	1	6	5,670	3,610
26Ek3195	7	1	5,700	9,425
26Ek3196	4	3	5,720	11,800
26Ek3197	6	5	5,720	4,556
26Ek3198[b]	4	21	5,740	12,724
26Ek3200	1	-	5,760	242
26Ek3201	1	3	5,730	2,474
26Ek3202	-	1	5,700	8
26Ek3203[a]	-	-	5,710	8,230
26Ek3204	-	1	5,680	60
26Ek3032				
Locality 19[c]	-	1	5,600	10
Locality 20	-	3	5,630	200
Locality 21	-	1	5,600	100
Locality 22	-	1	5,580	5
Locality 23	1	-	5,640	30
Locality 25[a]	-	7	5,700	2,250
Locality 93	-	-	5,600	1
Locality 98	1	-	5,600	900

[a]Amorphous scatter outcrop/cobble quarrying debris
[b]Includes subsurface hearth
[c]Possible disturbed quarry pit

Eight sites contain quarry pits. While many also include additional cultural features reflecting the entire range of toolstone extraction techniques observed at Tosawihi, the excavation of quarry pits appears to have contributed most of the raw material acquired at them; this differentiates these sites from others in the East. Numerous reduction stations complement quarry features, and the debitage comprising the berms and fill of pits suggest that raw toolstone was reduced at least partially at the sources. Such sites seem to have been located where opalite outcrops presaged the occurrence of toolstone quality substrate in near-surface contexts. Quarry pits generally are confined to the bedrock-controlled crest of Ramadan Ridge and the rimrock of knolls at the southern margin of Undine Gorge. Two exceptions consists of isolated pit excavations at the eastern limit of the subarea and on the midslope of Lower Holmes Ridge.

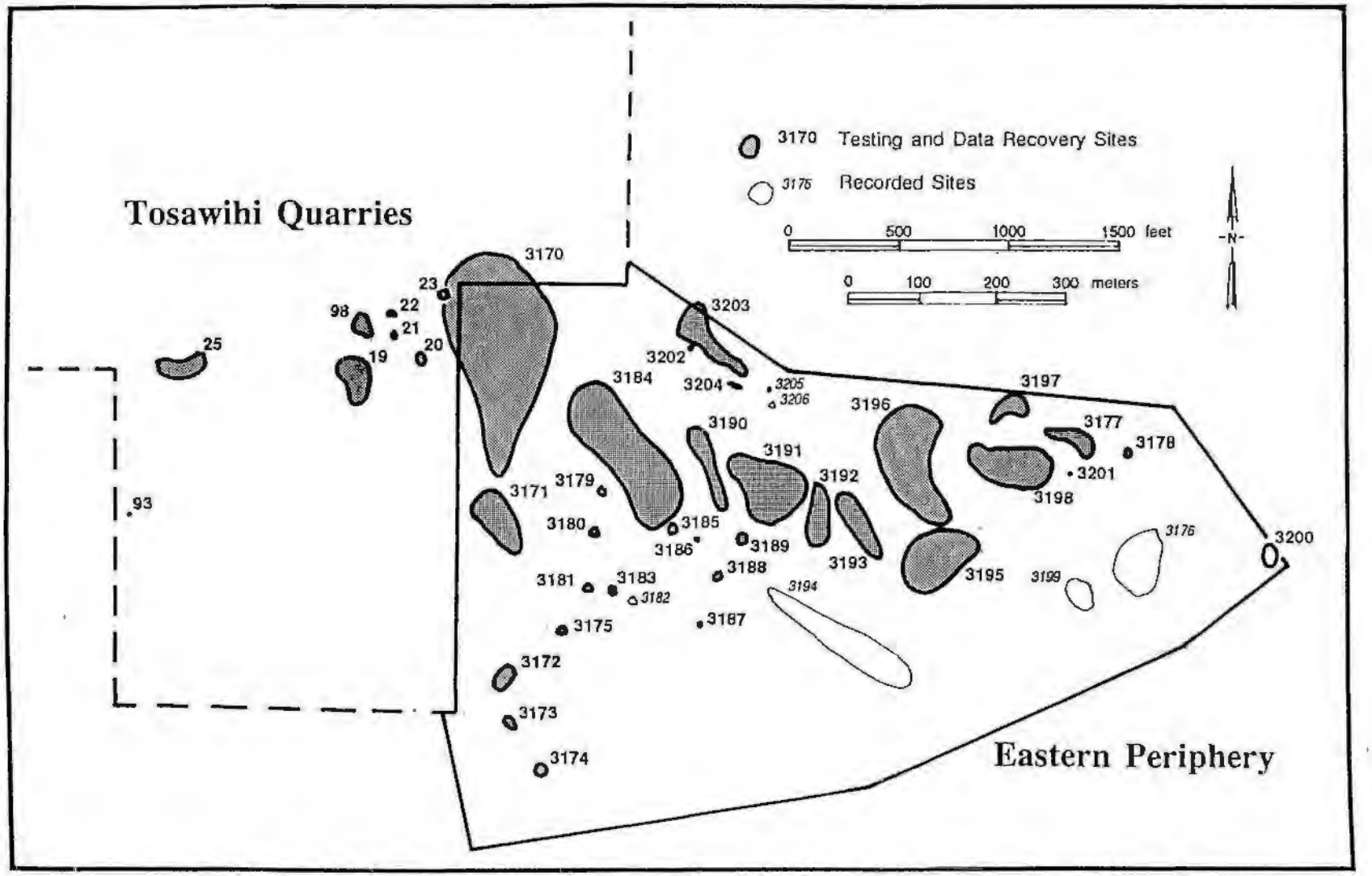


Figure 142. Eastern Periphery site location map.

Eight sites reflect the extraction of toolstone from exposed sources only (opalite ledges and, to a lesser degree, colluvial accumulations of opalite cobbles). Although outcrop quarries are numerous across the East, they appear for the most part to represent episodic, expedient use of low quality or low volume sources. Most such minimal exploitations of outcrops are juxtaposed with numerous reduction features bearing dense accumulations of processing debris; we infer that the presence of raw material at these sites did little to condition their use. Instead, most appear to have offered commodious workspace near other, higher quality toolstone sources. Outcrop quarries occur on microtopographic flats on Lower Holmes Ridge, amid the bedrock exposures rimming knoll tops along the southern edge of Undine Gorge, and at the brink of Italian Mesa (cf. Figure 141).

Twenty sites in the Eastern Periphery lack exploited toolstone sources and are defined almost exclusively by concentrations of reduction debris, differing chiefly in overall size and number of features. The largest occur along the foot slope of Holeplug Ridge, coincident with the broad, relatively flat knoll tops overlooking Undine Gorge (cf. Figure 141). High quality toolstone is available to these locations in abundance and within easy access at nearby quarries to the west and east. Both sites cover areas exceeding 2000 m^2 and are punctuated by cultural features consisting, for the most part, of concentrations of opalite reduction debris. Numerous smaller, but apparently functionally equivalent, sites are widespread throughout the subarea. Their size owes perhaps to topographic constraints (they occur on steeper slopes) their somewhat greater distance from material sources than the larger sites along Undine Gorge. Most are located on the midslopes of Holeplug Ridge and along the highest bench of Ramadan Ridge (cf. Figure 141).

The remainder of the open sites in the Eastern Periphery are defined exclusively by amorphous, diffuse lithic scatters topping finger ridges in the apparently little used hinterland of Corral Fan. Their assemblages are dominated by opalite reduction debris.

Four rockshelters occupy recesses in the southern face of Italian Mesa and one occurs in rimrock above the southern verge of Undine Gorge. All are rather small, offering only minimal weather protection. None contains remains indicating intensive residential use. They appear to have functioned chiefly as semi-enclosed reduction stations; the walls of two seem to have been exploited for toolstone as well.

An isolated andesitic basalt metate was found in an area otherwise devoid of cultural remains on the east slope of Red Hill at the western margin of the Tosawihi Quarry. Designated Locality 93, it is described in Chapter 12.

Testing and Data Recovery Results

Fielded during the spring and summer of 1988, the testing program constituted the first systematic post-reconnaissance examination of the archaeology of the Eastern Periphery. The eight localities within the Tosawihi Quarry were tested by non-invasive techniques; no artifact collection or excavation occurred at this time. Instead, the localities were transected by close interval inspections, their surficial boundaries determined, and the contents of their cultural features described. More intensive means were employed outside 26Ek3032; 31 of the 37 sites in the Eastern Periphery were tested. Test data were reviewed to evaluate the significance of the sites examined; we assumed significance to be reflected by the degree to which test results promised information pertinent to identified research issues (Intermountain Research 1988a; cf. Chapter 4). Sixteen sites appeared to merit further investigation.

The sites and localities identified for expanded sampling included at least one representative of each variety of quarry and a selection of reduction stations thought to reflect the full range of size and complexity in the Eastern Periphery. Eight of the sites lie outside the Tosawihi Quarry proper; they include 26Ek3170, 26Ek3171, 26Ek3184, 26Ek3192, 26Ek3195, 26Ek3198, 26Ek3200, and 26Ek3204. The remainder consists of Localities 19, 20, 21, 22, 23, 25, and 98 of 26Ek3032.

Intermountain Research (1988b; 1988c) designed a program for data recovery at these sites and implemented it in spring and summer of 1989. The remainder of this chapter describes the archaeological content of the Eastern Periphery as revealed by these investigations on a site by site basis. Emphasis is on the results of data recovery; test phase results are treated more summarily, as they are reported elsewhere (Botkin 1989). Table 150 provides an overview of field actions employed during both phases of work; Table 151 summarizes the collections that resulted.

Table 150. Summary of Collection Procedures, Eastern Periphery.

Site/ Locality Number	Phase	FEATURES RECORDED Total (n)	Sampled (n)	FEATURE CONTEXT Surface Scrape (m^2)	Subsurface Excavation (m^3)	NONFEATURE CONTEXT Surface Scrape (m^2)	Subsurface Excavation (m^3)
26Ek3170*	T	14	2	9.75	-	5.00	0.78
	DR	-	3	33.00	0.19	-	6.58
26Ek3171*	T	8	3	5.44	-	-	1.40
	DR	-	3	-	0.49	-	5.42
26Ek3172	T	6	1	8.00	-	-	-
26Ek3173	T	4	1	40.00	0.07	-	-
26Ek3174	T	2	0	-	-	-	-
26Ek3175	T	1	0	-	-	-	-
26Ek3177	T	1	1	0.75	0.025	-	-
26Ek3178	T	4	1	5.00	-	-	-
26Ek3179	T	2	1	13.00	-	-	-
26Ek3180	T	1	0	-	-	-	-
26Ek3181	T	1	1	24.00	0.04	-	-
26Ek3183	T	1	1	15.00	-	-	-
26Ek3184*	T	26	4	9.00	0.17	-	-
	DR	-	6	113.00	0.58	76.00	-
26Ek3185	T	7	1	20.00	0.04	-	-
26Ek3186	T	2	0	-	-	-	-
26Ek3187	T	1	0	-	-	-	-
26Ek3188	T	1	0	-	-	-	-
26Ek3189	T	4	0	-	-	-	-
26Ek3190	T	11	2	40.00	0.07	-	-
26Ek3191	T	1	1	4.00	-	-	-
26Ek3192*	T	5	2	29.00	4.31	-	-
	DR	-	2	-	11.13	-	-
26Ek3193	T	7	2	7.00	-	-	-
26Ek3195*	T	8	2	1.13	-	-	-
	DR	-	2	-	-	-	-
26Ek3196	T	7	2	6.00	0.28	-	-
26Ek3197	T	11	3	1.25	0.50	7.00	-
26Ek3198*	T	25	4	37.75	0.13	-	-
	DR	-	3	-	5.57	-	-
26Ek3200*	T	1	1	0.75	-	-	-
	DR	-	1	-	-	-	-
26Ek3201	T	4	3	10.50	0.10	-	-
26Ek3202	T	1	1	0.50	0.24	-	-
26Ek3203	T	-	0	-	-	3.75	-
26Ek3204*	T	1	1	1.00	0.48	-	-
	DR	-	1	-	0.40	-	-
26Ek3032							
Locality 19	DR	1	1	8.00	-	-	-
Locality 20	DR	3	3	7.00	-	-	-
Locality 21	DR	1	1	2.00	0.30	-	-
Locality 22	DR	1	1	6.00	0.20	-	-
Locality 23*	DR	1	1	3.00	-	-	-
Locality 25	DR	7	2	10.00	-	-	-
Locality 93	DR	-	0	-	-	-	-
Locality 98	DR	1	1	10.00	-	-	-

* Trenches were placed in these locations; volume is not included.

T = Test Phase
DR = Data Recovery Phase

Table 151. Artifacts Recovered from Sites in the Eastern Periphery During Testing and Data Recovery.

Site	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces*	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
26Ek3170	42,014	78,544.5	11	5	226	3	46	3	4	2	-	-	300
26Ek3171	30,870	192,534.4	2	4	103	8	16	6	3	1	8	-	151
26Ek3172	1,258	1,969.9	-	-	6	-	-	-	-	-	-	-	6
26Ek3173	3,856	8,704.5	2	-	9	1	4	-	-	-	-	-	16
26Ek3174	-	-	-	-	1	-	-	-	-	-	1	-	2
26Ek3175	-	-	-	-	1	-	-	-	-	-	-	-	1
26Ek3177	726	588.2	2	1	3	-	-	-	1	-	-	-	7
26Ek3178	3,737	6,463.7	3	-	14	-	-	1	-	-	-	-	18
26Ek3179	1,219	1,421.5	-	-	2	-	3	-	-	-	-	-	5
26Ek3180	-	-	-	-	1	-	-	-	-	-	-	-	1
26Ek3181	3,585	6,297.8	-	-	11	-	5	-	-	1	1	-	18
26Ek3183	2,175	2,454.0	-	-	4	-	-	-	-	-	-	-	4
26Ek3184	56,011	156,462.6	7	6	287	9	76	5	4	1	-	2	397
26Ek3185	2,117	3,199.9	8	4	22	-	13	-	3	1	-	-	51
26Ek3186	-	-	-	-	1	-	-	-	-	-	-	-	1
26Ek3187	-	-	-	-	-	-	-	-	-	-	-	-	0
26Ek3188	-	-	-	-	-	-	-	-	-	-	-	-	0
26Ek3189	-	-	-	1	2	-	-	-	-	-	-	-	3
26Ek3190	8,875	11,228.8	9	2	69	2	17	-	-	1	-	1	101
26Ek3191	23	79.3	1	-	7	1	5	-	-	-	-	-	14
26Ek3192	39,246	69,157.5	16	4	231	4	69	4	6	7	102	1	444
26Ek3193	3,296	12,204.2	-	-	22	-	1	-	1	-	-	-	24
26Ek3195	44,888	42,604.3	-	-	46	-	4	-	6	-	-	-	56
26Ek3196	4,785	21,414.4	-	-	23	-	3	4	8	1	-	-	39
26Ek3197	1,171	6,738.0	-	-	35	-	1	-	6	-	-	-	42
26Ek3198	8,230	26,269.6	27	15	66	7	13	-	2	-	4	1	135
26Ek3200	240	1,012.1	-	-	12	-	1	-	-	-	-	2	15
26Ek3201	4,086	6,088.7	-	-	38	-	1	-	5	2	-	-	46
26Ek3202	3,111	2,128.6	-	-	3	-	-	-	-	-	-	-	3
26Ek3203	388	1,745.5	-	-	6	-	-	2	-	-	-	-	8
26Ek3204	123,915	73,990.0	6	5	90	2	21	6	9	1	-	-	140
26Ek3032													
Locality 19	14,673	73,017.8	-	-	65	5	23	-	2	1	-	-	96
Locality 20	9,587	32,983.5	1	-	21	4	6	-	-	-	-	-	32
Locality 21	1,794	39,896.1	-	-	7	8	2	4	-	-	-	-	21
Locality 22	2,067	13,681.6	-	-	6	3	1	-	-	-	-	-	10
Locality 23	38,487	104,890.4	6	1	70	10	26	3	2	-	-	1	119
Locality 25	25,716	81,379.8	-	-	103	6	13	2	5	-	-	-	129
Locality 93	-	-	-	-	-	-	-	-	-	1	-	-	1
Locality 98	1,287	12,303.3	-	-	9	-	1	-	1	-	-	-	11
Totals	483,433	1,091,454.5	101	48	1622	73	371	40	68	20	116	8	2,467

* Count includes "possible" bifaces

Quarry Pit Sites

Sites containing quarry pits were the focus of a significant proportion of fieldwork in the Eastern Periphery. In addition to the quarry pits themselves, whose stratified, often charcoal-laden deposits chronicle how most of the toolstone obtained in the East was extracted, the largest sites encompass the widest variety of cultural features; at several, quarry pits are accompanied by outcrop and cobble quarries, reduction stations, and biface caches.

From its base in Big Meadows at the confluence of Little Antelope Creek and Undine Gorge, Ramadan Ridge rises gradually southward in a series of broad, nearly flat benches to span the southwestern quarter of the Eastern Periphery. Three of the seven sites containing quarry pits (26Ek3170, 26Ek3171, and Locality 23) occupy two of its largest benches. In light of their shared topography and archaeological similarities, the following remarks are pertinent to each.

Unlike other quarry pit sites in the subarea, quarry and reduction assemblages from the Ramadan Ridge sites are augmented by implements commonly associated with maintenance and subsistence chores, e.g., ceramics, flake tools, ground stone, projectile points, and preforms. Given this, and the nearness of the most reliable water source in the East, it is tempting to regard the residential qualities of quarry sites on Ramadan Ridge geographical extensions of the domestic behavior more evident around the spring in Big Meadows (Leach and Botkin 1991).

The importance of the ridge as a place to acquire and process toolstone eclipses its residential qualities. A relatively shallow colluvium of sandy silt with abundant gravels overlies a tuff substrate, in places sufficiently well silicified to provide high quality opalite. At several widely scattered locations along the western slope, and especially on slope risers between benches, opalite bedrock is exposed in low ledges or is weathered into extensive cobble fields. These exposures were exploited, in four instances, by the excavation of pits. Utilization of the cobble fields was common but less spatially focused; as a result, little of this activity left discrete cultural features.

Vegetation occupying the ridge is essentially identical to that of the surrounding countryside, a broken mosaic of big sage and low sage grasslands. More productive plant assemblages occur immediately adjacent the ridge, however, in riparian settings around Big Meadows and along Little Antelope Creek.

26Ek3170

26Ek3170 encompasses the entire first bench of Ramadan Ridge (Figure 143). Its northern boundary is coterminous with that of the Tosawihi Quarry and is more an administrative convention than an archaeological judgement; only a slight undulation in the ridgeline differentiates 26Ek3170 from habitation Locality 27 in Big Meadows. As defined by topography and artifact distribution, 26Ek3170 also subsumes the quarry pits of Localities 23 and 26 (cf. Figure 142).

Even with these localities deleted, the site remains the most extensive in the Eastern Periphery, covering 31,000 m^2 of the ridgeline between 5585 feet (1702 m) and 5660 feet (1725 m) amsl. Close interval inspection during testing resulted in the detection of twelve reduction stations and a quarry pit. An additional feature (a biface cache) was discovered after the conclusion of data recovery.

Nonfeature Contexts

An abundant and diverse assemblage of artifacts lies outside features. Surface collections recovered scores of bifaces and other reduction forms, as well as an assortment of maintenance and subsistence implements (Table 152). Cultural remains are particularly abundant in the northwestern quadrant of the site, where the ground surface is overlain by a nearly continuous, moderate density scatter of debitage and formed artifacts. Visual assessment of the content of this area proved difficult, as its structure is reflected by subtle differences in surface artifact density over a broad expanse. To help quantify variation within it, a discontinuous series of five 1 m x 1 m units was surface scraped along a baseline spanning the scatter from ridgecrest to western midslope.

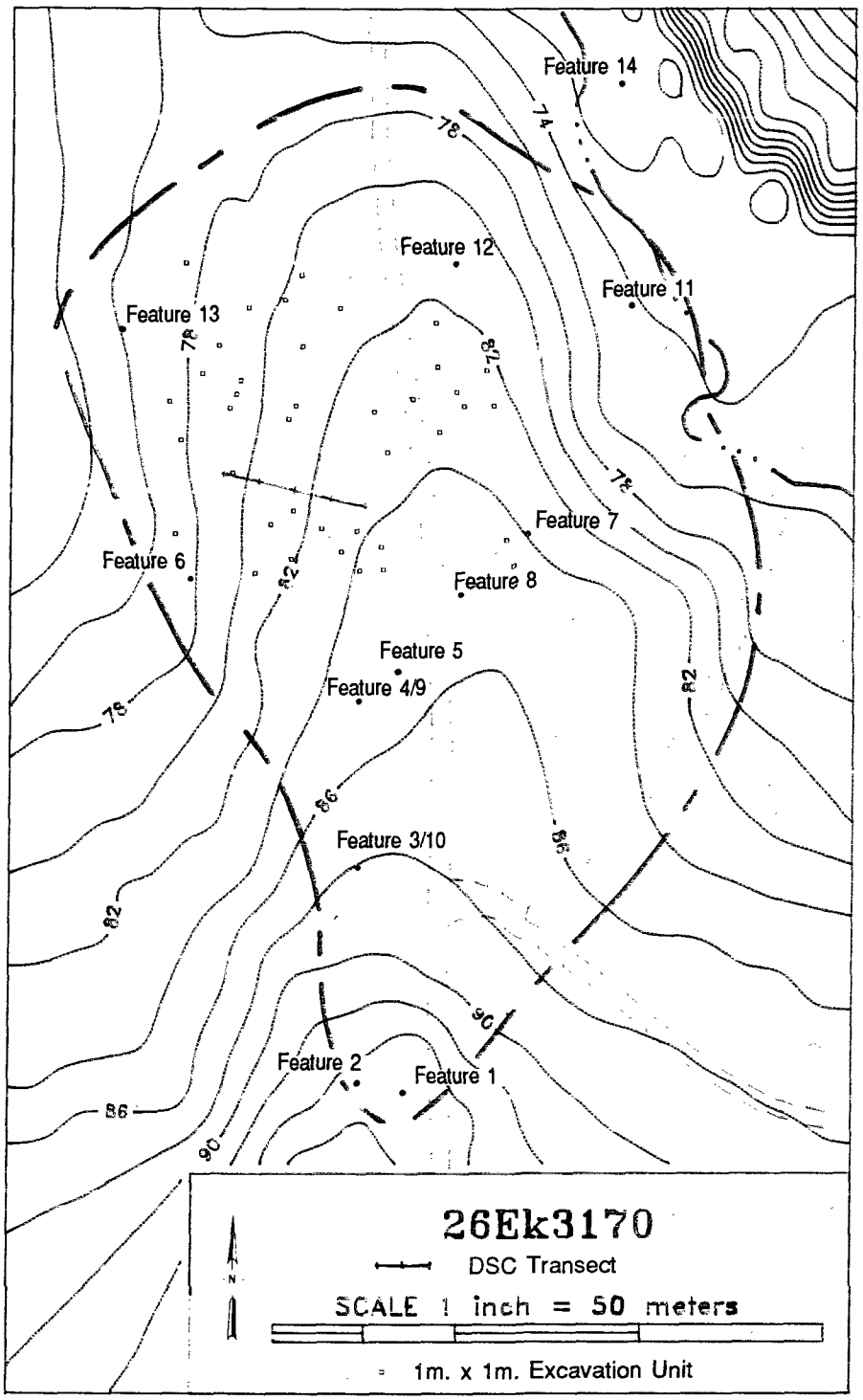


Figure 143. 26Ek3170 site map.

Table 152. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3170.

Feature	Total Area (m^2)	DEBITAGE[a] n	DEBITAGE[a] wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces[b]	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Total
1*	145	895	4,215.2	-	-	5	-	-	1	-	-	6
2	75	-	-	-	-	2	-	-	-	-	-	2
3	13	1[c]	1.2	-	-	1	-	-	-	-	-	1
4	63	6[c]	6.6	-	-	-	-	1	-	-	-	1
5	50	-	-	-	-	6	-	1	-	-	-	7
6	44	-	-	-	-	4	-	-	-	-	-	4
7	560	5[c]	24.9	-	-	9	-	1	1	-	-	11
8*	79	20,538	32,131.5	3	1	27	-	15	-	-	-	46
9*	6	2,664	5,784.6	-	-	2	-	-	-	-	-	2
10	71	2[c]	7.6	-	-	2	-	2	-	-	-	4
11	5	-	-	-	-	1	-	-	-	-	-	1
12	1,420	-	-	-	-	18	-	-	-	-	-	18
13	189	1[c]	18.6	-	-	7	-	1	-	-	-	8
14*	0.22	129	183.7	-	-	11	-	1	-	-	-	12
Surface Isolate		10[c]	40.7	3	1	89	1	14	1	4	1	114
Other Nonfeature		11,187	21,122.1	5	3	42	2	10	-	-	1	63
		35,438	63,536.7	11	5	226	3	46	3	4	2	300

* Sample feature
[a]Does not include trench samples
[b]Includes "possible" bifaces
[c]Obsidian only

The results of the exercise merit note in two particulars. First, absolute flake density peaks strongly toward the center of the area, as does the frequency of flakes of smallest mean size. Second, the ratio of flakes to shatter also reaches its peak at this point. This suggests that, generally, later stage reduction occurred in the center of the area, earlier stage reduction along the peripheries. Noteworthy too, is the great color diversity of opalite recovered from all collection units, suggesting that the zone consists of a palimpsest of reduction episodes, often involving material from diverse off-site sources.

Because of the abundance and variety of surface materials in this area, as well as the possibility of depth in the silty deposits, two 1 m x 1 m excavation units tested the vertical distribution of artifacts. One coincided with the upslope surface collection unit; the other explored an expanse to the north. The units exposed basically similar profiles, revealing rhyolite tuff bedrock at a depth of ca. 40 cm, overlain by bioturbated, moderately compact gravely silty loam. Opalite debitage and formed reduction products dominate the assemblages, and as in surface contexts, tools not directly associated with toolstone processing (i.e., Desert Series projectile points, preforms, and a metate fragment) were recovered as well (Table 153).

Subsequently, 42 excavation units were dug in the northwest quadrant in order to clarify its cultural content. This large sample was inspired by the recovery of groundstone and by the observed diversity of other artifact types suggesting residential function. Too, the proximity of the spring in Big Meadows and relatively flat local topography suggested that prehistoric activities might not have been limited to toolstone processing. The additional units were selected at random to compose a sample stratified by topographic contour. Units measured 1 m x 50 cm; their contents were passed through 1/4 inch mesh save for Units 12 and 28, for which 1/8 inch mesh was used.

The results of the expanded sampling reflect those of test excavations. Subsurface contexts are shallow. Only in Unit 43 had deposits accumulated to 50 cm; most units encountered tuff bedrock between 30 cm and 40 cm. The sandy, gravelly silt loams that characterize the soils are heavily bioturbated. Cultural accumulation is relatively homogeneous; although artifact densities are somewhat higher in the upper 10 cm, cultural materials occur in all unit levels, and artifact compositions mirror those of surface contexts. Opalite debitage is ubiquitous, and constitutes the entire cultural content of nearly one-third (n=13) of the units. Obsidian waste was recovered in scant quantities, and then only by capture in 1/8 inch screens. Small numbers of bifaces and flake tools comprise the formed artifact component of most units. Excavations encountered no subsurface cultural features.

Table 153. Artifacts Recovered from Excavation Units and Discretionary Surface Collection in Nonfeature Contexts, 26Ek3170.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Ground Stone	Total
1 (TS)[a]	0.38	2,373	3,509.4	3	2	-	-	1	-	6
2 (TS)	0.40	911	3,163.4	-	-	4	1	-	1	6
3 (EU)	0.20	83	378.3	-	-	1	-	-	-	1
4 (EU)	0.20	63	66.7	-	-	-	-	-	-	0
5 (EU)	0.20	47	47.9	-	-	-	-	-	-	0
6 (EU)	0.20	94	332.7	-	-	1	-	-	-	1
7 (EU)	0.15	66	82.8	-	-	1	-	-	-	1
8 (EU)	0.20	139	164.4	-	-	-	-	-	-	0
9 (EU)	0.15	81	153.5	-	-	-	-	-	-	0
10 (EU)	0.20	84	358.9	-	-	-	-	1	-	1
11 (EU)	0.20	70	71.2	-	-	2	-	-	-	2
12 (EU)[b]	0.15	208	89.9	-	-	1	-	-	-	1
13 (EU)	0.10	30	31.7	-	-	-	-	-	-	0
14 (EU)	0.15	94	148.3	-	-	-	1	1	-	2
15 (EU)	0.10	66	602.2	-	-	2	-	-	-	2
16 (EU)	0.15	175	187.6	-	-	2	-	-	-	2
17 (EU)	0.15	128	480.4	-	-	1	-	-	-	1
18 (EU)	0.15	58	170.8	-	-	-	-	-	-	0
19 (EU)	0.20	129	632.5	-	-	1	-	-	-	1
20 (EU)[b]	0.20	181	116.8	-	-	1	-	-	-	1
21 (EU)	0.15	114	226.1	-	-	1	-	-	-	1
22 (EU)	0.10	111	217.8	-	-	-	-	1	-	1
23 (EU)	0.20	201	347.4	-	-	2	-	1	-	3
24 (EU)	0.20	311	530.3	-	-	3	-	-	-	3
25 (EU)	0.10	79	91.1	-	-	1	-	-	-	1
26 (EU)	0.15	82	64.9	-	-	1	-	-	-	1
27 (EU)	0.20	305	613.6	-	-	4	-	1	-	5
28 (EU)[b]	0.10	115	215.7	-	-	2	-	-	-	2
29 (EU)	0.15	203	506.0	-	-	2	-	-	-	2
30 (EU)	0.15	129	196.8	-	-	3	-	-	-	3
31 (EU)	0.10	43	41.7	-	-	-	-	-	-	0
32 (EU)	0.10	44	158.4	-	-	-	-	1	-	1
33 (EU)	0.15	33	24.8	-	-	-	-	-	-	0
34 (EU)	0.10	35	23.6	-	-	1	-	-	-	1
35 (EU)	0.15	38	43.7	-	-	1	-	-	-	1
36 (EU)	0.10	36	33.4	-	-	-	-	-	-	0
37 (EU)	0.15	89	210.7	-	-	-	-	-	-	0
38 (EU)	0.20	65	136.4	-	-	-	-	-	-	0
39 (EU)	0.20	94	163.7	-	-	2	-	-	-	2
40 (EU)	0.15	20	49.9	-	-	-	-	1	-	1
41 (EU)	0.10	49	159.0	-	-	-	-	1	-	1
42 (EU)	0.20	263	271.7	-	-	-	-	-	-	0
43 (EU)	0.25	302	397.8	-	-	-	-	-	-	0
44 (EU)	0.20	173	242.1	1	-	-	-	-	-	1
1 (DS)	0.02	48	155.7	-	-	-	-	-	-	0
2 (DS)	0.02	122	285.2	-	-	-	-	-	-	0
3 (DS)	0.02	1,164	1,815.3	-	-	-	-	-	-	0
4 (DS)	0.02	62	111.4	-	-	-	-	-	-	0
5 (DS)	0.02	51	167.6	-	-	-	-	-	-	0
Totals	7.58	9,461	18,291.2	4	2	40	2	9	1	58

(TS) = Test Excavation Unit
(EU) = Excavation Unit
(DS) = Discretionary Surface Collection Unit

[a]Excavated below DS Unit 3
[b]Includes a 50 x 50 cm 1/8 inch mesh control quadrant

Overall, the northwestern zone hosted a variety of activities, none spatially focused enough or the remains of any sufficiently well preserved to be isolated from the general accumulation. Toolstone processing left the most abundant remains. Debitage and biface assemblages reflect core reduction as well as biface production from early through late reduction stages. One-third (n=40) of the 123 bifaces recovered from extra-feature contexts have been heat-treated (cf. Chapter 6). While common white opalites, probably from the quarries immediately upslope or elsewhere in the East, dominate the assemblage, the range of distinctive, colorful opalites implies utilization of raw materials from a variety of off-site sources as well. From the incidence of flake tools, projectile points, preforms, groundstone, and non-opalitic (obsidian) raw material we infer that activities other than toolstone processing took place here; however, evidence for residential use of the place is not incontrovertible (cf. Chapter 24).

Cultural Features

The remainder of fieldwork focused on cultural features. Feature 1, the quarry pit, was sampled and trenched during testing, and was revisited for additional stratigraphic work during data recovery. Most of the twelve reduction features are known exclusively from surface inventories conducted during the test phase. Varying chiefly in size, they consist of dense artifact accumulations dominated by opalite debitage, bifaces, and, less common, cores. Flake tools and other implements augment a number of the assemblages (cf. Table 152). Features 8 and 9 were selected for sampling and received systematic scrutiny during data recovery, and the inventory of Feature 12 was expanded. Subsequently the biface cache, Feature 14, was discovered, recorded, and collected in full.

Feature 1

The quarry pit and associated reduction debris at the southern extreme of the site was manifest on the surface as a shallow depression ca. 3 m long, adjacent the downslope side of a low opalite outcrop (Figure 144). The outcrop is small, occurring in a matrix of highly weathered red tuff. It is impossible to say whether the opalite is the end of a stratum of silicified rock between two strata of tuff, or more likely, a localized pocket or lens. During testing a discontinuous series of 12 25 cm x 25 cm surface scrape units spanned the feature at 1 m intervals. In addition to a large quantity of opalite debitage, units yielded a small collection of formed reduction products. Density and average weight of debitage is greatest upslope of the pit, marking the feature's principal workshop (Table 154).

A backhoe trench excavated during tests proved uninformative. The trench transected the pit from the edge of the outcrop through the downslope extent of the berm, revealing only that the depression is 30 cm deep and that, in sharp contrast to pits tested elsewhere, its berm contains very little quarry debris. This suggests that the toolstone source was not exploited intensively. A second trench was excavated during data recovery. Analysis of the resulting stratigraphic profile served to clarify the internal structure of the feature and amplifies our initial impression that it is relatively incipient.

Trench 2 intersects the trench dug during testing along a roughly perpendicular east-west axis and exposes a profile nearest the downslope edge of the opalite outcrop. The profile shows a very simple sequence of quarry debris overlain by a disturbed silt mantle (Figure 145). Unit 5 is a mixture of fine opalite chips in a clay loam matrix, typical of the hashy stratum commonly mantling quarry pit floors at Tosawihi. Unit 3 is composed of medium to coarse opalite flakes and chunks in an abundant matrix of dark brown silty clay loam with a weak granular structure. There appears to be a fair amount of bioturbation and some soil development here and in other units in this shallow pit. Unit 3 does not appear to have extended very much farther west, across the gap now formed by Trench 1. Unit 2 is a weakly granular silt loam with common tuff clasts and opalite flakes and chunks. The opalite and tuff clasts probably were introduced into the silts both by disturbance during quarrying and from subsequent slopewash and bioturbation. Unit 1 is a thin veneer of organically rich silt that is less pronounced on the east side of the profile.

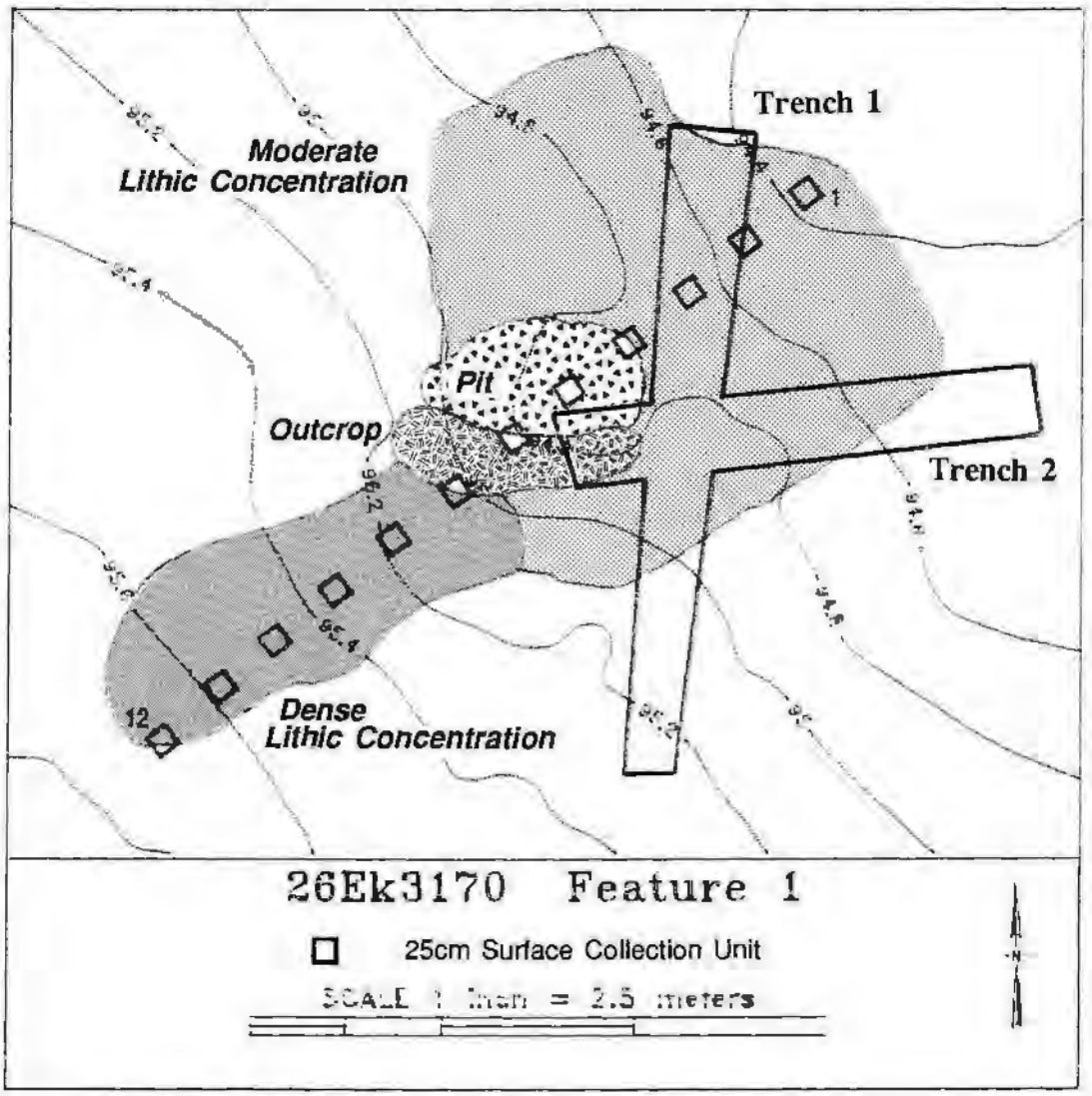


Figure 144. Feature 1 plan, 26Ek3170.

Table 154. Artifacts Recovered from Feature 1, 26Ek3170.

Unit No. (Type)	Surface Scrape (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces	FORMED ARTIFACTS Modif. Chunks	Total
1 (SF)	0.063	304	506.1	-	-	0
2 (SF)	0.063	48	290.9	-	-	0
3 (SF)	0.063	38	33.7	-	-	0
4 (SF)	0.063	88	281.4	-	-	0
5 (SF)	0.063	145	281.8	-	-	0
6 (SF)	0.063	35	63.9	-	-	0
7 (SF)	0.063	49	94.5	1	-	1
8 (SF)	0.063	87	866.4	-	-	0
9 (SF)	0.063	124	590.2	-	-	0
10 (SF)	0.063	145	874.4	-	-	0
11 (SF)	0.063	79	615.3	-	-	0
12 (SF)	0.063	16	61.4	-	-	0
Surface Inventory	N/A			4	1	5
Trench Samples	N/A	6,601	15,107.4	-	-	0
Totals	0.756	7,759	19,667.4	5	1	6

(SF) = Surface Scrape

Feature 8

Located on the eastern slope (cf. Figure 143), Feature 8 covers 79 m^2 and consists of a moderate to dense scatter of debitage; it was sampled in order to assess the contents of one of the largest reduction features at the site. Two close-set 16 m^2 artifact concentrations in the center of the feature were the focus of sampling. The entire surface of each was scraped by a block of 16 1 m x 1 m units. Unit recovery rates reveal the contents of both loci to be similar (Table 155). Where surface density was greatest, one 1 m x 50 cm excavation unit explored subsurface contexts. Dense artifact concentrations similar in composition to those on the surface were found throughout the deposit until bedrock was encountered at 40 cm (Table 155). These remains appeared to be concentrated in a slight subsurface depression, but soil turbation renders this tentative.

Table 155. Artifacts Recovered from Feature 8, 26Ek3170.

Locus/ Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Total
LOCUS A								
45-60 (SF)[a]	0.32	6,564	10,147.2	1	-	7	4	12
55 (EU)[b]	0.14	1,340	2,242.2	-	-	1	2	3
LOCUS B								
61-76 (SF)[c]	0.32	12,634	19,742.1	2	1	16	9	28
Surface Inventory[d]	N/A	-	-	-	-	3	-	3
Totals	0.78	20,538	32,131.5	3	1	27*	15	46

(SF) = Surface Scrape
(EU) = Excavation Unit
*Includes "possible" bifaces
[a]Includes 50 x 50 cm 1/8 inch mesh control quadrant in SF Unit 15
[b]1 m x 50 cm; below SF Unit 55
[c]Includes 50 x 50 cm 1/8 inch mesh control quadrant in SF Unit 68
[d]Combines Locus A and Locus B

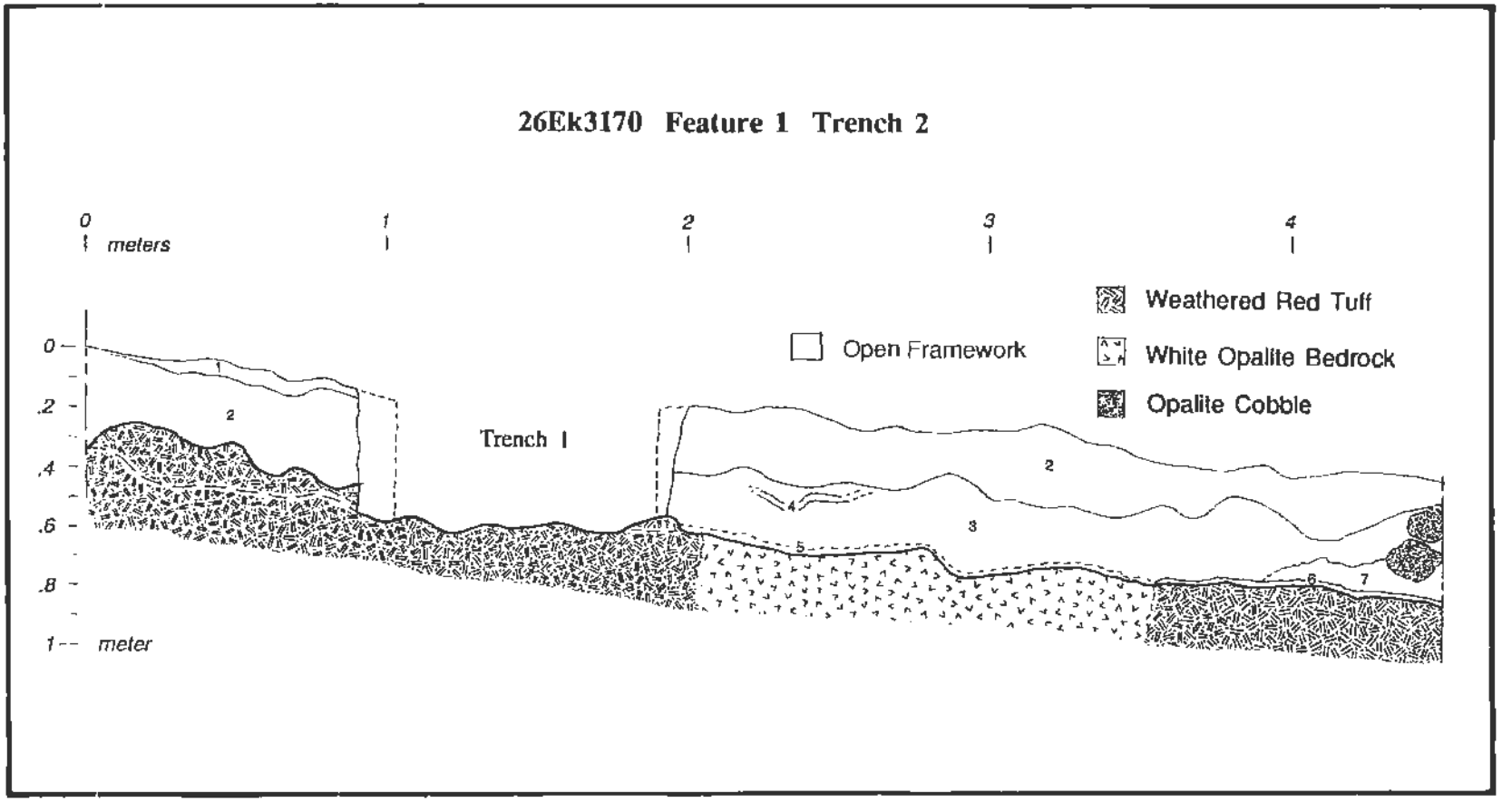


Figure 145. Description of stratigraphic units, Trench 2, 26Ek3170.

Figure 145. Description of stratigraphic units, Trench 2, 26Ek3170.

Stratum	Description
1	Very dark brown (10YR 3/1) dry; silt; loose; abundant charred organic matter; boundary clear.
2	Dark brown (10YR 3/5) slightly moist; silt loam; loose to very weak granular; abundant small opalite and reddish tuff clasts, rare fine opalite flakes; abundant fine roots; boundary clear.
3	Dark brown (10YR 3/3) slightly moist; silty clay loam; weak granular; common fine to medium reddish tuff clasts, common medium to coarse opalite flakes and chunks; common roots.
4	Subhorizontal fine to medium opalite flakes forming a distinct lens.
5	Dark brown (10YR 3/3) moist; clay loam; abundant hashy fine opalite chips.
6	Dark reddish brown (5YR 3/4) moist; fine sandy clay, weathered tuff; rare angular tuff and opalite clasts.
7	Dark brown to dark yellowish brown (10YR 4/3 to 4/4) slightly moist; silty clay loam; common fine subrounded to subangular pebbles; boundary clear and irregular.

Predictably, vast quantities of opalite debitage dominate the assemblage; its character suggests early to intermediate stage biface manufacturing, and more than half the 26 chert bifaces recovered are heat-treated. The opalite debitage from one locus revealed an uncommonly high incidence of heat-treatment (cf. Chapters 6 and 10). Beyond this, however, both loci yielded small quantities of obsidian waste, and diverse flake tools. Unclassifiable projectile point fragments were encountered in both loci, and one contained a Stemmed Series point, a preform, and an obsidian biface as well.

Feature 9

Feature 9 lies on a nearly flat portion of the ridgecrest in the southern portion of the site (cf. Figure 143). It was selected for sampling due to its simplicity and clarity. Its entire 6 m^2 surface expression was collected by surface scrapes; the character of the resulting collection suggests that the feature served as a station for early stages of biface reduction (cf. Chapters 6 and 10). Three obsidian waste flakes hint that the location witnessed other tasks as well (cf. Table 151).

Feature 12

Feature 12 is the largest feature at 26Ek3170. Defined by a moderate to high density concentration of opalite debris, it covers 1420 m^2 on the eastern ridgeslope near the site's northern limit (cf. Figure 143). Our observation that additional bifaces had been exposed on its surface during the year-long hiatus between testing and data recovery led us to inventory it a second time. The exercise added seven bifaces to the 11 collected during testing. They reflect intermediate stage reduction, and imply that, as at Feature 8, much of this effort was performed on heat-treated specimens (cf. Chapter 6).

Feature 14

Located on the northern bank of the intermittent stream course that drains Undine Gorge, Feature 14 fell just outside the site boundary as originally defined and subsequently was included as a component of 26Ek3170 on the basis of proximity (cf. Figure 143).

At the time of its accidental discovery, Feature 14 was manifest as a tight cluster of eight opalite bifaces (Figure 146) exposed on the surface less than a meter higher than the creek bed in an area otherwise nearly devoid of cultural remains. A 1 x by 1 m surface scrape was superimposed to identify its full extent and to search for buried specimens. The excavation revealed that most of the cache already was exposed; two additional bifaces were found stacked beneath other specimens in the center. The pile clustered in less than 250 cm^2; most of the specimens touched on another. Scant debitage and a flake tool were recovered by screening soils from general contexts within the scrape. The ten bifaces are whole or nearly so; nine reflect intermediate reduction stages; (Stage 3), one is a large biface flake blank (Stage 1), and none has been heat-treated (cf. Chapter 6). The survival of the feature so near the seasonally flooded and occasionally torrential drainage seems miraculous. It appears to represent a store of bifaces stockpiled on the stream bank, intended for eventual heat-treatment and further reduction, but never retrieved.



Figure 146. Biface cache, 26Ek3170.

Implications

The most overt aboriginal uses of 26Ek3170 left behind the copious, imperishable wastes of toolstone procurement and processing. But toolstone procurement appears to have been comparatively slight given the minimal development of the quarry pit at Feature 1, while the numerous reduction features contain vast quantities of processing debris incommensurately larger than likely to have been yielded by the meager on-site source. This, coupled with abundant, colorful opalite debitage in the northwestern quadrant, suggests that it served largely for the reduction of toolstone brought from elsewhere. As is the case for most sites tested in the Eastern Periphery where reduction forms dominate assemblages, flake tools (as well as other artifacts assumed to derive from maintenance and subsistence chores) occur in small numbers in many reduction features as well as throughout general site contexts. The degree to which their presence allows us to infer residential function remains problematical; the question is addressed from broader perspectives in Chapters 23 and 24.

26Ek3171

26Ek3171 occupies the second bench of Ramadan Ridge, immediately upslope and south of 26Ek3170. It covers some 7540 m^2 and contains two quarry pits, a cobble quarry, and five reduction stations. The quarries occur on the eastern slopes. The broad, moderately flat surface of the ridgetop appears to have constituted a "workshop zone" in which toolstone was processed. Here, in addition to distinct reduction features, the site is littered with a light to moderate density scatter of opalite debitage exhibiting considerable variety in color and texture (Figure 147).

Nonfeature Contexts

Close interval examination of nonfeature contexts isolated numerous bifaces as well as a variety of maintenance/subsistence tools and several obsidian waste flakes. Also, eight grayware ceramic sherds were recovered from the surface at the southern extreme.

Surficial evidence suggests that the silt loams hosting the lithic scatter in the northwestern portion of the site have undergone rodent churning sufficiently intense to have resulted in the dispersal and/or burial of cultural features. In light of this, three 1 m x 1 m excavation units probed the area during testing; each revealed cultural materials and depositional contexts generally similar to those found in the northwestern quadrant of 26Ek3170. Soils are heavily turbated and only weakly stratified. Artifacts, chiefly opalite debitage, occur throughout until bedrock is encountered (40 cm - 50 cm below the surface; cf. Table 156). The uppermost deposits (to 10 cm depth) contributed most artifacts recovered. Soils here consist of a loose silt loam stained a dark, midden-like color (presumably the result of a range fire that swept the ridge in 1985). This zone is underlain by about 20 cm of more compact silt loam in which, coincident with a general decline in cultural materials, the incidence of large clasts of opalite and unwelded tuff increases. Below this, soils become increasingly clayey and rocky and artifact densities diminish toward bedrock, much of which is well silicified and is of toolstone quality; most flakes in deposits immediately above it are of robust size. Thus, we suspect that the substrate may have served as a lithic source.

Expanded exposure of the nonfeature zone was undertaken during data recovery to clarify its possible quarry content and to assess its other functional characteristics. To provide this expanded perspective, 30 1 m x 50 cm excavation units were dug at randomly selected locations; cultural materials returned by the effort are summarized in Table 156. Overall, artifacts

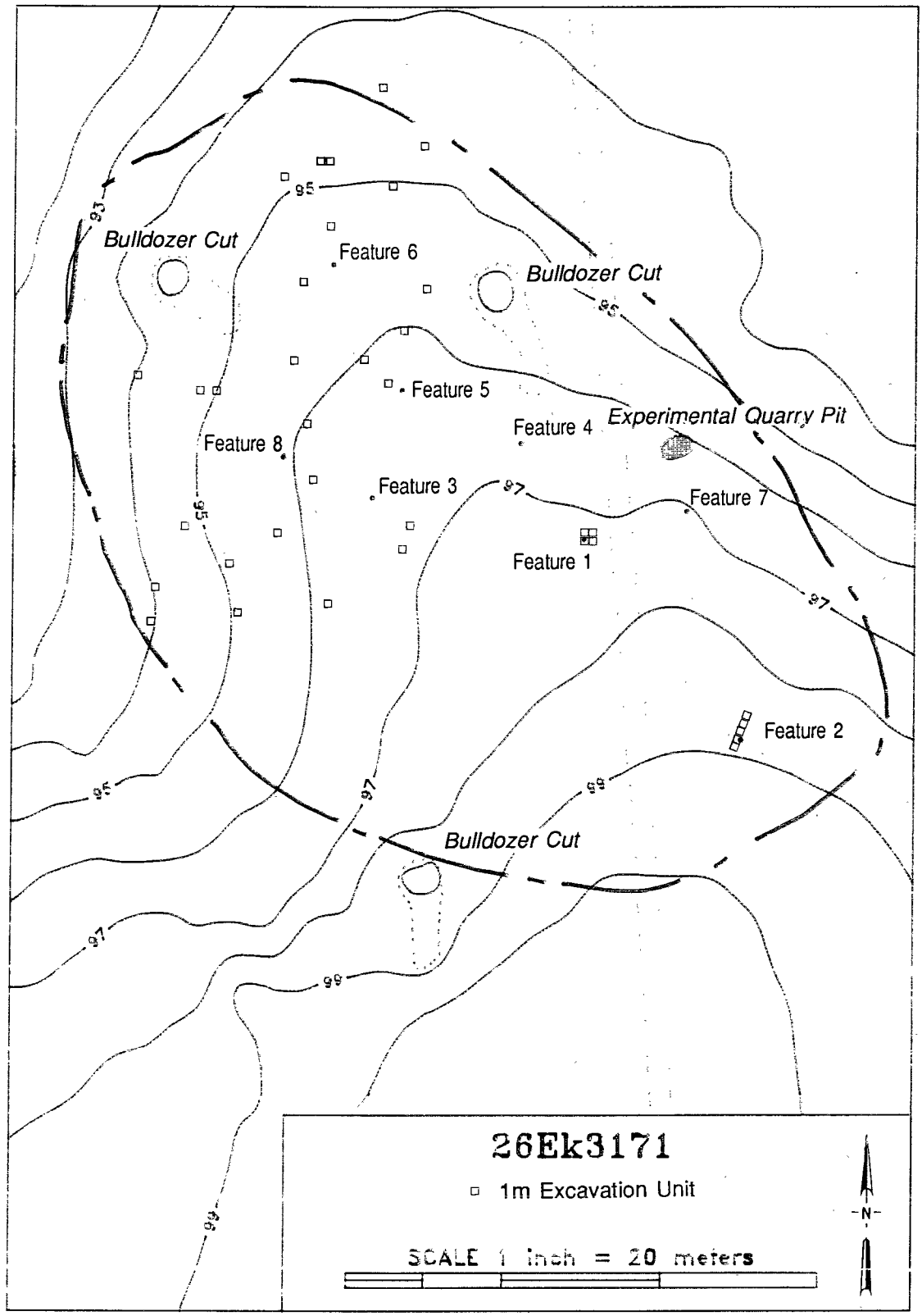


Figure 147. 26Ek3171 site map.

artifacts are distributed rather homogeneously throughout the horizontal extent of the area, and artifact accumulations and soils are essentially identical to those sounded during tests. The depth of deposits everywhere were constrained by subtle undulations of the tuff substrate. Most units encountered bedrock between 30 cm and 40 cm, a few as shallow as 20 cm, some as deep as 50 cm. Opalite debitage dominates all proveniences, and in nine units constitutes the *only* artifact class. Small numbers of bifaces and other reduction products accompany opalite waste in the remainder of the sample; at widely scattered locations these are supplemented by a few flake tools and preforms.

Table 156. Artifacts Recovered from Excavation Units in Nonfeature Contexts, 26Ek3171.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Total
1 (TS)	0.40	139	1,118.3	-	-	-	-	-	-	-	0
2 (TS)	0.50	269	773.9	-	2	-	-	-	-	1	3
3 (TS)	0.50	180	380.7	-	-	-	-	-	-	-	0
4 (EU)	0.20	72	233.3	-	1	-	-	-	-	-	1
5 (EU)	0.20	137	255.5	-	3	-	-	-	-	-	3
6 (EU)	0.20	84	609.4	-	2	-	-	-	-	-	2
7 (EU)	0.20	200	339.5	-	3	-	1	-	-	-	4
8 (EU)	0.15	194	474.3	-	1	-	-	-	-	-	1
9 (EU)	0.20	171	264.2	-	1	-	-	-	-	-	1
10 (EU)	0.20	117	173.4	-	-	-	-	-	-	-	0
11 (EU)	0.20	110	206.2	-	1	-	2	-	-	-	3
12 (EU)	0.25	139	570.5	-	3	-	-	-	-	-	3
13 (EU)[a,†]	0.15	10,613	19,414.8	-	7	-	2	-	-	-	9
14 (EU)[a]	0.20	155	428.2	-	-	-	-	-	-	-	0
15 (EU)	0.20	97	267.4	-	-	-	-	-	-	-	0
16 (EU)	0.25	94	194.3	-	-	-	-	1	-	-	1
17 (EU)	0.25	77	204.7	-	-	-	-	-	-	-	0
18 (EU)	0.20	126	147.2	-	1	-	-	-	-	-	1
19 (EU)	0.20	139	241.3	-	-	-	-	-	-	-	0
20 (EU)	0.25	43	142.5	-	1	-	-	-	-	-	1
21 (EU)	0.25	113	518.8	-	2	-	-	-	-	-	2
22 (EU)	0.25	542	1,019.1	1	3	-	-	1	1	-	6
23 (EU)	0.15	81	73.1	-	-	-	-	-	-	-	0
24 (EU)[a]	0.25	232	1,842.4	1	4	1	-	-	-	-	6
25 (EU)	0.10	57	234.6	-	1	-	-	-	-	-	1
26 (EU)	0.20	34	37.1	-	-	-	-	-	-	-	0
27 (EU)	0.15	71	1,226.5	-	1	-	-	-	-	-	1
28 (EU)	0.15	84	169.1	-	2	-	-	-	-	-	2
29 (EU)	0.25	116	1,123.2	-	3	2	-	-	-	-	5
30 (EU)	0.10	80	243.9	-	-	-	-	-	-	-	0
31 (EU)	0.15	100	340.2	-	1	-	-	-	-	-	1
32 (EU)	0.20	40	252.2	-	1	-	-	-	-	-	1
33 (EU)	0.15	58	240.9	-	-	-	-	-	-	-	0
Totals[b]	7.25	14,764	33,760.7	2	44*	3	5	2	1	1	58

(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a] Includes a 50 x 50 cm 1/8 inch mesh control quadrant
[b] Total excludes EU 13 artifacts
[†] Unit in Feature 3
*Includes 2 "possible" bifaces

No subsurface cultural features were found. Although toolstone-quality opalite occurs within the bedrock exposed by a numerous units, none of it had been exploited. The character of both debitage (cf. Chapter 10) and the biface assemblage (cf. Chapter 6) suggests that most culturally modified opalite recovered from the area is attributable to early to intermediate stage biface manufacture. Twenty percent of the bifaces have been heat-treated.

Cultural Features

The surface content of each cultural feature was inventoried during testing. The five reduction features (Features 1, 3, 5, 6, and 8) occur along the ridgecrest, and consist of moderate to high density accumulations dominated by opalite debitage. There are few formed artifacts. Several assemblages contain small numbers of bifaces and flake tools, and Feature 5 returned a Desert Side Notched projectile point. Reduction Feature 1 was sampled during testing.

At Feature 4, a cobble quarry, weathering of the opalite bedrock created a supply of naturally liberated raw material. Use of the source appears to have been minimal, but much of it has been obliterated by a bladecut of historical origin. The light to moderate density scatter of debitage and assayed cobbles remaining contain several biface fragments, a pair of flake tools, and an unclassifiable projectile point.

Features 2 and 7 lie on slopes east of the ridgecrest. Both are well developed quarry pits; they were sampled during testing and data recovery. Table 157 summarizes the artifact content of all features as revealed by both phases of fieldwork.

Table 157. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3171.

		DEBITAGE[a]		FORMED ARTIFACTS									
Feature	Total Area (m^2)	n	wt. (gm)	Proj. Points	Preforms	Bifaces[b]	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Total
1*	189	1,704	23,738.2	-	-	10	2	-	2	-	-	-	14
2*	140	8,865	124,206.8	-	-	15	1	1	1	1	-	-	19
3*	16	1,933	8,987.8	-	-	5	-	1	-	-	-	-	6
4	227	-	-	1	-	4	-	2	1	-	-	-	8
5	177	-	-	1	-	6	-	-	-	-	-	-	7
6	63	-	-	-	-	1	-	1	-	-	-	-	2
7*	55	-	-	-	-	6	1	-	-	-	-	-	7
8	28	-	-	-	-	2	-	-	-	-	-	-	2
Surface Isolates		3[c]	16.2	-	2	14	-	3	-	1	-	8	28
Other Nonfeature		12,831	24,772.9	-	2	40	4	8	2	1	1	-	58
Totals		25,336	181,721.9	2	4	103	8	16	6	3	1	8	151

* Sample Feature
[a]Does not include trench samples
[b]Includes "possible" bifaces
[c]Obsidian only

Feature 1

Feature 1 was sampled because of its small, spatially discrete nature that promised recovery of the residue of a single event of toolstone reduction. The feature was collected completely by four 1 m x 1 m surface scrapes. Raw materials are strikingly uniform in color and texture, dominated by robust items characteristic of core reduction. Cores and biface fragments comprise the total artifact assemblage, reflecting flake blank production through intermediate stage biface reduction (cf. Chapter 6). Absent chemical characterization of opalite, proximity and visual comparison of raw materials suggest that the scatter was created during the reduction of toolstone acquired from the quarry pit of Feature 7, ten meters east.

Feature 2

The smaller quarry pit, Feature 2, was manifest on the surface as a shallow, circular, 6 m diameter depression accompanied by a low berm of quarry debris issuing from its northern, downslope margin. The pit, berm, and surrounding ground surface are mantled by a moderate to high density lithic scatter encompassing about 140 m^2 (Figure 148).

During tests, surface contexts were sampled by scraping two discontinuous baselines of units arrayed in a cruciform pattern and centered on the pit interior. Unit contents consist almost exclusively of opalite debitage, densest on the pit berm. Formed artifacts are scarce, represented by a single core and three bifaces (Table 158). To explore the pit interior, we hand excavated a trench (Trench 1) that bisected the depression along its north-south axis. Although revealing stratified deposits to a depth of 70 cm, the trench proved too narrow to allow close assessment of the resulting profile.

Table 158. Artifacts Recovered from Feature 2, 26Ek3171.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Total
1 (SF)	0.063	2	3.3	-	-	-	-	-	0
2 (SF)	0.063	26	39.1	-	-	-	-	-	0
3 (SF)	0.063	8	51.9	-	-	-	-	-	0
4 (SF)	0.063	45	352.5	-	-	-	-	-	0
5 (SF)	0.063	44	59.8	-	-	-	-	-	0
6 (SF)	0.063	45	101.6	-	-	-	-	-	0
7 (SF)	0.063	41	95.3	-	-	-	-	-	0
8 (SF)	0.063	21	68.6	-	-	-	-	-	0
9 (SF)	0.063	6	36.9	-	-	-	-	-	0
10 (SF)	0.063	16	58.2	-	-	-	-	-	0
11 (SF)	0.063	14	32.4	-	-	-	-	-	0
12 (SF)	0.063	9	15.6	-	-	-	-	-	0
13 (SF)	0.063	12	12.4	-	-	-	-	-	0
14 (SF)	0.063	21	198.8	-	-	-	-	-	0
15 (SF)	0.063	7	15.5	-	-	-	-	-	0
16 (SF)	0.063	11	30.0	-	-	-	-	-	0
17 (SF)	0.063	15	53.7	-	-	-	-	-	0
18 (SF)	0.063	30	151.5	-	-	-	-	-	0
19 (SF)	0.063	24	51.0	-	-	-	-	-	0
20 (SF)	0.063	23	118.3	-	-	-	-	-	0
21 (SF)	0.063	24	113.9	1	-	-	-	-	1
22 (SF)	0.063	36	164.6	-	-	-	-	-	0
23 (SF)	0.063	-	-	-	-	-	-	-	0
50 (EU)	0.300	8,385	122,381.9	12	-	1	1	1	15
Surface Inventory	N/A	-	-	2	1	-	-	-	3
Trench Samples	N/A	5,537	10,828.7	4	1	-	-	-	5
Totals		14,402	135,035.5	19*	2	1	1	1	24

(SF) = Surface Scrape
(EU) = Excavation Unit

*Includes "possible" bifaces

Field efforts during data recovery sought to clarify the internal structure and content of the pit. To this end, a backhoe trench (Trench 2) sectioned the depression perpendicular to the original cut. Trench 2 exposed a roughly northwest-to-southeast profile through the center of the pit (Figure 149). Prehistoric quarrying created a broad, shallow pit and a minor pit to the east, separated by a low septum of weathered tuff.

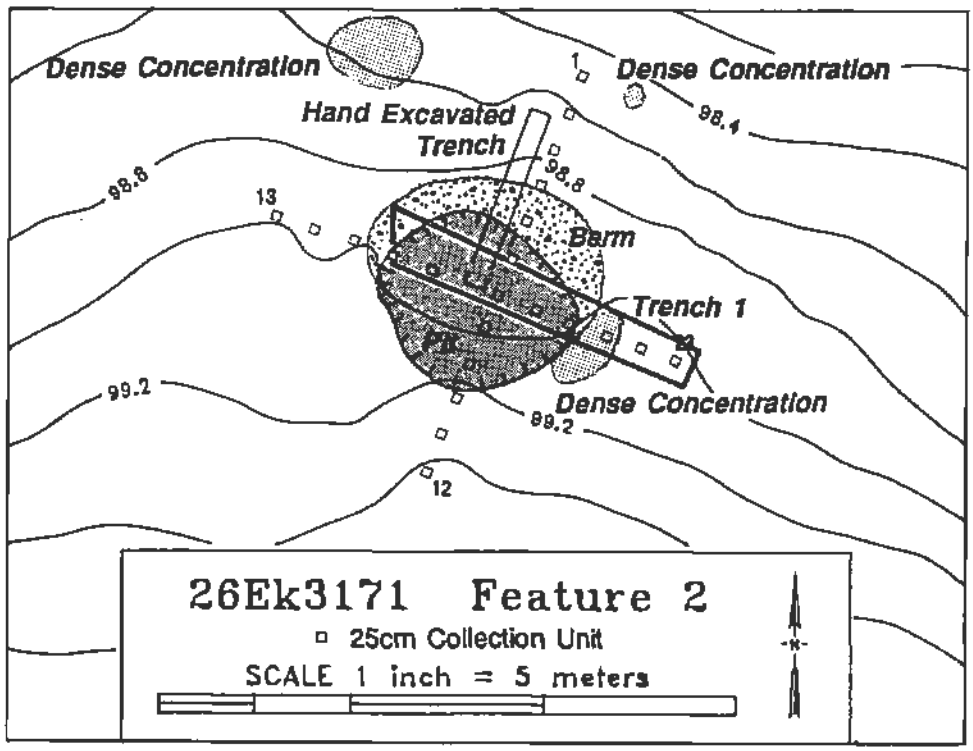


Figure 148. Feature 2 plan, 26Ek3171.

Bedrock consists of white tuff, both silicified and unsilicified. The unsilicified tuff has weathered to clay mixed with blocky clasts of soft "chalky" tuff. Silicified tuff opalite toolstone is exposed in the bottom of the large western pit, but not in the smaller eastern pit. This suggests that the eastern pit may represent a failed prospect. The opalite toolstone does not appear to form a layer below the weathered, unsilicified material; perhaps the opalite here is a "pod" or localized zone of silicification.

The stratigraphy is fairly simple, with relatively few distinct strata. Unit 12, for example, covers the entire floor of the main pit. This unit is composed of abundant, very fine to fine, angular opalite chips with a sandy pale brown clay matrix. Quite possibly, at least some of the fine sand and clay matrix in the "hash" is the product of natural slopewash.

Unit 11, like unit 12, extends across most of the pit. It is a poor, open framework of fine to medium opalite chunks and flakes with a brown, sandy, clay loam matrix. Vague lenses of alternating coarse and fine fill can be detected, none distinct enough to warrant division into separate stratigraphic units. Mantling Unit 11 over much of its surface is a grayish brown silt loam with common opalite and tuff gravel and cobbles and a few opalite flakes, especially in the accumulation of dry organic matter and charcoal nearest the surface. The slightly weathered opalite boulders and cobbles common in this unit and in Units 3 and 4 of the underlying clay-rich paleosol are relics of Pliocene/Pleistocene Little Antelope Creek (Bartlett et al. 1991).

The only moderately complex set of strata occur at the westernmost end of the pit, where Units 13-19 cover Units 11 and 12 and are overlain by the silt loam of Unit 2. Units 13-19 consist of quarry debris with varying sizes and amounts of opalite chunks and flakes in a sandy clay or sandy clay loam matrix. Bedrock also reaches its deepest point in this area. The smaller quarried area at the eastern end of the profile shows little extensive working; quarry waste consists of opalite chunks with a few flakes in a sandy clay loam matrix.

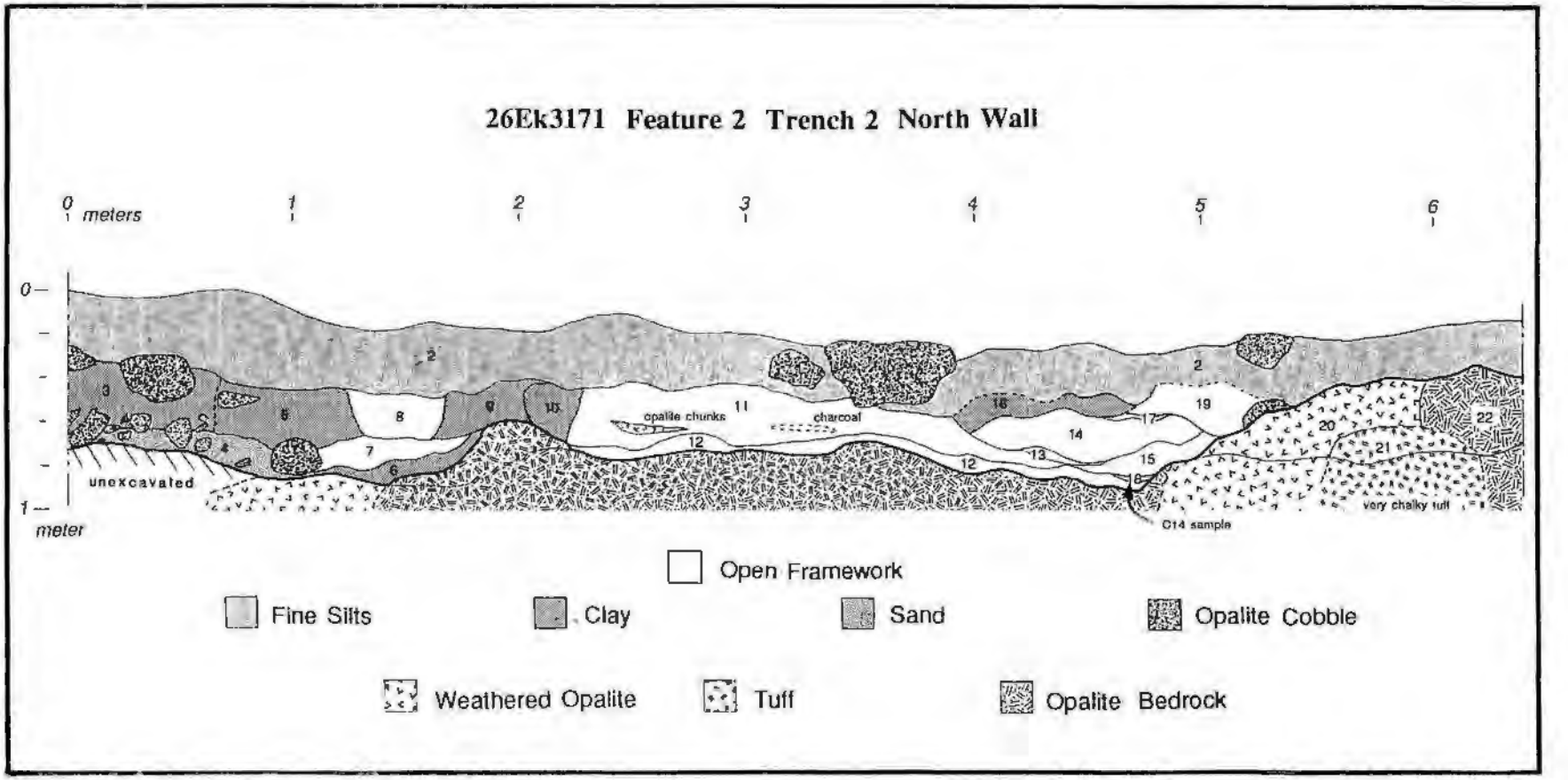


Figure 149. Description of stratigraphic units, Trench 1, 26Ek3171.

Figure 149. Description of stratigraphic units, Trench 1, Feature 2, 26Ek3171.

Stratum	Description
1	No typical silt loam unit 1 was identified at this trench.
2	Grayish brown (10YR 5/2) dry; silt loam; loose to weak medium granular; common medium angular to subrounded pebbles and common medium subangular to subrounded cobbles; common fine roots; common medium opalite chips, chunks and flakes; boundary clear and irregular.
3	Dark brown to strong brown (7.5YR 4/4 to 4/6) slightly moist; sandy clay; strong medium angular blocky; common fine to medium subrounded to rounded pebbles and common subangular to subrounded boulders; rare fine roots; moderate clay skins on ped surfaces; common fine opalite chips; boundary clear and irregular.
4	Very pale brown to yellow (10YR 7/4 to 7/6) dry; loamy sand, becomes more clay rich to west; common fine to medium subrounded to rounded pebbles, common subangular to subrounded boulders; boundary unexposed.
5	Mottled brown (10YR 4/3) slightly moist; silty clay loam; and brown (7.5YR 4/4) slightly moist; sandy clay; fine subangular blocky; common subangular to subrounded pebbles and cobbles; common fine roots; rare opalite chips; boundary clear and irregular.
6	Brown (10YR 5/3) moist; clay; with rare clasts of unit 4 material; possible manganese nodules, black (2.5YR 2/1) moist; boundary abrupt and irregular.
7	Moderate open framework, very fine to medium opalite chips, chunks, and flakes; moderate clayey opalite and tuff sand matrix, yellowish brown to brown (10YR 5/4 to 4/3) moist; boundary clear and irregular.
8	Moderate to poor open framework, medium to coarse opalite chunks and some flakes; moderate clay loam matrix, yellowish brown to brown (10YR 5/4 to 4/3) moist.
9	Brown (10YR 4/3) slightly moist; clay loam; no apparent structure; common medium chips and chunks, and rare fine opalite flakes; boundary clear and irregular.
10	Strong brown (7.5YR 4/6) slightly moist; sandy clay; no apparent structure; common medium opalite chips and chunks.
11	Poor open framework, with vague lensing of coarse and fine fill, common fine to medium opalite chunks and flakes; common hashy, sandy clay loam matrix, brown (10YR 4/3) slightly moist; boundary clear and smooth.
12	Pale brown to brown (10YR 6/3 to 5/3) moist; very fine clayey hash.
13	Moderate open framework, thin lense of fine to medium opalite flakes, and some medium opalite chunks and pebbles; moderate hashy, sandy clay matrix, dark brown (10YR 4/3) moist.
14	Poor open framework, very fine to coarse opalite and tuff chunks; common hashy, sandy clay matrix, dark brown (10YR 4/3) moist; boundary clear and smooth.
15	Poor open framework, fine to coarse opalite and tuff chunks and chips; common hashy, sandy clay loam matrix; strong brown to dark brown (7.5YR 4/6 to 3/4) moist; rare charcoal flecks.
16	Dark grayish brown (10YR 4/2) slightly moist; silt clay loam; weak fine granular; common fine to medium tuff and opalite chunks, rare coarse tuff chunks, and rare to common medium opalite flakes; this unit appears to be a mixture of units 2 and 14.
17	Subhorizontal fine to medium opalite flakes and chunks, and some chips, in a matrix similar to unit 16.
18	Abundant charcoal chunks and flecks in a matrix of brown (10YR 4/3) moist; sandy clay; the bedrock here is also burned or stained with carbon.
19	Similar to unit 16, except for more abundant weathered chalky and glassy tuff chunks, and some medium opalite flakes.
20	Dark brown (7.5 4/4) moist; clay to sandy clay; strong medium angular blocky; tuff fragments weathering in situ with clay filling joints; common clay skins on ped faces.
21	Lensed silty clay from weathered tuff, white (10YR 8/2) moist, and clay, yellowish brown (10YR 5/2) moist.
22	In situ weathering, glassy tuff bedrock, with clays as similar to unit 20 infiltrating joints.

Grouping strata by horizon was not attempted in Feature 2 because strata are intercalated lenses, many less than 2 m in length. While there are trends in their relationships, it seldom is possible to discern obvious stratigraphic horizons delimiting different episodes of use. Indeed, the total duration of use may have been short. Within the fill of the westernmost depression, for instance, the surface of Unit 11 appears to have been truncated by a shallow pit subsequently filled by Units 13 and 14; Unit 14 then was truncated by another shallow pit and filled by Units 16 and 19. No unit contains weathered material or exhibits the accumulation of fine residues associated with intervals of disuse.

After profiling, a 1 m x 50 cm excavation unit was dug into the north wall of Trench 2. This methodological experiment sought to develop a means for sampling quarry pit contents systematically, and, as well, to expose and sample the charcoal at the bottom of Feature 2. The unit spanned the depth of the pit from ground surface to bedrock, using depositional levels defined during stratigraphic analysis for vertical control. Formed artifacts were recovered at all depths (cf. Table 158). At the bottom of our probe, the westernmost end of stratigraphic Unit 12 ("hash") and a charcoal lens (cf. Figure 149: Unit 18) filled a shallow depression in the bedrock. The bedrock "floor" of this depression was charcoal-blackened over a 60 cm x 30 cm area, yielding a radiocarbon date of 410±70 B.P. (Appendix L). We surmise that it may have resulted from firing during the quarrying process.

Methodologically, the exercise disclosed that most strata are difficult to follow any distance into the sidewall due to pronounced changes in their composition. As well, the loose, often debris-rich, constitution of some strata resulted in wall collapses, confounding reliable vertical control. The results of these efforts led us to pursue other means of obtaining samples of stratigraphic units.

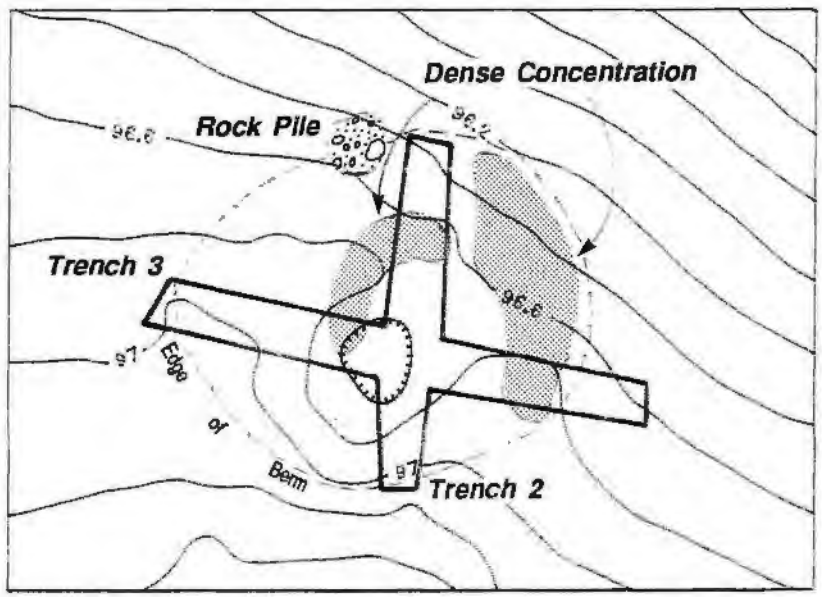
Feature 7

Feature 7 is an oval depression with its long axis running north-south, perpendicular to the slope. It lies ca. 30 m north and downslope of Feature 2. Save its larger depression (9 m maximum dimension), the pit, berm, and dense lithic scatter covering them present a surface manifestation similar to that of Feature 2 (Figure 150). Inventory revealed few formed artifacts, solely products of opalite processing (cf. Table 157).

The depression was quartered by two backhoe trenches arrayed in a cruciform centered on the pit. The north-south trench (Trench 2) was dug during testing and the east-west trench (Trench 3) during data recovery (cf. Figure 150). A stratigraphic drawing was made of the west wall of Trench 2, but strata were not described formally. The north wall of Trench 3 was drawn and described subsequently (Figure 151); Trench 3 is emphasized in the following discussion, but reference is made to Trench 2 as well.

Bedrock at Feature 7 is composed of white crystalline tuff and well silicified opalite. The upper 20-30 cm of tuff is weathered into blocky, angular, cobble sized clasts in an orange brown clay matrix. Opalite bedrock lies below the weathered horizon, varying in degree of silicification.

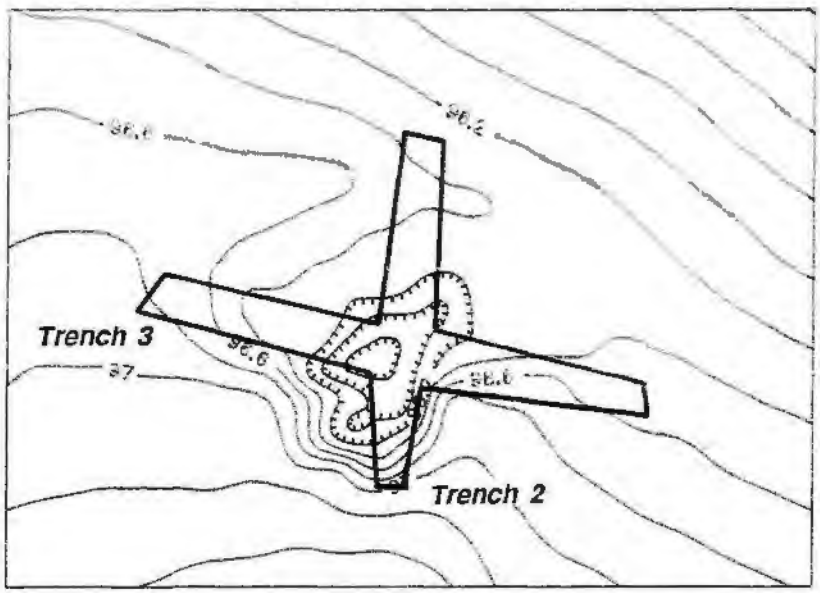
The intersecting trenches allowed a three dimensional examination of strata filling the quarry pit. While some stratigraphic units can be traced around the corner from the west wall of Trench 2 to the north wall of Trench 3, the limited size of most units makes them difficult to follow. Units such as 1 and 13 through 18 are traceable, however. Because of the gap created by the east-west trench, units in the eastern half of Trench 3 can be correlated only tentatively with units in the western profile. The fairly large Unit 14, basal Unit 18, and Unit 1 at the surface appear equivalent in both profiles, and Unit 16 may be equivalent to Unit 57. Units occurring farther west in the north wall profile of Trench 3 may be equivalent to other



26Ek3171 Feature 7 Surface

SCALE 1 inch = 5 meters

a



26Ek3171 Feature 7 Excavated Pit

SCALE 1 inch = 5 meters

b

Figure 150. Feature 7 plan, 26Ek3171. a. surface; b. excavated pit.

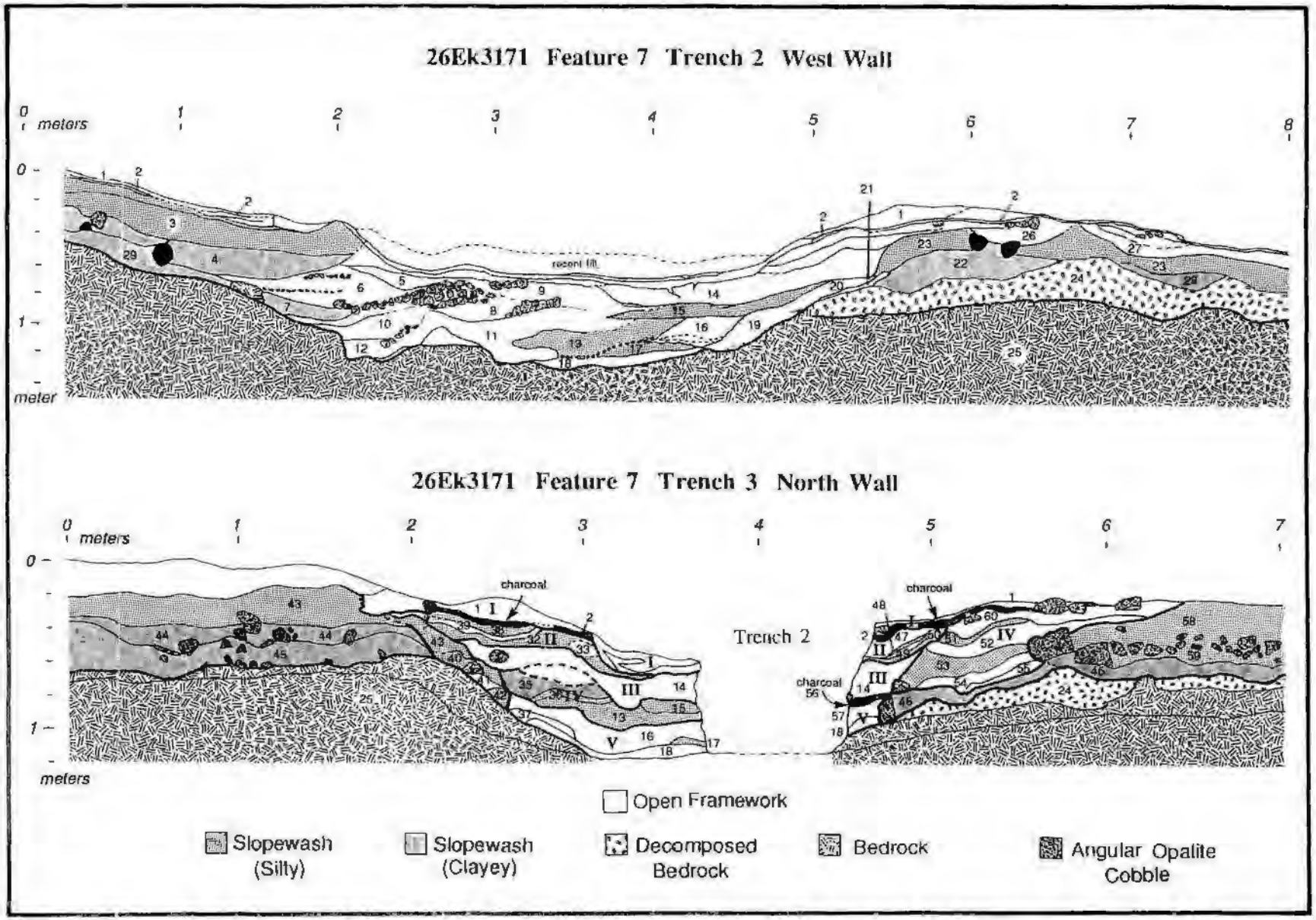


Figure 151. Description of stratigraphic units, Trench 3, Feature 7, 26Ek3171.

Figure 151. Description of stratigraphic units, Trench 3, Feature 7, 26Ek3171.

Stratum	Description
1	Pale brown (10YR 6/3) dry; sandy silt loam; common medium subrounded pebbles; common to abundant fine to coarse opalite chunks, chips and flakes; this unit has been strongly disturbed by backhoe and drilling activity, unit 1b is a pink hole plug that has contaminated unit 1 and parts of unit 14; boundary abrupt and irregular.
2	Light brownish gray (2.5YR 6/2) dry; silt loam; loose to fine granular; common fine subangular pebbles; common fine roots; common charcoal flecking; boundary abrupt and irregular.
13	Coarse hash; brown (10YR 5/3) dry; sandy clay loam with common very fine to fine chunks, rare fine flakes.
14	Moderate open framework, common medium to coarse opalite flakes, with less common fine to medium chunks and chips, in a moderate open framework; sparse matrix of brown (10YR 5/3) dry; sandy loam; matrix is generally sparser and opalite flakes and chunks coarser towards the center of the pit.
15	Fine hash; dark brown (10YR 3/3) dry; silt loam with common very to fine flakes and chips of opalite.
16	Moderate open framework, coarse flakes and chunks in a poor to moderate open framework with a moderate amount of pale brown (10YR 6/3) dry; medium subangular sandy loam matrix.
18	Fine hash; brown (10YR 4/3) slightly moist; silty clay with abundant fine opalite flakes and chips and rare fine chunks of tuff; rare charcoal flecking scattered in western half of unit.
25	Opalite bedrock exposed in trench wall.
26	Weathered white opalite bedrock, with silty clay as in unit 45 and 46, filling cracks.
32	Fine hash; brown (10YR 5/3) dry; sandy loam with common very fine to rare medium fine opalite chips and rare medium opalite flakes.
33	Coarse hash; dark grayish brown (10YR 4/2) dry; sandy silt with abundant fine to medium opalite flakes, and rare coarse flakes.
34	Poor open framework of abundant fine to medium, predominantly subhorizontal, opalite flakes with rare coarse flakes and chunks in a moderate matrix of pale brown (10YR 6/3) dry; fine to medium subrounded to angular sandy loam, with abundant fine opalite chips; rare charcoal flecks.
35	Coarse hash; brown (10YR 5/3) dry; clay loam with common medium opalite flakes, and rare fine chips and coarse flakes.
36	Moderate open framework, predominantly subhorizontal medium to coarse opalite flakes and chunks, with sparse matrix of brown (10YR 4/3) slightly moist; clay loam similar to unit 35.
37	Poor open framework of coarse opalite chunks with moderate matrix of pale brown (10YR 6/3) dry; sandy loam similar to unit 16.
38	Fine hash; dark brown (10YR 3/3) slightly moist; loose coarse sandy silt loam with rare medium opalite flakes and chunks.
39	Moderate open framework of commonly coarse rarely medium and fine, subhorizontal opalite flakes and chunks with sparse to moderate matrix of pale brown (10YR 3/3) slightly moist; coarse sandy silt as in unit 38.
40	Fine hash; dark brown (10YR 3/3 to 4/3 slightly moist) loam with common very fine to fine opalite chips and fine flakes; rare charcoal flecks.
41	Poor open framework to coarse hash, fine angular opalite chunks tightly packed with sparse matrix of dark yellowish brown (10YR 4/4 slightly moist) silty clay.
42	Fine hash; dark yellowish brown (10YR 4/4 slightly moist) silty clay with abundant fine opalite chips and chunks.
43	Dark brown (10YR 3/3 slightly moist) silty clay loam; loose to moderate granular; common subangular to angular pebbles; common fine roots and pores; boundary clear and wavy to irregular.
44	Brown to dark yellowish brown (10YR 4/3 to 4/4 slightly moist) silty clay loam; weak to moderate medium subangular blocky; common fine to medium pebble and opalite clasts; boundary clear and irregular.
45	Strong brown (7.5 YR 4/6 to 5/6 slightly moist) clay loam; moderate to strong medium subangular blocky; thick clay skins on ped faces; common medium and coarse subrounded to rounded cobbles; contact with bedrock is sharp.
46	Coarse hash; dark yellowish brown (10YR 3/4 to 4/6) slightly moist; sandy silty clay; weak fine granular; rare to common angular pebbles; rare to fine roots; unit generally coarsens westward to common medium to coarse opalite chunks in silty clay matrix; matrix also fills cracks in weathered bedrock of unit 26.

Figure 151, continued.

47 Poor open framework to matrix supported, medium to coarse opalite cores, chunks and flakes; abundant sandy silt loam matrix, very dark grayish brown (10YR 3/2) slightly moist.

48 Fine hash to poor open framework; dark brown (10YR 3/3) moist; sandy clay loam; rare fine to medium opalite flakes and chunks.

49 Moderate open framework, fine to medium opalite flakes, rare coarse flakes and cores; common sandy clay loam matrix as in unit 48.

50 Dark yellowish brown (10YR 4/4) moist; sandy clay loam; rare to common fine opalite flakes and pebbles.

51 Coarse hash; dark brown to brown (10YR 3/3 to 4/3) moist; sandy clay loam; common fine opalite flakes and chunks.

52 Moderate open framework; common coarse cores, chunks and flakes, rare fine to medium flakes; moderate sandy clay loam matrix same as unit 50.

53 Dark brown to dark yellowish brown (10YR 3/3 to 3/4) moist; silty clay; common fine opalite flakes and chunks; dispersed fine charcoal flecks.

54 Moderate open framework; medium to coarse opalite chunks, subrounded cobbles and fine flakes; sparse to moderate silty clay matrix as in unit 53.

55 Fine hash; brown (10YR 4/3) moist; silty clay; rare fine opalite chunks and flakes; some areas of this unit is fairly open framework.

56 Fine hash; dark brown (10YR 3/3) moist; silty clay; common fine opalite flakes and chips; abundant charcoal pieces.

57 Moderate open framework, fine to medium opalite flakes, rare fine opalite chunks and chips; moderate sandy clay matrix, dark brown (10YR 3/3) moist.

58 Brown (10YR 4/3) moist; silty clay; weak granular to subangular blocky; boundary clear and irregular.

59 Dark yellowish brown (10YR 4/4) moist; silty clay; common fine to medium angular to subangular pebbles; common very coarse subrounded cobbles; common fine opalite chips; boundary clear and irregular.

60 Poor open framework, poorly sorted, fine to coarse opalite flakes chunks and chips; common silt loam matrix, very dark grayish brown to dark brown (10YR 3/2 to 3/3). moist.

units farther north in the west wall of the original trench, but no confident correlations can be made. Units in Trench 3 have been numbered successively beginning with Unit 32, where numbering in the north-south trench terminated. Due to the complex intercalation of debris lenses in this pit, strata numbering may not reflect the vertical sequence seen in the stratigraphic column. The manner in which the strata develop in west wall profiles (cf. Figure 151), however, suggests that work in the pit progressed up-slope, from north to south.

Fill deposits were removed to ascertain the extent to which the pit had been mined into bedrock. The limits of quarrying activity were identified easily by the presence of an undisturbed soil profile around the pit margin. The bedrock excavation below the surrounding berm forms an approximately oval depression with a remarkably smooth floor.

Because of good exposure and the typical appearance of the fill in this pit, chemical analyses for several oxides were performed on samples from Trench 3. The chemical data have been arranged into profiles to reflect signs of weathering, soil development, and phosphorus enrichment in the pit fill and the results are discussed below.

The various strata filling Trench 3 are composed of debris from quarrying or of material introduced by natural processes. The quarry debris are composed primarily of coarse opalite chunks and flakes with only sparse sand filling voids between the larger clasts. Natural slopewash units typically have abundant fine sandy silt matrices, commonly with fine pebbles of opalite and tuff and a few coarse opalite flakes and chunks. While several units easily are classified into these basic types, others are more enigmatic. It is probable that some which appear silt-rich slopewash units may, in fact, consist of quarry debris where soil has been introduced during digging. This could occur easily during the lateral expansion of pits, or during backfilling, when debris was mixed as it was shoveled away from the outcrop face. The identification of units with abundant sandy clay silt matrix and common fine chips of opalite and tuff referred to as "hash" also is problematical. An example is Unit 18; although the deposit *could* be the result of fines washing out of courser strata and settling in the bottom of the pit, it is more likely that hash was created by hammering or bashing bedrock during quarrying. The sand-sized and smaller tuff and opalite material was mixed with clays from the paleosol and the overlying weathered tuff bedrock, and with silts from the surrounding surface soil washed into the pit. Debris similar in texture and appearance was produced during quarrying experiments. Caution must be exercised, however, when assigning such deposits either a quarrying or natural origin; undoubtedly, opportunity for the mixing of genetically different materials occurred often.

Because of the limited size of individual strata, their depositional complexity, and the difficulty of determining which may be of primary origin, an exact interpretation of the events that created the pit and its fill at Feature 7 can achieve only a simple iteration of the relative chronology based on seven stratigraphically apparent horizons. In addition, Trench 3 is perpendicular to the axis of quarrying activity, and provides no clue to the direction in which quarrying progressed. Quarrying began with the removal of overlying materials, in deposits such as Units 43, 44, 45, 58, and 59 of Horizon VIII. Following the initial removal of overburden, exploration for usable opalite progressed downward to a limited depth and laterally (generally southward), as indicated by the north-south trench profile (cf. Figure 151).

As quarrying continued, debris was thrown away from the working face. These debris deposits eventually filled the quarried area; they consist of Units 40, 41, 42, 50-55, and 60, and comprise stratigraphic Horizon VI. A truncation of these units on both sides of the pit suggest that they were more extensive in the past. This implies that a substantial amount of reworking and renewed digging occurred before the deposition of Horizon V. Horizon VI appears to be composed of alternating events of quarry deposition and slopewash. Units such as 53 clearly are mixtures of opalite flakes and chunks with the reddish clay of the adjacent soil.

Horizon V units which fill the depression left by the truncation of Horizon VI are composed predominantly of quarry debris with little slopewash apparent. Unit 18, for example, may be a product of hammering that produced "hashy" material, while Units 16 and 57 are processing debris. The separation of Horizon V from Horizon IV is based on a change to

generally finer debris and the charcoal accumulation of Unit 56. The actual time separating Horizons IV and V may have been very short. The separation of Horizon IV from III is more apparent owing to the truncation of Units 34, 35, 36, 13, and 15. Horizon III is a resumption of the deposition of coarse opalite flakes and chunks, and is composed only of Unit 14. There may be, however, some unrecognized divisions in this unit. Overlying Horizon III, the strata of Horizon II are again a mixture of slopewash and quarry debris similar to those of Horizon IV. Above these, the silty organic and charcoal rich Units 1 and 2 of Horizon I mantle the profile, representing the modern surface; charcoal probably is the result of recent brush fires. Several other units contain small bits of charcoal, particularly Unit 56. Samples were taken, but flotation failed to recover enough carbon for conventional radiocarbon dating.

Chemical profiles through selected vertical sections reveal interesting features. Profile A, of undisturbed deposits outside the pit, shows the structure of the natural soil (Figure 152). Increased leaching is indicated downwards in the profile. Eolian silts at the surface predictably show less leaching, increased carbonate, and enhancement of phosphorus. Profile B, through units of Horizon VI and VII, shows a similarly predictable trend of generally increased leaching of iron and aluminum (Figure 153). Bases, especially carbonates, increase nearing Unit 53, possibly reflecting an incipient calcic horizon formed in early deposits. The fluctuating phosphorus percentage, with increases in the coarser units, may be attributable to human origins, although such a clear distinction would be unusual. Profile C, through horizons I, II, III, IV, and V, show less developed chemical trends due, possibly, to their younger age (Figure 154). There is a slightly higher degree of leaching near Units 35 or 36 that may owe to extended exposure during a hiatus in quarrying. Unit 34 may be an early part of Horizon III rather than part of Horizon IV.

Feature 7 has suffered recent disturbance, apparently from drilling. A rectangular pit, 3 m long, 2 m wide, and 20 cm deep, was excavated in its center (cf. Figure 151). The recent pit intruded prehistoric deposits of quarry waste and opalite processing debris. The material was thrown out as backdirt onto the downslope (northern) berm of the prehistoric feature. The high surface density of debitage in the northwest quadrant is mostly the consequence of recent pit excavation.

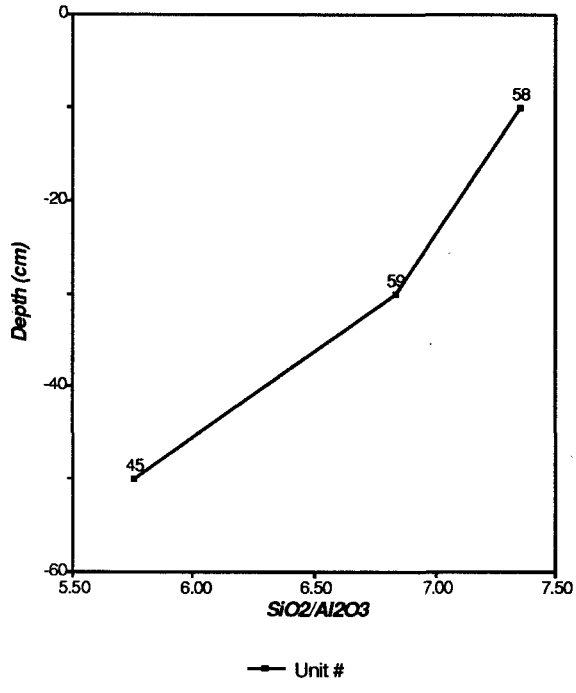
Gray drilling mud and a red slurry apparently comprised of drilling mud and drill cuttings forms a layer in the bottom of the recent pit and lenses at the surface of the pit margins. Slurry also is found in the interstices of prehistoric strata filling the pit, particularly in layers of coarse, openwork quarry debris (Units 14 and 16) on the north side. The slurry either has trickled into the lower strata from the bottom of the recent pit or has moved laterally from the drill hole.

In summary, the bedrock cavity and deposits at Feature 7 are typical of quarry pits intruding a soil cover to a horizontal bedrock surface. Individual horizons generally alternate between predominantly coarse or fine textured units. The main stratigraphic horizons appear to reflect episodes of coarse debris deposition or alternating fine and coarse deposition.

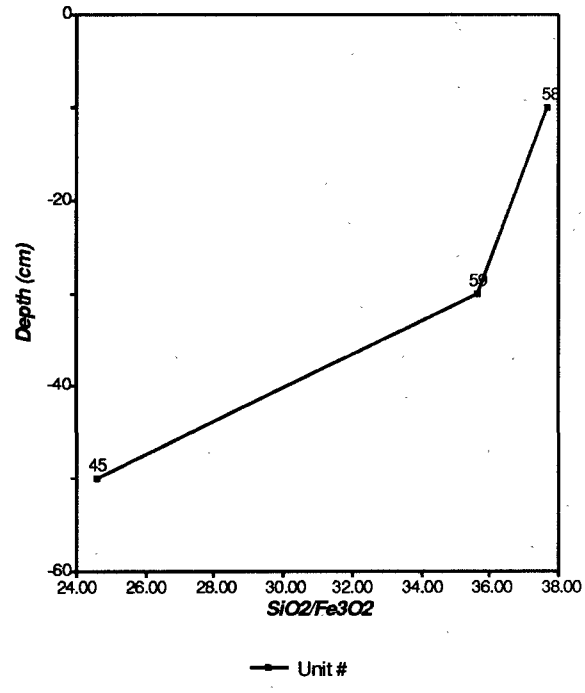
Subsequent to stratigraphic analyses, the entire contents of the depression were removed in order to expose the full extent of bedrock exploited. Upon the completion of all archaeological examination, and to address other questions, experimental quarrying was undertaken within the pit and nearby (cf. Chapter 22).

Implications

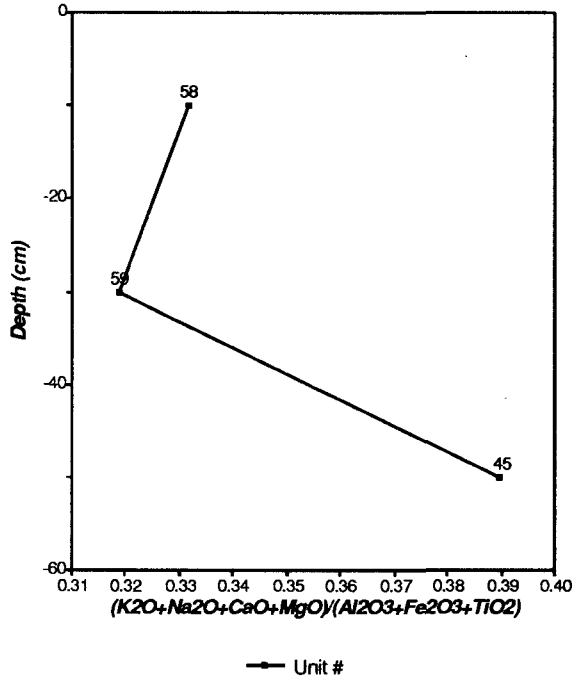
26Ek3171 appears to have witnessed behaviors similar to those carried out at 26Ek3170. Toolstone acquisition and processing produced prolific waste, much of which remains organized in cultural features. Quarry sources are more numerous, more highly developed, and, if the cobble quarry at Feature 4 is considered, more varied than those of 26Ek3170.



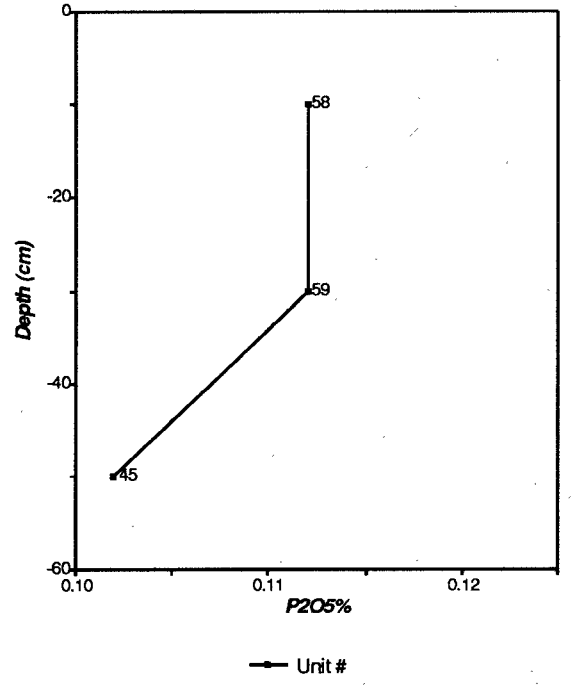
a.



b.

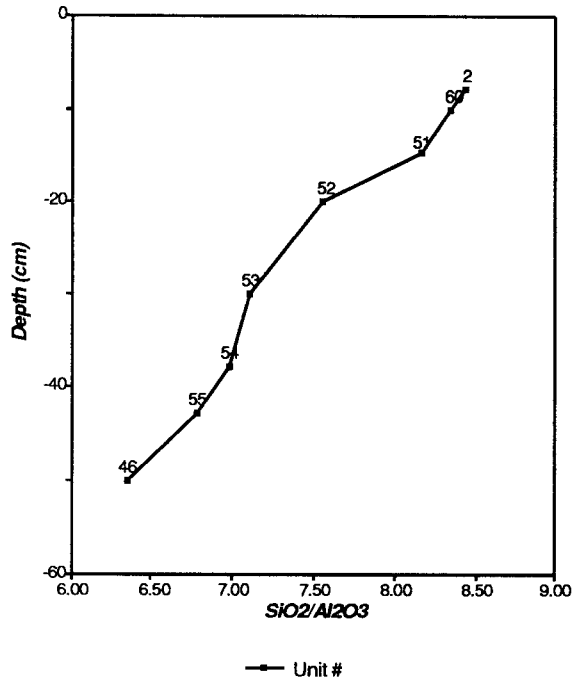


c.

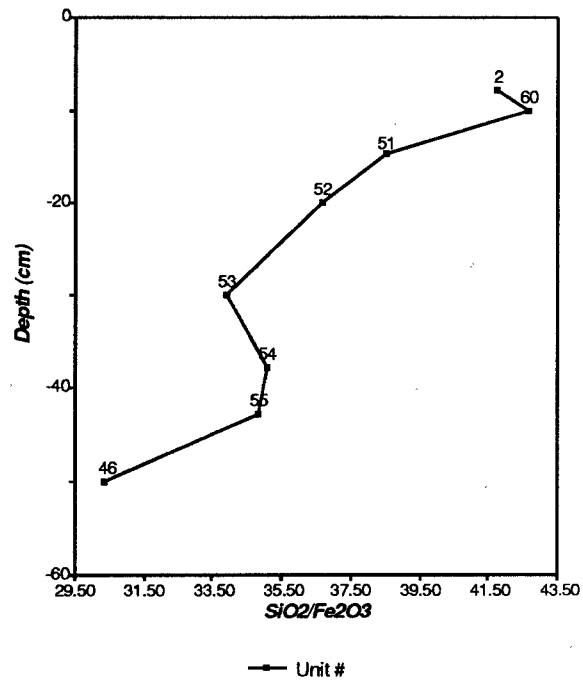


d.

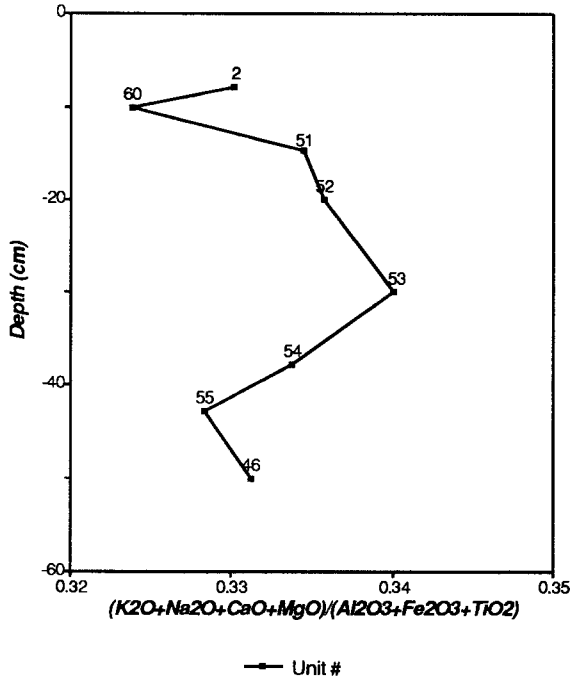
Figure 152. Molecular weathering ratios for 26Ek3171, Trench 3, profile A, displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.



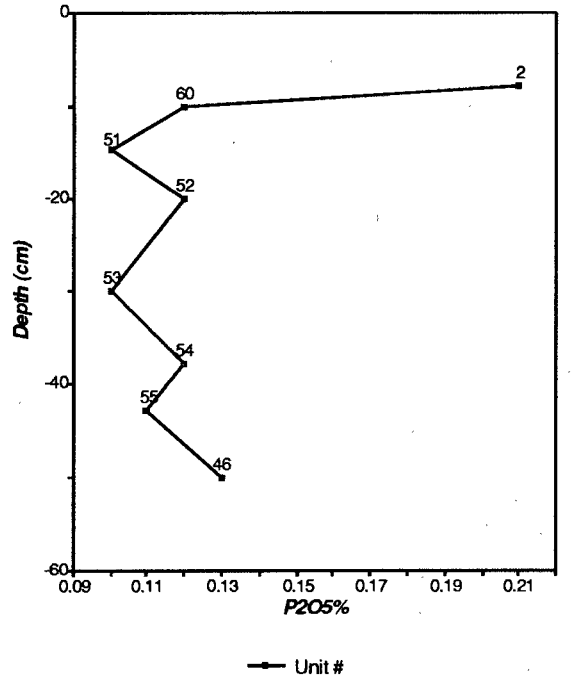
a.



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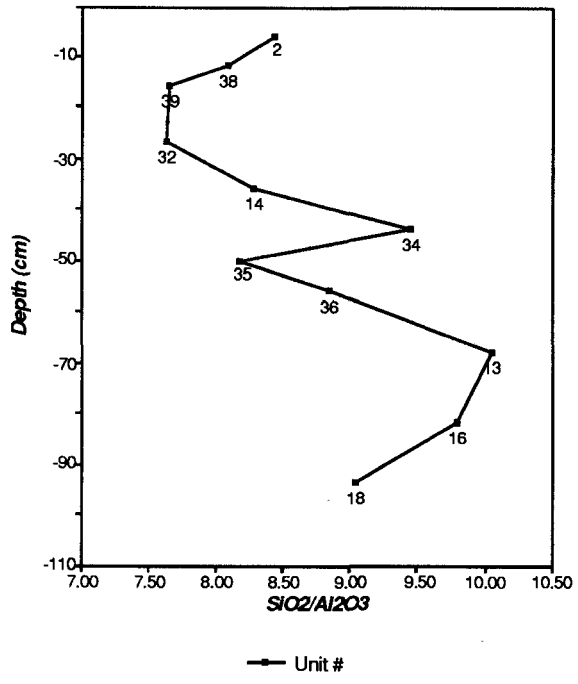


c.

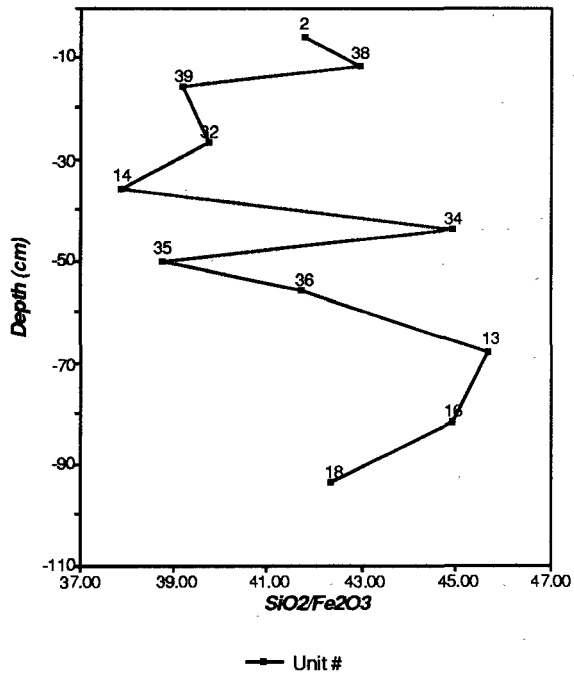


d.

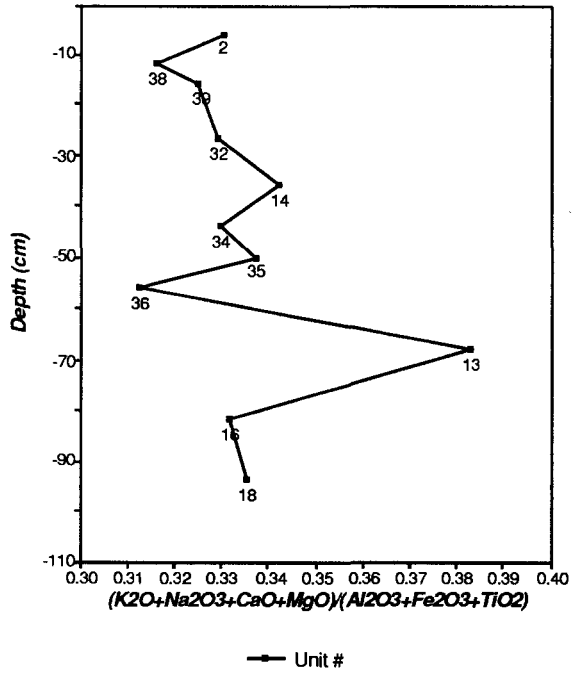
Figure 153. Molecular weathering ratios for 26Ek3171, Trench 3, profile B, displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.



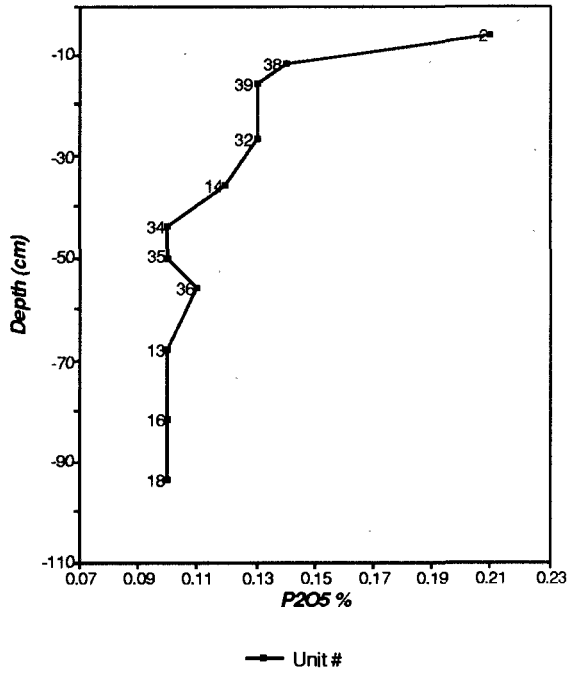
a.



b.



c.



d.

Figure 154. Molecular weathering ratios for 26Ek3171, Trench 3, profile C, displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, (d) weight percent phosphorus.

Like 26Ek3170, however, nonfeature contexts in the northwestern quadrant of 26Ek3171 appear to have hosted a variety of activities; most involved processing toolstone from local as well as off-site sources, and some involved maintenance and subsistence chores. No use of this portion of the site, however, left more than the scantiest artifact accumulation.

26Ek3032/Locality 23

Locality 23 contains a pair of quarry pits. The larger (easternmost) was visible on the surface before testing. Later, in the course of trenching, a second, smaller excavation was revealed immediately west of the surface pit. The locality was selected for study owing to its apparently clear record of toolstone extraction and associated tasks. Lying wholely within the bounds of 26Ek3170, separate enumeration of Locality 23 was dictated by administrative convention. The pits and the surrounding accumulation of artifacts are prominent, however, and for the most part are reliably distinguishable from the very light lithic scatter manifest by the larger site.

The locality lies on the northwestern brink of the lowest bench of Ramadan Ridge, where the mildly inclined ridgetop gives way to steeper slopes toward Little Antelope Creek (cf. Figure 141). This break in slope (possibly a remnant terrace feature of Little Antelope Creek) appears to be controlled by the bedrock substrate, and it positions the site on a locally anomalous portion of Ramadan Ridge. In contrast to the deeper soils elsewhere on the western ridgeslope, Locality 23 occupies a zone where low, ground-hugging exposures of weathered opalite bedrock daylight sporadically from beneath a generally thin veneer of sandy colluvium covered with low sage and phlox. Tall sage is restricted almost exclusively to the quarry pit berm. Prehistoric miners probably were attracted to the place for the near-surface toolstone promised by the low outcrops.

Feature 1

Prior to testing, the quarry pit consisted of a roughly circular, mildly dished surface depression 50 cm deep and 8 m in diameter. A well developed arcuate berm, dense with quarry debris, 2 m wide and 50 cm higher than the surrounding ground, had accumulated about the western, downslope half of the pit. A dense lithic scatter of distinctive white and purple opalite covered the pit and berm and mantled the surrounding surface. These components comprised the totality of the 133 m^2 area of Locality 23, and defined sampling strata for our investigations (Figure 155).

The surface scatter proved densest on the berm top and the downslope surface. Formed artifacts include abundant bifaces (n=45), a pair of hammerstones, and a core. In addition, however, non-quarrying artifact classes proved numerous; they include three Great Basin Stemmed projectile points, an unidentified point fragment, three flake tools, and several obsidian waste flakes (Table 159).

Table 159. Artifacts Recovered from Feature 1, 26Ek3032, Locality 23.

Unit Number	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Other/ Exotic	Total
1 (SF)†	3,200	36,929.6	-	-	10	5	12	3	-	-	30
2 (SF)†	6,029	13,675.6	1	1	5	1	2	-	-	-	10
3 (SF)†	8,000	25,386.4	1	-	10	3	9	-	-	-	23
Surface	-	-	4	-	45	1	3	-	2	-	55
TS	21,258	28,898.8	-	-	-	-	-	-	-	1	1
Totals	38,487	104,890.4	6	1	70*	10	26	3	2	1	119

SF = Surface Scrape
TS = Trench Samples
*Includes possible bifaces
†Includes 50 x 50 cm 1/8 inch control quadrant

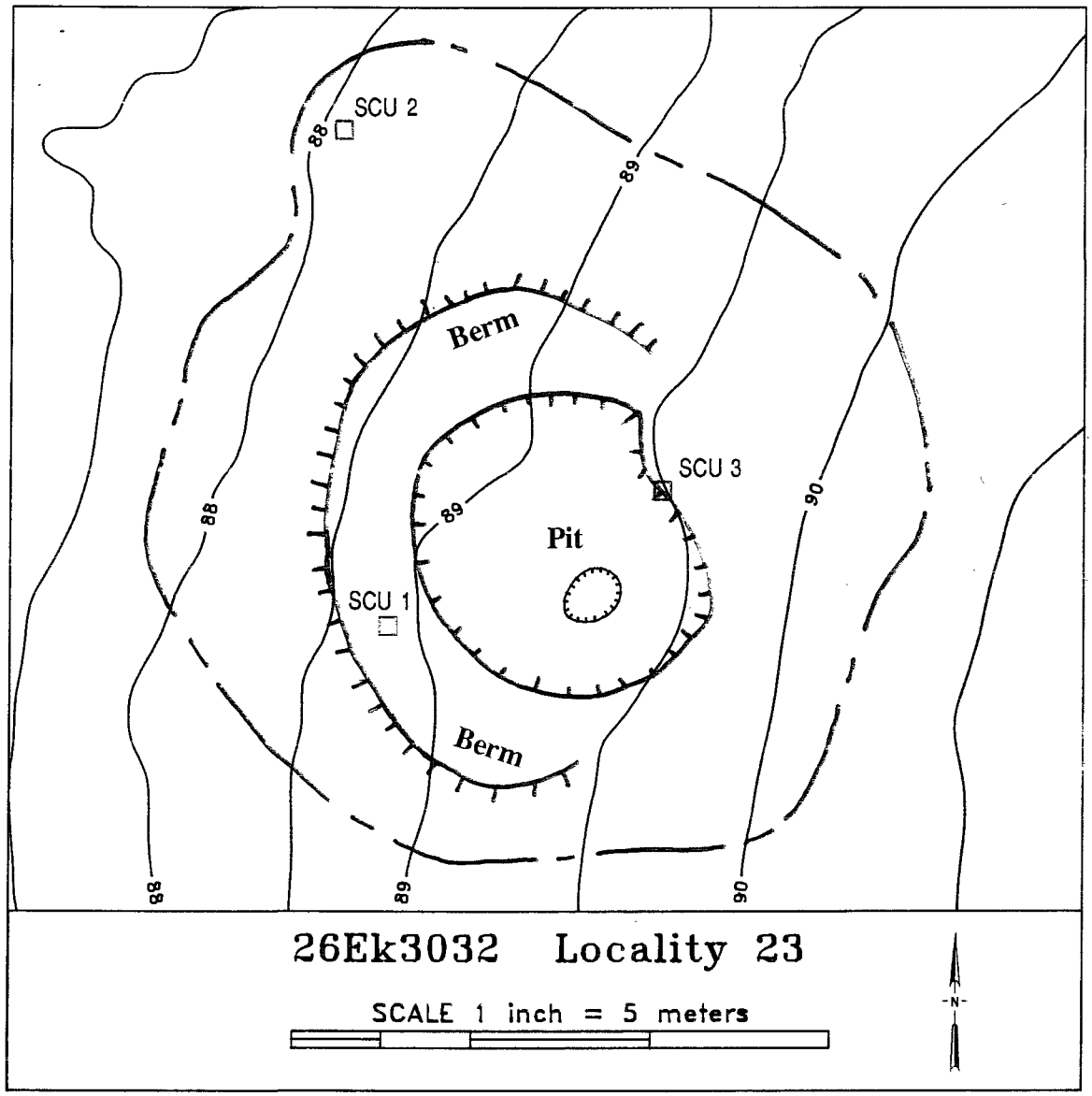


Figure 155. Locality 23 site map, 26Ek3032.

Three surface scrapes assayed the surface assemblage in greater detail. Each 1 m x 1 m unit included a 1/8 inch mesh control quadrant, and each sampled a spatially distinct component of the feature (the top of the berm, a concentration on the surface just downslope and northwest of the berm, and the upper margin of the pit; cf. Figure 155). Returns from the surface scrapes varied (Table 159).

All units returned vast quantities of opalite debitage and numerous formed artifacts. Debitage is dominated by robust specimens characteristic of quarrying and core reduction (cf. Chapter 10); the biface assemblage reflects production tasks ranging from the creation of blanks through intermediate stage reduction (cf. Chapter 6). The sample implies that on-site toolstone processing occurred directly around the pit. Cores and bifaces proved most common on the berm top, among the largest waste flakes (11.5 g average), and at the upper pit margin where they are accompanied by much smaller debitage (ca. 3 g/item). Flake tools are rare in these places. Away from the pit, the assemblage contains comparatively few formed artifacts and opalite debris of the smallest average size (ca. 2 g/item). Flake tools are scarce, but an unclassifiable projectile point, a preform, and several obsidian waste flakes suggest a variety of activities.

Other field efforts focused on the quarry pit itself. In order to expose a stratigraphic cross-section, a backhoe trench bisected the feature along its east-west axis from just above the upper margin, through the depression and berm, and into the slope below (cf. Figure 155). The worked proximal end of an antler was found in the trench backdirt; it had been used as a billet and possibly as a wedge for quarrying (cf. Chapter 14).

The stratigraphy revealed by trenching is illustrated and summarized in Figure 156. Two quarry pit features were recognized in the trench profile. They are separated clearly by a berm of intact red clay paleosol, designated Unit 32, over an in-place segment of weathered opalite and tuff bedrock. The eastern pit contains the more complex depositional record; as many as six horizons are present.

Horizon VI, comprising Units 16, 17, 19-26, and 29, alternates layers of common fine to medium opalite flakes with varying proportions of fine silts and clay matrix. Horizon VI units were truncated by an episode of re-excavation and deposition reflected by Unit 28 (Horizon V), consisting of medium to coarse opalite flakes in a sparse, brown silty matrix. Overlying Horizons VI and V, depositional Horizon III, is composed of Units 31 and 33 (brown sandy clay loams with rare opalite flakes). Horizon III is truncated at its west end and overlain by Units 14, 27 and 30 of Horizon II. Units 2-12 also belong to Horizon II.

Horizon I is a typical grayish brown, relatively organic rich, surficial silt cover. It covers most of the two quarry features, except where Unit 35 is present, probably the result of a recent range fire.

Horizons I and III overlie Horizon IV which comprises all the fill in the western quarry feature. These units are similar to those filling the eastern pit, but slightly less rich in matrix. Given the onlapping of units from Horizon III, it appears that the eastern pit was created first, then filled in part from debris excavated from the western pit.

Implications

Locality 23 served as a source of high quality, often colorful, toolstone. Flake tools and other maintenance/subsistence implements are relatively abundant as well. Perhaps the proximity of Locality 27 (a residential base immediately north) contributed to the observed assemblage complexity.

26Ek3184

Most of the low, nearly flat northern extension of Holeplug Ridge falls within the boundary of 26Ek3184 (Figure 157). Occupying some 12,680 m^2, the site is the second largest in the East. Twenty-six cultural features and an intervening lithic scatter fall within it; almost exclusively they are consequences of toolstone reduction (Table 160). Absent the quarrying debris that obscures reduction features elsewhere, features at this site reflect toolstone processing with remarkable clarity, and they offer the best opportunity in the East to study opalite reduction away from toolstone sources.

Table 160. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3184.

				FORMED ARTIFACTS								
Feature	Total Area (m^2)	DEBITAGE[a] n	DEBITAGE[a] wt. (gm)	Proj. Points	Preforms	Bifaces[b]	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Other/ Exotic	Total
1*	0.40	11	32.0	-	-	16	-	-	1	-	-	17
2*	2	1,989	8,797.4	-	-	1	1	1	-	-	-	3
3*	144	1,101	2,110.0	2	1	13	-	4	-	1	1	22
4	44	-	-	-	-	-	-	-	-	-	-	0
5	15	3[c]	13.1	-	-	4	-	1	-	-	-	5
6	2	-	-	-	-	1	-	-	-	-	-	1
7	1	-	-	-	-	-	-	-	-	-	-	0
8*	64	15,077	26,771.8	-	3	105	2	14	3	2	1	130
9	16	-	-	-	-	-	-	-	-	-	-	0
10	148	4[c]	13.8	-	-	10	-	1	-	-	-	11
11	16	-	-	-	-	1	-	-	-	-	-	1
12*	22	6,360	26,329.0	-	-	25	-	11	1	1	-	38
13	14	-	-	-	-	-	-	-	-	-	-	0
14*	2	2,016	3,332.7	-	-	1	3	-	-	-	-	4
15	86	-	-	-	-	1	-	-	-	-	-	1
16	23	-	-	-	-	4	-	-	-	-	-	4
17	2	-	-	-	-	-	-	-	-	-	-	0
18	50	-	-	-	-	3	-	1	-	-	-	4
19*	39	9,106	18,089.3	2	-	16	10	-	-	-	-	28
21	22	-	-	-	-	2	-	1	-	-	-	3
22	57	-	-	-	-	6	-	-	-	-	-	6
23*	63	11,868	20,120.0	-	-	36	2	12	1	-	-	51
24	177	-	-	1	-	1	-	-	-	-	-	2
25	12	-	-	-	-	-	-	-	-	-	-	0
26	112	2[c]	4.3	-	-	5	-	2	-	-	-	7
Surface Isolates	-	-	-	1	2	8	1	2	-	-	-	14
Other Nonfeature		3,103	7,280.3	1	-	16	-	8	-	-	-	25
		50,640	112,893.7	7	6	275	19	58	6	4	2	377

*Sample feature
[a]Does not include trench samples
[b]Includes "possible" bifaces
[c]Obsidian only

Soils generally are shallow, composed of a grayish brown silt loam with abundant inclusions of tuff gravels and weathered opalite fragments. On the somewhat higher eastern quadrant of the site, these deposits are overlain by thin accumulations of loess. Bedrock tuff underlies the site, and flow banded rhyolite occurs along its northeastern margin, forming the southern slope of Undine Gorge. Prehistoric quarrying occurred at only one location (Feature 20).

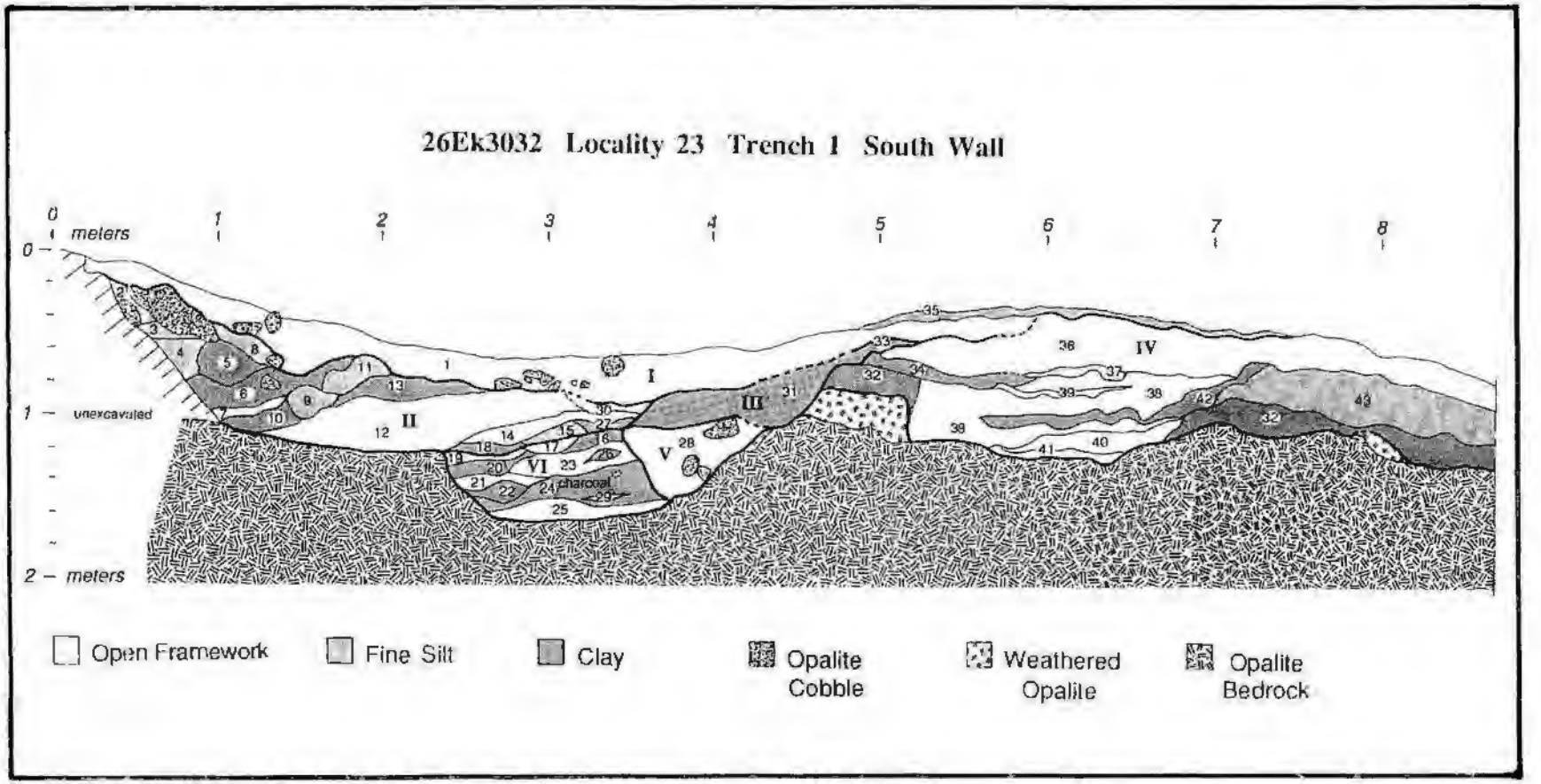


Figure 156. Description of stratigraphic units, Trench 1, 26Ek3032, Locality 23.

Figure 156. Description of stratigraphic units, Trench 1, 26Ek3032, Locality 23.

Stratum	Description
1	Grayish brown (10YR 5/2) dry; silt loam; weak to moderate granular; common pebbles and coarse cobbles; abundant fine to medium roots; common medium to coarse opalite flakes and chunks; boundary clear and smooth.
2	Reddish brown to yellowish red (5YR 4/4 to 4/6) dry; sandy clay; common fine to medium subangular pebbles; common fine roots; no cultural materials; boundary gradual.
3	Strong brown (7.5YR 4/6 to 5/6) dry; clay with coarse sand to fine gravel; common fine to medium subangular to subrounded pebbles; no cultural materials; boundary gradual and irregular.
4	Yellow (10YR 7/6) dry; silt to coarse sand with some clay; clasts from weathering tuff bedrock; no cultural material; boundary clear and irregular.
5	Dark brown (10YR 3/3) slightly moist; silty clay; weak fine granular; common medium opalite chunks and subrounded cobbles; rare clay clasts; rare medium opalite flakes; boundary clear and irregular.
6	Dark brown to strong brown (7.5YR 3/4 to 4/6) slightly moist; silty clay; strong granular to medium subangular blocky; abundant angular to subrounded coarse sand to fine pebbles; rare fine opalite flakes; rare charcoal flecks; boundary clear and irregular.
7	Moderate open framework, medium to coarse opalite chunks with some flakes; moderate matrix of silt loam clasts mixed with silty clay clasts, brown (10YR 4/3) moist; boundary clear and irregular.
8	Dark grayish brown (10YR 4/2) dry; silt loam; weak fine to medium granular; rare medium angular to subangular pebbles; abundant fine roots; rare fine to medium opalite flakes; boundary clear and irregular.
9	Brown (10YR 4/3) slightly moist; silty clay loam; common medium subangular to subrounded pebbles; no cultural material; boundary clear and irregular.
10	Dark yellowish brown (10YR 3/4) slightly moist; silty clay loam; rare medium opalite chunks; boundary clear and smooth.
11	Brown (10YR 4/3) slightly moist; silt loam; weak granular; rare medium subrounded pebbles; rare fine opalite chunks; boundary clear and irregular.
12	Strong brown (7.5YR 4/6 to 5/6) moist; compact, sand clay; abundant medium angular to subangular pebbles; common fine to coarse opalite flakes, and rare very coarse opalite flakes and cores; boundary abrupt to clear and irregular.
13	Brown (10YR 4/3) moist; clay loam; weak granular; rare medium subangular pebbles; rare fine opalite flakes and chunks; boundary clear and irregular.
14	Moderate open framework, medium opalite flakes and cores; sparse to moderate sandy clay matrix as in unit 12.
15	Brown (10YR 4/3) moist; sandy loam; common fine angular to subrounded pebbles and fine opalite chips and flakes.
16	Brown (10YR 4/3) moist; clay loam; common medium subangular to rounded pebbles; rare fine opalite flakes.
17	Moderate open framework; common, medium to coarse opalite chunks, abundant fine opalite flakes; moderate sandy clay matrix, dark yellowish brown (10YR 4/4) moist.
18	Dark yellowish brown (10YR 4/4) moist; sandy clay; common medium subangualr gravel; common fine opalite chips.
19	Moderate open framework, medium opalite flakes and chunks; moderate sandy clay loam matrix, brown (10YR 4/3) moist.
20	Dark yellowish brown (10YR 4/4) moist; sandy clay loam; common subrounded pebbles; rare to common fine to medium opalite flakes and chunks; similar to unit 12.
21	Poor open framework, medium opalite chunks and flakes; common clay loam matrix, brown to yellowish brown (10YR 4/3 to 4/4) moist.
22	Brown (10YR 4/3) silty clay; rare fine opalite flakes and chips; rare patches of red cinnabar.
23	Poor open framework, fine to medium opalite chunks and flakes; moderate to abundant silty clay matrix, brown (10YR 4/3) moist.
24	Yellowish brown to dark yellowish brown (10YR 5/4 to 4/4) slightly moist; sandy clay; common fine opalite flakes and chips; common fine subangular red cinnabar clasts; charcoal concentration as noted on profile.
25	Same as 24, except coarser opalite chunks.
26	Strong brown (10YR 4/6 to 5/6) slightly moist; sand clay; common very fine opalite flakes and chips.

Figure 156, continued.

27 Dark brown to strong brown (7.5YR 4/4 to 5/6) moist; sandy clay; rare very fine opalite chips.
28 Typical to moderate open framework, medium to coarse opalite flakes, rare medium pebbles; sparse sandy clay loam matrix, brown (10YR 4/3) moist; unit is generally finer to the west.
29 Poor open framework, fine to medium opalite chunks; common matrix as in unit 24.
30 Poor open framework, fine to medium opalite flakes; matrix of silts from unit 1.
31 Strong brown (7.5YR 4/6) moist; compact, sandy clay loam; common fine to coarse subrounded pebbles; rare fine to medium opalite flakes.
32 Strong brown (7.5 YR 4/6) moist; sandy clay; moderate to strong granular to subangular blocky; moderate clay skins of ped faces; clay becomes sandier near bedrock and fills cracks in weathered bedrock.
33 Same as unit 31, except it appears to be surface wash directed at western quarry pit.
34 Brown (10YR 4/3) slightly moist; silt loam; loose; rare subangular pebbles; common medium roots; no cultural material.
35 Very dark grayish brown to dark brown (10YR 3/2 to 3/3) slightly moist; silty fine sand; abundant organics and charcoal; common fine to medium flakes and cores.
36 Yellowish brown to dark yellowish brown (10YR 5/4 to 4/3) dry; silty fine sand; loose; abundant angular pebbles; abundant fine opalite chunks and flakes.
37 Poor open framework, fine to medium opalite flakes and chunks; common matrix as in unit 36.
38 Dark brown (10YR 3/3) moist; clayey silt loam; common to abundant angular to subrounded opalite clasts in common irregular lenses, with clasts of clay from unit 32.
39 Moderate open framework, fine to medium opalite flakes; moderate matrix as in 38.
40 Same as unit 39, except range of flake and chip size is greater.
41 Typical hash unit; occurring just above bedrock.
42 Dark brown (7.5YR 4/4) moist; reworked clay with abundant sand and silt, and fine angular opalite chunks and chips.
43 Dark grayish brown (10YR 4/2) moist; silt loam; weak granular to subangular blocky; rare fine to medium subangular to subrounded pebbles.

Nonfeature Contexts

Most of the site is littered with a light density lithic scatter of opalite waste and occasional obsidian debitage. Few formed artifacts lie within it (cf. Table 160). A series of 19 2 x 2 m surface scrapes spanned the site at 10 m intervals across its greatest dimension (cf. Figure 157); results of the exercise reflect the sparse cultural content of inter-feature contexts (Table 161). Most units yielded little, mostly opalite debitage. Contrasting retrievals were obtained only adjacent Features 20 and 10, and in a unit coinciding with a small lithic concentration.

Table 161. Artifacts Recovered from Surface Collection Units, 26Ek3184.

Unit	DEBITAGE		FORMED ARTIFACTS			
Number	n	wt. (gm)	Proj. Points	Bifaces	Flake Tools	Total
1	225	746.2	-	1	-	1
2*	-	-	-	-	-	0
3	13	11.2	-	-	-	0
4	5	2.8	-	-	-	0
5	9	15.8	-	-	-	0
6	79	82.3	-	-	-	0
7	20	37.7	-	-	-	0
8	8	34.2	-	-	-	0
9	16	35.0	-	-	-	0
10	58	58.6	-	-	-	0
11	28	84.7	-	-	-	0
12	23	161.0	-	-	-	0
13	24	54.1	-	-	-	0
14	51	52.3	-	-	-	0
15	202	239.6	1	2	1	4
16	227	368.7	-	1	1	2
17	1,127	4,344.6	-	11	3	14
18	784	691.2	-	-	3	3
19	107	109.7	-	-	-	0
20	97	140.4	-	1	-	1
Totals	3,103	7,280.3	1	16	8	25

*Unit not scraped; coincident with Feature 20

Cultural Features

All save two cultural features at 26Ek3184 are reduction stations; Feature 1 is a biface discard and Feature 20 reflects an incipient, abandoned effort at quarry pit excavation. The surface content of each feature was inventoried and four (Features 1, 2, 3, and 8) were sampled during testing. In data recovery, sampling of Feature 8 was expanded and five additional features were collected entirely. The selection of features sought to capture the full range of variation at the site, reflecting size, density of scatter, artifact diversity, and apparent reduction stage. Features 12, 14, 19, 20, and 23 were added to the analytic sample. Artifact yields of all fieldwork are summarized for each feature in Table 160.

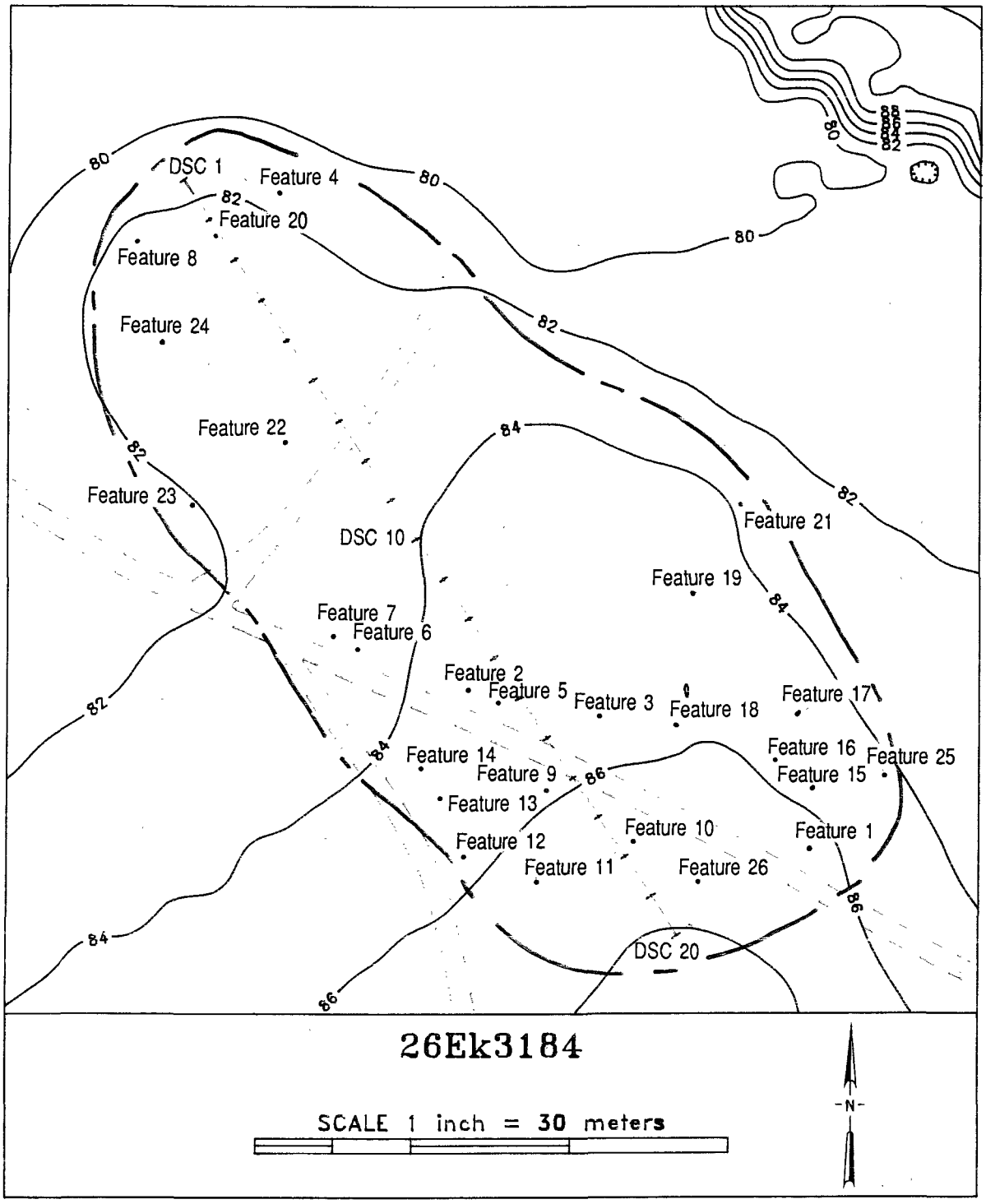


Figure 157. 26Ek3184 site map.

Feature 1

The surface of Feature 1, before we picked it up, consisted of a cluster of seven opalite bifaces and one obsidian biface adjacent a dirt road in an area otherwise devoid of cultural materials (cf. Figure 157). Surface scraping recovered eight additional opalite bifaces and paltry debitage. An excavation unit dug immediately below the scrape yielded only two additional waste flakes in 10 cm of deposit.

Each of the fifteen opalite bifaces are Stage 3 specimens. All are fragmentary (about 50% complete), roughly of similar size and shape; six were heat-treated. We suspect that the feature represents a discard pile rather than a cache; biface caches elsewhere in the Tosawihi vicinity consist almost exclusively of whole specimens. Since the biface cluster is confined to the surface (i.e. < 2 cm deep) and lies adjacent a prominent dirt road, we remain skeptical about its origin; while it may, indeed, represent a stockpile of rejects intended for redirection into smaller forms, it could as well be a pothunter's discard pile.

Feature 2

Feature 2 exemplifies the small reduction stations at the site (cf. Figure 157). It is defined by a dense 2 m^2 concentration of opalite debris with discrete boundaries. Our 4 m^2 block of surface scrape units apparently captured all material laying in primary deposition; no flakes were found below the scraped surface save in a zone of rodent disturbance. The assemblage consists almost entirely of opalite wastes indicative of core reduction, augmented by a single Stage 3 biface and a flake tool (cf. Table 160). The size of the feature and its discrete clustering of debris suggest formation during a single reduction event. That the debitage exhibits several colors of opalite leads us to infer the processing of multiple cores or biface blanks.

Feature 3

Feature 3 allowed us to sample a much larger reduction station. It covers 144 m^2 and contains several high density concentrations within the bounds of a moderate density surface scatter (cf. Figure 157). Surface inventory returned the only formed artifacts recovered from the feature, consisting of intermediate stage opalite bifaces, a hammerstone, and a variety of maintenance/subsistence tools (cf. Table 160). A discontinuous baseline of eight 50 cm x 50 cm surface scrapes spanned the feature, examining contexts within and between concentrations. Opalite debitage from early stage biface reduction and a few obsidian waste flakes constitute the assemblage. Densities observable on the surface do not necessarily reflect subsurface quantities of cultural material; areas *between* concentrations yielded densities comparable to those *within* them. The data suggest that the feature is a single, rather homogeneously dense scatter on and just below the surface, and that differential exposure falsely suggests multiple concentrations (cf. Botkin 1989:370-372).

Feature 8

Feature 8 consists of two moderately dense concentrations of opalite processing debris surrounded by a somewhat less dense lithic scatter over an area of 64 m^2 (Figure 157). A 1 m

x 20 cm cluster of nine opalite bifaces was noted atop the larger concentration. The feature was sampled on the assumption that it might represent a cache within a discrete workshop area.

One of a pair of 1 m x 1 m excavation units was centered on the biface cluster and the entire surrounding surface was collected in 28 scraped 1 m x 1 m units. These efforts accumulated a large and diverse assemblage of formed artifacts (cf. Table 160).

Surface scrapes recovered 13 opalite bifaces from the cluster; 20 additional specimens were recovered during subsequent excavation immediately below the scrape. Deposits below a depth of 10 cm were marked by an abrupt reduction in cultural content; these contexts returned sparse opalite waste and a single flake tool. Excavation was halted 20 cm below the surface. The cluster is more diffuse than other observed biface caches, and the loose, rodent-churned, sandy loams within the excavation units failed to clarify its depositional context. We were unable to discover if the pieces had been buried in a shallow pit or merely discarded on the surface and partially covered by natural soil processes. The scatter otherwise is a generally homogeneous, dense accumulation of opalite debitage; 61 bifaces, other reduction-related artifacts, numerous flake tools (n=11), and a pair of preforms were found as well.

Feature 8 is noteworthy on several counts. The biface assemblage is large (n=100), and represents a wide range of toolstone processing tasks (cf.Chapter 6). Most bifaces (n=86) are Stage 3 specimens; Stage 2 and Stage 4 reduction are represented only by 11 and one specimen, respectively. About half the bifaces (n=46) have been heat-treated. The opalite debitage is dominated by debris reflecting early stage biface reduction; that portion subjected to technological analysis (Chapter 10) reveals the highest incidence of heat-treatment observed in the Eastern Periphery.

Feature 12

Feature 12 is an homogeneous, 22 m^2, moderate density scatter of opalite reduction debris. It lies in the southeastern portion of the site, where a shallow loess deposit has accumulated to a depth of several centimeters (cf. Figure 157). A close-set pair of complete opalite bifaces near the center of the scatter prompted sampling in hopes that they represented a partially exposed biface cache.

The surface of the scatter was recovered by scraping a block of 18 1 m x 1 m units; a third complete biface was found immediately below the surface specimens. To explore further, a 1 m x 50 cm excavation unit was centered on the location of the three bifaces; no additional specimens were encountered, but scant quantities of opalite debitage were found to a depth of 25 cm. A second 1 m x 50 cm unit probed deposits contiguous to the original unit. One additional complete biface was recovered from the upper 2 cm of the deposit, and three more were exposed in a loose cluster immediately below. Only small quantities of opalite debitage were recovered at greater depth.

The origin and depositional context of the biface cluster remain ambiguous; it is unclear whether it constituted a cache. All seven specimens were confined to the loess deposit, and no evidence of intentional burial was observed. The pieces are, however, complete and unbroken, a condition encountered only rarely outside of caches. On the other hand, unlike caches recorded elsewhere, the bifaces in Feature 12 lay in disarray; only the three surface specimens touched one another, while the remainder were scattered both vertically and horizontally. Perhaps, as at Feature 8, the cluster represents a dispersed cache, its dispersal the product of post-depositional processes.

Aside from the biface cluster, the feature is typical of other reduction stations sampled throughout the project area. Opalite debitage makes up the bulk of the assemblage, and

displays characteristics chiefly of core reduction; heat-treated waste occurs in only minuscule amounts (cf. Chapter 10). The total biface assemblage (n=24) is dominated by Stage 3 specimens (n=18), but it includes biface blanks and incipient reduction stages as well (cf. Chapter 6). Flake tools are numerous and diverse (cf. Table 160).

Feature 14

Feature 14 lies 15 m west of Feature 12 at the southern margin of the site (cf. Figure 157). Covering only 2 m^2, it consists of a single, dense concentration of opalite waste punctuated by a single biface fragment. It was selected for sampling to represent the class of small reduction feature displaying very sparse formed artifacts. Six 1 m x 1 m surface scrape units removed the entire feature. The exercise revealed that the apparent surface extent accurately predicted its configuration in the upper 2 cm of deposit. Four units centered on the concentration returned virtually all the cultural material recovered; units beyond the concentration yielded only minor traces of debitage. The sparse surface artifact assemblage was mirrored in the units. Debitage constitutes nearly the entire return, supplemented only by the surface biface and a few flake tools (cf. Table 160). The biface (a Stage 3 specimen) and the small, sparse debitage suggest that the feature was a product of early biface reduction, perhaps a single reduction event.

Feature 19

Feature 19 occupies 39 m^2 on the northeastern quarter of the ridge top, in relative isolation from most other features (cf. Figure 157). It is defined by two dense, close-set concentrations of reduction debris, the larger (10 m^2) designated Feature 19A, the smaller (2 m^2), Feature 19B. Although the concentrations are dominated by opalite debitage, numerous formed artifacts and an abundance of obsidian is visible on the surface of each; they are particularly numerous on the surface of Feature 19A, and their prevalence in both led us to sample the feature to clarify the apparent diversity of activities represented.

Both concentrations were collected in their entirety; 12 1 m x 1 m units were scraped at Feature 19A, and four at Feature 19B. The concentrations were revealed to be confined to the upper 2 cm of deposit and the opalite debitage recovered from each reflects chiefly early stage biface production (cf. Chapter 6). The concentrations exhibit similar artifact assemblages, differing primarily in the incidence of obsidian. Feature 19A returned seven opalite bifaces, four flake tools, and two projectile points (an opalite Desert Side Notched and a non-diagnostic obsidian specimen). Obsidian waste flakes are especially abundant (n=66). Feature 19B yielded four opalite bifaces, an obsidian biface, six flake tools, and a pair of obsidian waste flakes. All the bifaces are intermediate reduction products (Stage 3).

Feature 20

Feature 20 represents a very incipient attempt at quarry pit excavation; it is the only quarry feature at 26Ek3184. Lying near a break in slope at the western margin of the site, it consists of a faint, shallow depression, ca. 5 m in diameter, fringed along its downslope edge by a weakly developed low berm (Figure 158). A moderate density scatter of quarry debris overlays and surrounds the pit, encompassing an area of 156 m^2. The surface was sampled by a cruciform of 19 1 m x 1 m surface scrape units arrayed along two baselines intersecting at

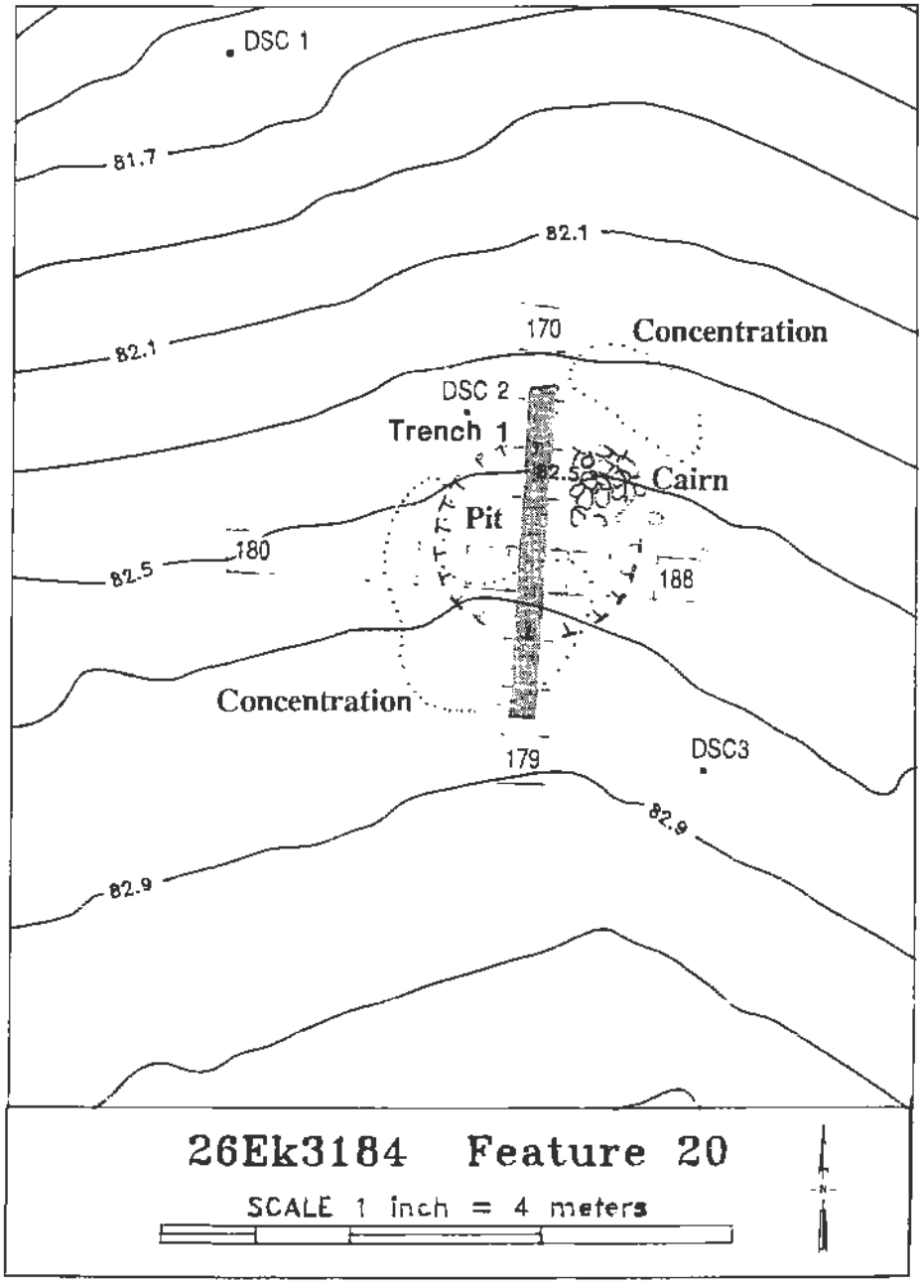


Figure 158. Feature 20 plan, 26Ek3184.

the center. Unit yields reveal a homogeneous, spatially undifferentiated deposit consisting almost exclusively of low quality opalite debitage, much of it angular shatter and waste flakes characteristic of core reduction. Formed artifacts are few; several bifaces and cores, and a single flake tool constitute the entire assemblage (cf. Table 160).

Following surface collection, the pit was bisected by a hand excavated trench (Trench 1) and the stratigraphic section revealed was drawn and described. The trench exposed a very small, shallow quarry pit with a simple stratigraphy of three units (Figure 159). The tuff bedrock contains a few pockets of opalite, but otherwise is not toolstone. Unit 3, filling the pit, contains cobbles, flakes, and cores of fine-grained bluish gray tuff; some isolated flake lenses are also present. Only Unit 3 contains quarry debris. Minor silt lenses among the coarser debris suggest possible multiple episodes of filling. The absence of Unit 3 in the western wall of the trench indicates that the center of quarrying activity was east of the trench. The hash commonly found in the bottoms of quarry pits is not present.

Unit 2 is a reddish clay paleosol washed into the pit but undisturbed outside its boundaries. Its presence at the bottom indicates that clay deposition took place before the deposition of Unit 3. Embedded in the surface of Unit 2 outside the pit are cobbles and boulders of fine grained, poorly silicified tuff. This may have invited prehistoric quarrying by promising better quality toolstone below. The clasts may represent a lag, but their origin is obscure.

Unit 1 is the typical, grayish brown silt loam that mantles much of the surface of the Tosawihi vicinity. It also contains large clasts of bluish-grey tuff.

Feature 23

Feature 23 is located at the southern edge of the site (cf. Figure 157). It covers some 63 m^2 with a moderate to high density scatter of opalite and artifacts. The latter, principally opalite bifaces, are uncommonly abundant; because of this, and a debitage accumulation reflecting a wide range of reduction stages (cortical flakes, simple interior flakes, biface thinning flakes), the feature was selected for sampling. Twenty-five 1 m x 1 m surface scrape units collected the central portion, and one scrape was continued as an excavation unit in the area of greatest artifact density.

Surface collection revealed a generally homogeneous distribution of cultural material. The excavation unit disclosed that the bulk of the feature resides in the upper 2 cm of the deposit; lower levels contain sparser cultural material, gradually diminishing with depth until bedrock is reached at ca. 30 cm. Subsurface soils are intruded heavily by rodent burrows and sage roots, and the resultant mixing probably accounts for the buried cultural deposits.

Although accompanied by numerous flake tools, the assemblage overwhelmingly reflects biface reduction (cf. Table 160). Debitage characteristic of early stage biface reduction predominates, but this emphasis is meager among the artifacts; it is represented only by two Stage 2 bifaces, a pair of cores, and a modified chunk. By contrast, most (n=33) of the 36 bifaces are intermediate stage forms (Stage 3). This discrepancy between debitage and the biface assemblage probably is a reflection of the stage at which bifaces most commonly fail during manufacture (cf. Chapter 21). The assemblage suggests that opalite arrived at Feature 23 in the form of cores (or perhaps blanks), and that these were rendered into at least early Stage 3 bifaces. Bifaces recovered by us represent unsuccessful events in this process, while specimens successfully reduced into incipient intermediate forms evidently were transported elsewhere.

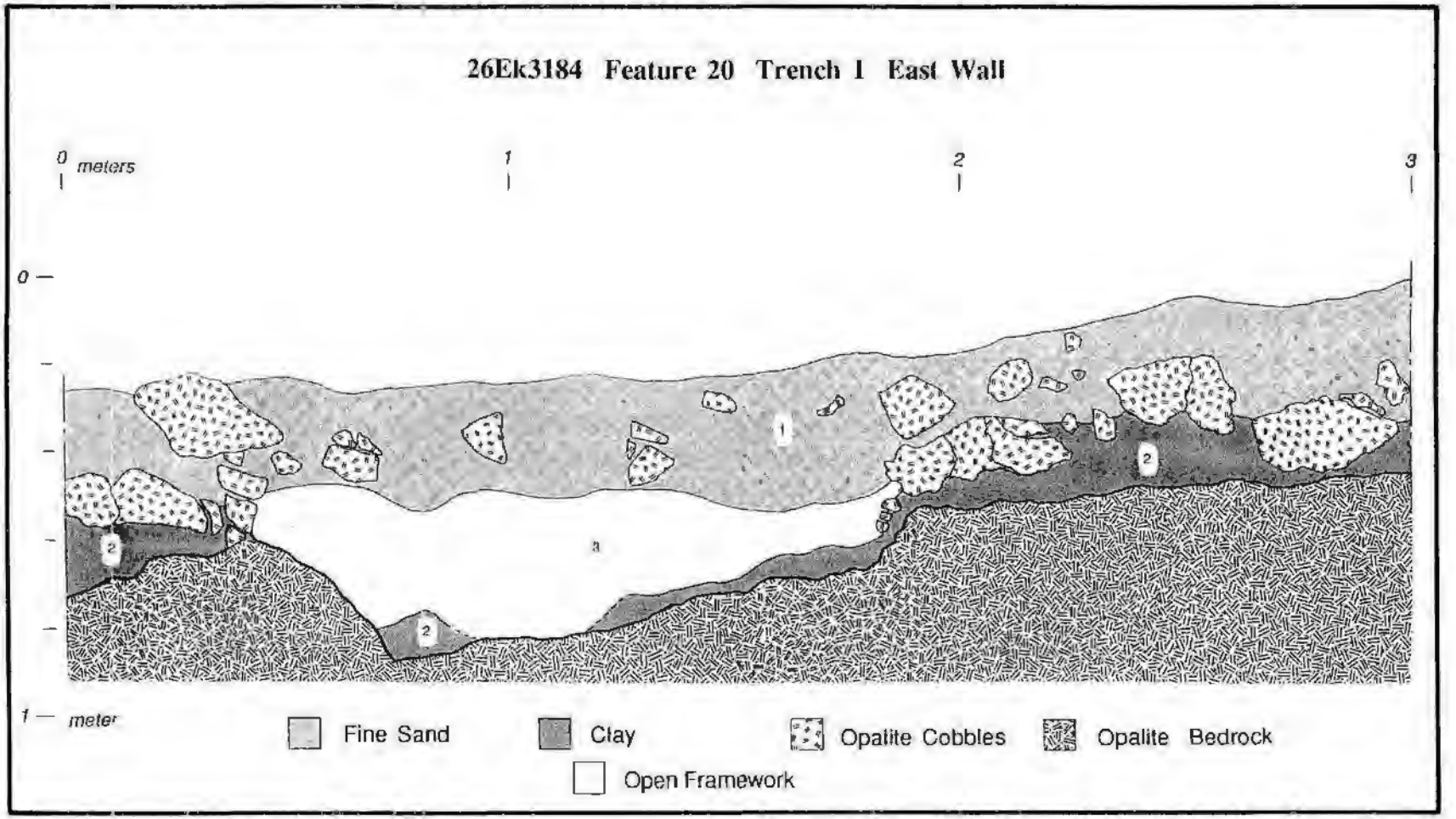


Figure 159. Description of stratigraphic units, Trench 1, 26Ek3184, Feature 20.

Figure 159. Description of stratigraphic units, Trench 1, 26Ek3184, Feature 20.

Stratum	Description
1	Light brownish gray (10YR 6/2) dry; silt loam; loose to weak granular; common opalite flakes and tuff cobbles; abundant fine and medium roots; boundary clear to gradual and irregular.
2	Dark brown (7.5 YR 4/3) slightly moist; sandy clay; strong granular, possibly reworked; common weathered opalite and tuff clasts from bedrock.
3	Moderate open framework with common bluish green tuff clasts and rare opalite flakes; common matrix of dark brown to brown (7.5 YR 4/2 to 10YR 4/3) slightly moist, less matrix in western profile indicating that the center of the pit is to the west.

Implications

The archaeological record at 26Ek3184 appears to have accrued primarily as a product of processing opalite toolstone from off-site sources. Concentrations of whole bifaces at Features 8 and 12 may reflect interim storage; as well, Feature 8 preserves a possible heat-treatment station (cf. Chapter 10). The only quarry feature within the site (Feature 20) seems to have been little used and soon abandoned; its raw material is of considerably lower quality than that found at reduction stations throughout the site. The variety of formed artifacts and the abundance of obsidian flakes recovered from reduction features imply other chores, as well.

26Ek3195

26Ek3195 is located on the southern margin of Undine Gorge, on a broad knoll at the foot of Corral Fan (cf. Figure 141). Covering 9425 m^2, it is the largest quarry site outside Ramadan Ridge. It encompasses the entire knoll top as well as its northern and western flanks, and contains four quarry pits, three outcrop quarries, and a reduction station (Figure 160). Despite its size, 26Ek3195 returned one of the Eastern Periphery's most depauperate formed artifact assemblages (Table 162).

Table 162. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3195.

		DEBITAGE[a]		FORMED ARTIFACTS			
Feature	Total Area (m^2)	n	wt. (gm)	Bifaces[b]	Flake Tools	Perc./ Cobble Tools	Total
1*	245	171	1,011.6	2	1	-	3
2*	143	452	2,972.1	12	2	2	16
3	86	-	-	3	-	1	4
4*	49	-	-	1	-	-	1
5	50	-	-	4	-	-	4
6	132	-	-	3	-	-	3
7	132	-	-	4	-	3	7
8	795	-	-	2	-	-	2
Surface Isolates	-	-	-	15	1	-	16
		623	3,983.7	46	4	6	56

*Sample Feature
[a]Does not include trench samples
[b]Includes "possible" bifaces

Nonfeature Contexts

During testing, the eight cultural features were isolated from a dense accumulation of opalite waste that literally paves the entire surface of the site. Most of the knoll outside feature boundaries appears to have served as a cobble quarry of variable quality opalite, and is strewn with hundreds of assayed cobbles, large flakes, and shatter. Underlying the amorphous scatter is a thin sandy colluvium. Low bedrock exposures of silicified tuff or sinter are extensive. Formed artifacts are rare in nonfeature contexts, consisting exclusively of early and intermediate stage opalite bifaces (cf. Table 162).

Cultural Features

Cultural features occur in all site contexts. Two shallow quarry pits (Features 3 and 4), three outcrop quarries (Features 1, 6, and 8), and Feature 5, the sole reduction station occupy the

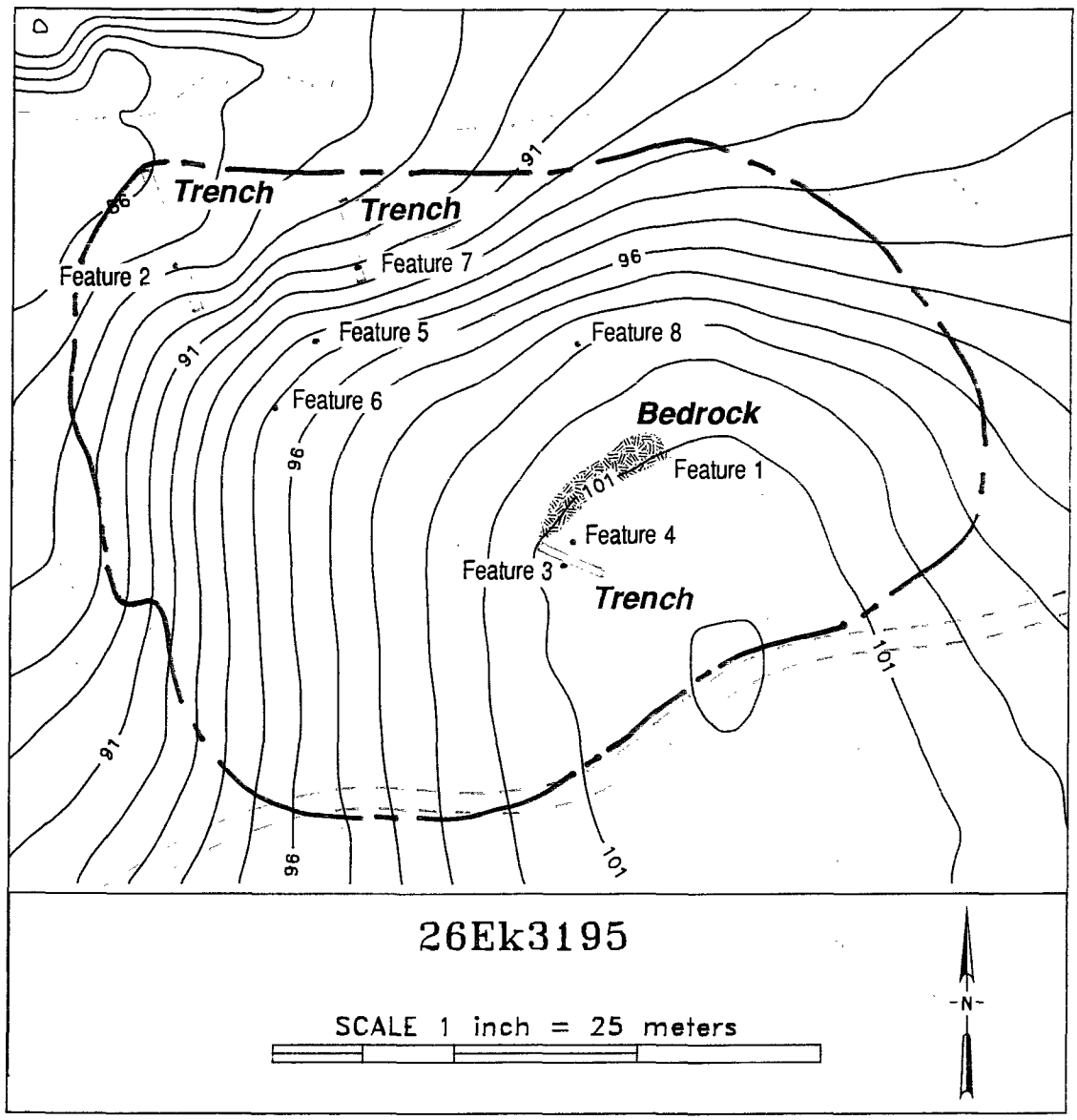


Figure 160. 26Ek3195 site map.

knoll top. Near the base of the knoll at the northern periphery of the site occur two additional quarry pits (Features 2 and 7). Both are deeper and more densely littered with quarry debris than those higher on the knoll. All features are dominated by opalite processing debris; none contains non-opalitic lithic materials, and all contain few formed reduction artifacts. Only two flake tools were encountered in Features 1 and 2 (cf. Table 162). During data recovery, work was expanded at Feature 2, and two additional quarry pits (Features 4 and 7) were trenched. Owing to its similarity to the profile of Feature 2, Feature 7 was eliminated from the analytical sample and is omitted from further discussion.

Feature 1

Feature 1 is an outcrop quarry and associated reduction area occupying 245 m^2 on a prominent opalite exposure on the knoll top (cf. Figure 160). Quarrying focused on both the outcrop and the material from the adjacent surface. Unlike the generally superior toolstone comprising the debitage, source material remaining in situ appears of inferior quality, suggesting that the better opalite was exhausted. A series of five surface units was scraped; the cultural content of the dense debris scatter surrounding the outcrop proved to be low (cf. Table 162; Botkin 1989:310-311). From the character of the debitage we infer that most of it derived from core reduction (cf. Chapter 10); the pair of bifaces recovered are early (Stage 2) reduction forms (cf. Chapter 6).

Feature 2

Feature 2, a 4 m diameter quarry pit and affiliated debris, is like many Tosawihi quarry pits; it lies at the base of a bedrock exposure, is surrounded by a berm, and has generated a downslope talus of debris (Figure 161). We sampled it because of its "typical" appearance. During testing, 13 surface scrape units bisected the feature, sampling the full complement of microtopographic surface contexts. Units returned debitage derived principally from core reduction and a formed artifact assemblage consisting of early and intermediate stage bifaces, a scraper, and a hammerstone (Table 163).

Table 163. Artifacts Recovered from Feature 2, 26Ek3195.

		DEBITAGE		FORMED ARTIFACTS			
Unit No. (Type)	Surface Scrape (m^2)	n	wt. (gm)	Bifaces	Flake Tools	Perc./ Cobble Tools	Total
1 (SF)	0.063	21	112.6	-	-	-	0
2 (SF)	0.063	4	4.3	-	-	-	0
3 (SF)	0.063	33	257.3	-	-	-	0
4 (SF)	0.063	60	472.9	-	-	-	0
5 (SF)	0.063	39	116.0	-	-	-	0
6 (SF)	0.063	33	85.1	-	-	-	0
7 (SF)	0.063	41	153.2	-	-	-	0
8 (SF)	0.063	1	0.2	2	-	-	2
9 (SF)	0.063	36	521.6	3	-	-	3
10 (SF)	0.063	180	1,247.9	-	1	-	1
11 (SF)	0.063	3	0.4	-	-	-	0
12 (SF)	0.063	-	-	-	-	-	0
13 (SF)	0.063	1	0.6	-	-	-	0
Surface Inventory	N/A	-	-	6	-	2	8
Trench Samples	N/A	44,265	38,620.6	1	1	-	2
Totals	0.819	44,717	41,592.7	12*	2	2	16

(SF) = Surface Scrape

*Includes "possible" bifaces

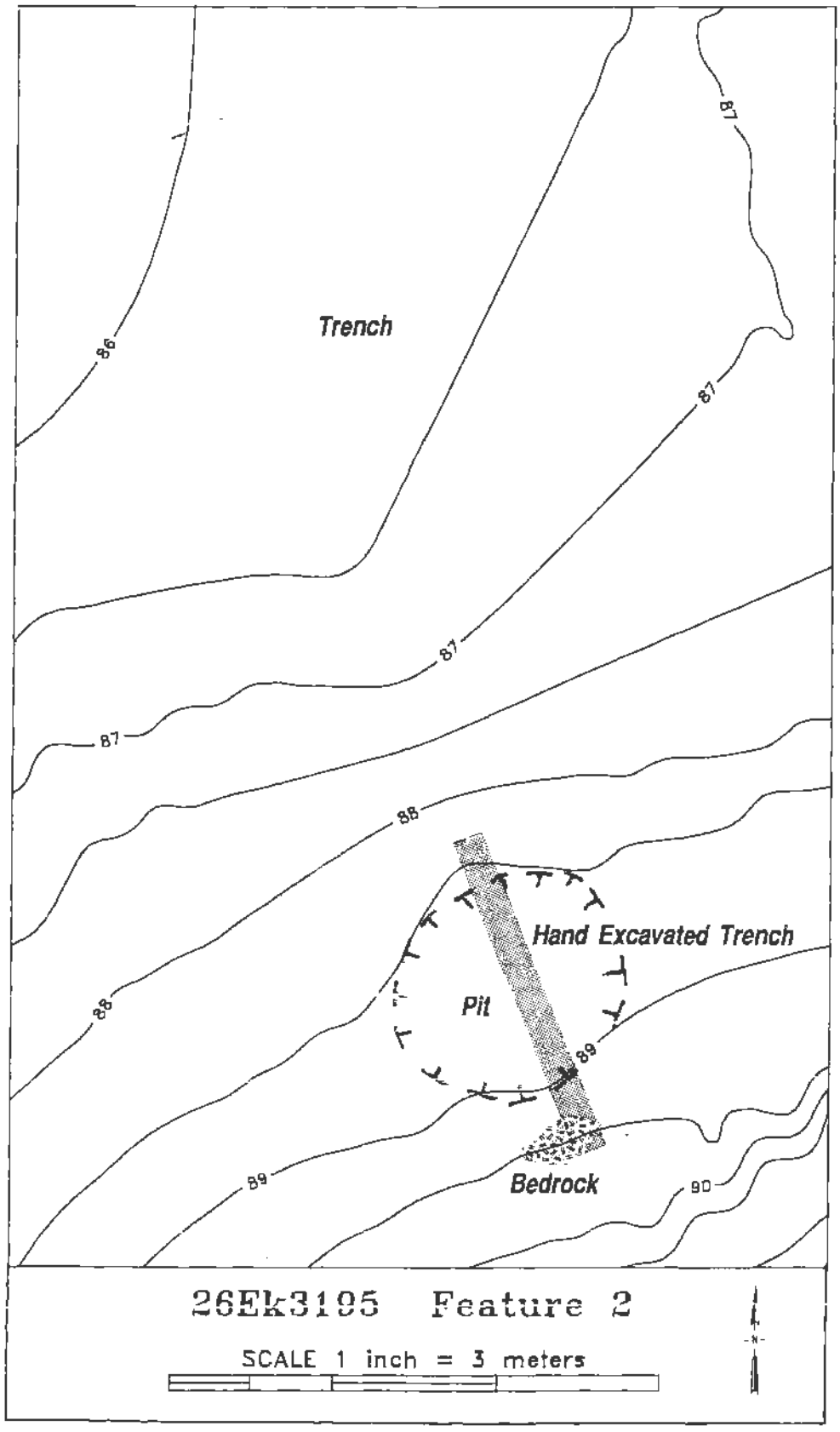


Figure 161. Feature 2 plan, 26Ek3195.

A hand-dug trench was excavated along the surface collection transect. It revealed stratified, charcoal-rich deposits to a depth of over a meter, and unearthed a prehistoric adit tunnelled into the bedrock face. However, it failed to expose the full vertical and horizontal dimension of the feature (Botkin 1989:313-315). More complete exposure was afforded during data recovery; a backhoe enlarged the original trench (Trench 1) and excavated a spur trench (Trench 2) at the base of the bedrock exposure (Figure 161).

Trench 1 exposed the underlying quarried bedrock and more of the small adit. Because of slumping and subsequent retrenching, the west wall of the enlarged Trench 1 lay approximately 20-30 cm farther west than the previous hand dug profile, and the trench was lengthened to extend downslope, into a moderately well developed soil profile. Trench 2 intersected Trench 1 along a roughly southwest-northeast axis approximately 2.0 meters northwest of the bedrock face, providing a three dimensional view of the strata. The adit at the southeast end continues along the outcrop face to the east, and almost certainly more unexposed quarried cavities lie in the bedrock. To the west, the adit ends a short distance beyond the profile face. The outcrop face probably was worked back to the south and downward to its present configuration. The horizon numbering of the original hand dug trench has been retained (Figure 162).

Horizon V is comprised mostly of Unit 43, a poorly sorted, moderately compact mixture of clayey silt loam with common pebbles and rare to common opalite chunks. It consists chiefly of colluvially derived deposit. These deposits, however, also fill a fairly large cavity quarried into the bedrock, beginning about 1.5 meters along the Trench 1 profile. Unit 48 lies on bedrock in the bottom of the pit below Unit 43, and is a poor open framework of opalite chunks composed mostly of quarry debris. Perhaps Unit 43 within the pit fill is washed material slumped into the pit from the berm.

Horizon IV also partly fills the large central pit. A charcoal accumulation at the bottom of the pit, in Unit 28, is dated to 500±80 years B.P. (Appendix L). The southern extent of Horizon IV is unclear, but a younger radiocarbon date of 320±50 years B.P. in Unit 21 of Horizon II indicates that Unit 20 perhaps is not part of Horizon IV, thus suggesting that Horizon IV ended somewhere near the middle of the central pit.

Horizon III is composed mainly of the framework Units 19, 26, and 42, and the finer Unit 25. Units 19 and 42 are probably equivalent; both directly underlie the distinct, clean silty Unit 18. Although the deposits mainly overly the central pit, they are probably associated with southward quarrying of the vertical bedrock face. A radiocarbon date of 360±60 years B.P. from charcoal in Unit 42 (Appendix L) fits well between dates from Horizons II and IV, although the degrees of error overlap.

Horizon II deposits fill the adit in the southern bedrock face with alternating moderate to typical open frameworks of medium to coarse opalite chunks and flakes, and hashy units of mixed sand, silt, and fine opalite chips. The coarse units clearly derive from quarrying. The finer units may have been formed during hammering and bashing of the bedrock during quarrying, or from slopewash mixing of soil and finer quarry refuse, or both. The Horizon II units in Trench 1 generally dip into the outcrop, while in Trench 2, they lie close to horizontal. A shaped stone disk was found in the open framework of Unit 11 of this horizon.

The poorly sorted gray brown pebbly silts and fine to medium opalite chunks of Horizon I appear colluvially derived. They extend only 2.5 meters downslope from the opalite outcrop.

Feature 4

Feature 4, located on the knoll top, consists of a single, roughly circular 4 m diameter depression ca. 10 cm deep (cf. Figure 160). Unlike most other such features, no berm could be

Figure 162. Description of stratigraphic units, Trench 1, 26Ek3195, Feature 2.

Stratum	Description
1	Grayish brown to brown (10YR 5/2 to 5/3) dry; silt loam, vesicular, loose to weak fine granular; common fine to medium subangular pebbles, sometimes in vague pebble lines; common fine roots; rare lenses of medium weathered subangular opalite chunks; boundary gradual to clear.
2	Light brownish gray (10YR 6/2) dry; silt loam; less vesicular and more compact than unit 2; weak angular blocky; abundant fine to medium pebbles and common fine opalite chunks; boundary clear and irregular.
3	Poor open framework, medium to coarse opalite chunks; common silt loam matrix as in unit 2.
4	Same as unit 2, except for a weak subangular blocky structure and more abundant pebbles and opalite chunks.
5	Same as unit 2.
6	Moderate open framework, very fine and fine opalite and tuff chunks; moderate silt loam matrix as in unit 2.
7	Moderate open framework, medium to coarse opalite and tuff chips chunks and flakes, clasts become more flake dominated to the north and more uniformly subhorizontal; moderate sandy silt matrix, brown (10YR 5/3) dry, becoming more common to the north.
8	Similar to unit 7. except for more sandy silt matrix.
9	Fine hash; grayish brown to light brownish gray (10YR 5/2 to 6/2) sandy silt; abundant fine opalite chips; notable charcoal concentration at south end of unit.
10	Moderately compact, fine poor open framework, hashy, very abundant very fine to fine opalite and tuff chips; common pulverized tuff with silt matrix, light gray (10YR 7/2) dry.
11	Typical to moderate open framework, medium to very coarse opalite chunks with medium to coarse opalite flakes; sparse matrix at coarsest center of unit becoming more common at margins, fine sand to pebbles size opalite and tuff chunks with silt, light gray (10YR 7/2) dry.
12	Fine, poor to moderate open framework, hashy, fine to medium opalite and tuff chips; common silty sand matrix, grayish brown (10YR 5/2) dry.
13	Similar to unit 12, except distinctly coarser with more medium size chips.
14	Same as unit 12.
15	Typical to moderate open framework, medium opalite chips and chunks; sparse silty sand matrix, light brownish gray (10YR 6/2) dry.
16	Fine hash of fine opalite chips with silty sand, light brownish gray to pale brown (10YR 6/2 to 6/3) dry.
17	Typical open framework, very fine to coarse opalite chips and flakes; very sparse pulverized opalite and tuff matrix; rare fine rhyolite chips.
18	Coarse hash; brown (10YR 5/3) dry; firm, compact, slightly vesicular, clayey silt; common fine to medium, angular to subangular opalite pebbles; common fine roots.
19	Typical open framework, medium to coarse opalite and tuff chunks, and medium opalite flakes; very sparse matrix as in unit 26.
20	Same as unit 18, except more abundant medium opalite chunks.
21	Typical fine hash of very fine to fine opalite chips with clayey sandy silt, grayish brown (10YR 5/2) dry.
22	Moderate open framework, fine to medium opalite chunks, chips and flakes; sparse opalite sand and silt, brown (10YR 5/2) dry.
23	Typical hash, common very fine to fine opalite chips, rare medium chips, pulverized opalite and tuff, silt, brown (10YR 5/2) dry.
24	Fine to medium chunks of tuff and some opalite in an abundant matrix as in unit 23.
25	Typical hash similar to unit 23, except for a lighter color, very pale brown (10YR 8/3) dry.
26	Typical open framework, medium to coarse opalite and tuff chunks with some medium and fine flakes; sparse hashy matrix as in unit 25.
27	Same as unit 23.
28	Typical hash, light brownish gray (10YR 6/2) dry; common charcoal.
29	Typical hash, pale brown (10YR 6/3) dry.
30	Same as unit 1.
31	Moderate open framework, coarse opalite chunks; moderate silt loam matrix as in unit 30.
32	Moderate open framework, abundant medium to coarse opalite flakes with some in lense-like orientation, rare chunks; moderate sandy silt matrix, brown (10YR 5/3) dry.
33	Moderate open framework, distinct lense of subhorizontal, fine to medium flakes of opalite, sparse matrix as in unit 32.

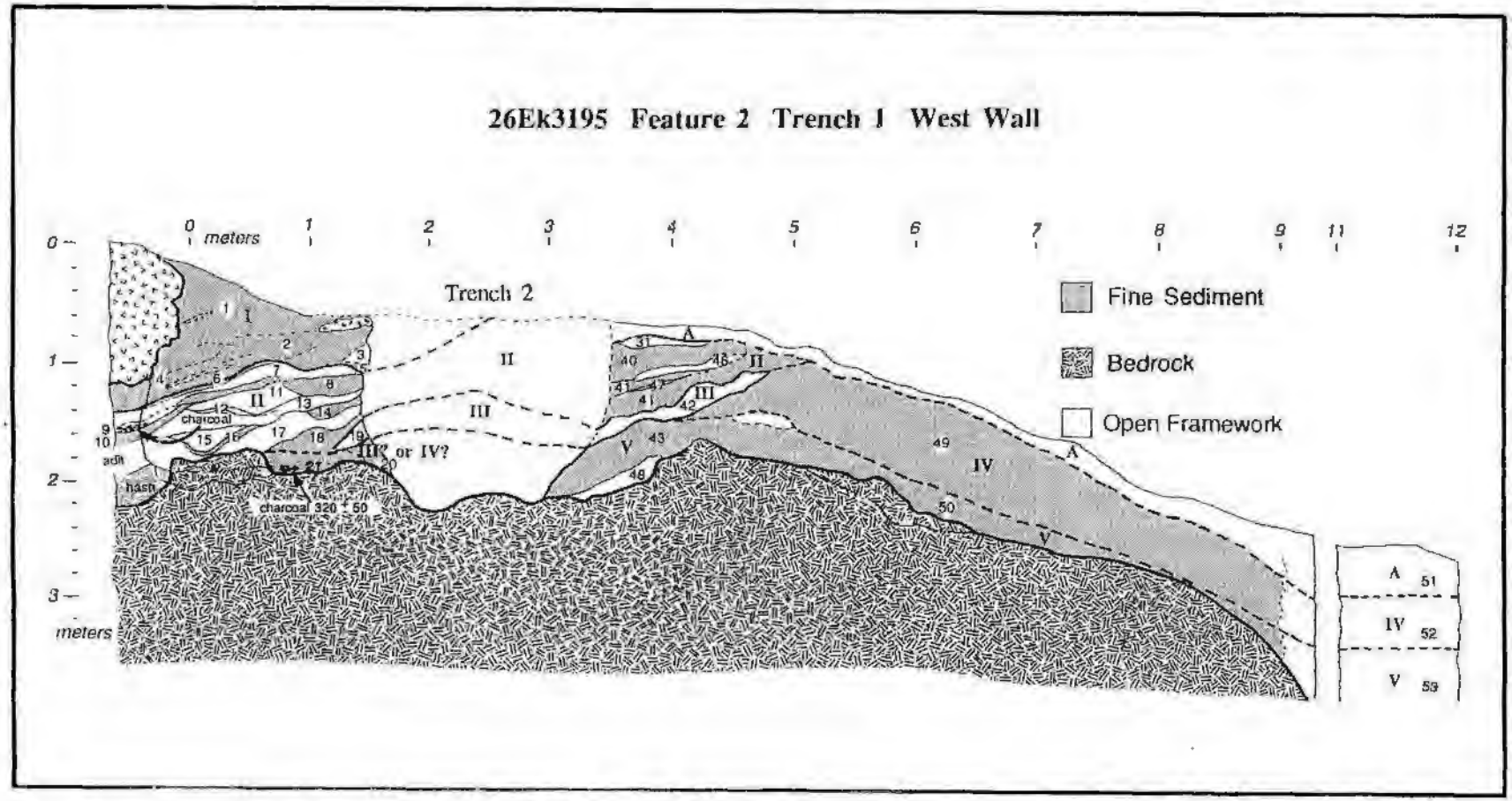


Figure 162. Description of stratigraphic units, Trench 1, 26Ek3195, Feature 2.

Figure 162, continued.

34 Brown (10YR 5/3) dry; clayey silt loam, weakly vesicular, weak fine granular, common fine roots and pores; rare to common subrounded fine pebbles.
35 Typical open framework, lense of medium to coarse opalite chunks.
36 Same as unit 34, except more common fine opalite chunks.
37 Poor open framework, fine to coarse opalite and tuff chips and chunks; moderate matrix same as in unit 36.
38 Fine open framework, very fine to medium opalite chips, chunks, and flakes, with some tuff; very sparse matrix.
39 Poor open framework, fine to coarse opalite and tuff chunks with some chips and pale brown (10YR 6/3) dry, sandy silt matrix; pink opalite is common in this unit.
40 Same as unit 39, except coarser chunks dominate, making a moderate open framework.
41 Same as unit 18, except more common opalite chips and charcoal flecks.
42 Moderate to poor open framework, very fine to very coarse opalite chips, flakes, and chunks; sparse to moderate silt loam matrix similar to unit 41; common to abundant charcoal.
43 Brown (10YR 4/3) dry; clayey silt loam; common fine angular to subrounded pebbles; rare to common opalite chunks.
44 Distinct charcoal accumulation.
45 Distinct charcoal accumulation.
46 Same as unit 35.
47 Moderate open framework, very thin fine to medium opalite flakes, moderate matrix as in unit 41.
48 Poor open framework, fine to coarse opalite chunks with some tuff; common silty sand matrix, very pale brown (10YR 7/3) dry.
49 Dark brown (10YR 3/3) slightly moist; clayey silt loam; loose to weak angular blocky; rare to common fine to medium pebbles; rare medium and coarse opalite chunks; boundary gradual and irregular.
50 Same as unit 49, except more abundant gravel and opalite chunks.
51 Dark grayish brown (10YR 4/2) dry; silt to silt loam; loose to weak granular or platy, to weak subangular blocky; abundant fine roots, common pores; boundary gradual and smooth.
52 Dark brown (10YR 3/3) slightly moist; clayey silt loam; weak medium subangular blocky; common fine to medium, subangular to subrounded pebbles; common fine roots; boundary gradual and smooth.
53 Dark yellowish brown (10YR 3/4), weakly mottled very dark brown (10YR 2/2) slightly moist; silty clay; common fine to medium subangular to subrounded pebbles; boundary gradual and smooth.
54 Dark brown (10YR 4/3) slightly moist; sandy clay, with abundant fine to coarse subangular to subrounded gravel; boundary unexposed.

identified. A light to moderate density accumulation of opalite debitage and naturally weathered opalite debris covers and encircles the pit over an area of 49 m^2, and yielded the only formed artifact found at the feature, a Stage 2 biface (cf. Table 162). A similar incipient quarry pit, Feature 3, lies immediately adjacent to the west. Numerous low bedrock exposures occur in the immediate vicinity, suggesting that activity was attracted by promise of shallow, unweathered raw material. Feature 4 was bisected by a backhoe trench (Trench 1) to investigate this minimal species of quarry pit excavation.

Trench 1 exposed a shallow profile above a near-surface opalite outcrop. At least three separate depressions may have been dug, but the natural irregularity of the bedrock surface makes it uncertain whether they are quarry pits. Since they are deepest where bedrock is softest and of the poorest quality, they perhaps are natural (Figure 163). Quarrying penetrated a brown surface loam mantling a reddish clay paleosol down to the opalite bedrock. The clays of Units 4 and 5 include sparse opalite flakes, probably either from mixing during quarrying or later bioturbation and clay swelling. The clays are fairly well consolidated and have clay skins on some ped faces. Unit 2 above the clays appears slightly ashy. If this is Mazama tephra the quarrying and redeposition of the clays could have occurred prior to 6,900 B.P., but it is more likely that Unit 2 is much younger, formed from reworked Mazama ash. Besides the limited depth of quarrying, the shallowness of the deposits may be a function of position on the crest of a small ridge, in a relatively flat area where few slopewash sediments are transported.

Implications

26Ek3195 served chiefly as a toolstone source. Quarrying efforts exploited subsurface toolstone reserves, but they extended as well to surface outcrops and colluvial supplies. The character and distribution of debitage and bifaces suggest that toolstone processing took place largely at the quarry features themselves, and that most such tasks aimed at creating early stage reduction forms. The small biface assemblage hints that most reduction products were transported away from the site for further reduction elsewhere (cf. Chapter 21).

26Ek3200

26Ek3200 is the easternmost and smallest quarry site tested in the Eastern Periphery (cf. Figure 142). Covering only 242 m^2, it lies isolated on a small bench on the mid-slope of Corral Fan (Figure 164). It occupies a region otherwise devoid of pronounced cultural accumulations, and is coincident with the only opalite outcrops occurring in this quadrant of the East.

Despite its isolation, the superior quality of opalite bedrock appears to have conditioned intensive use of the place; prehistoric quarrying intruded 80 cm of solid substrate. Results of our field efforts suggest that 26Ek3200 constitutes one of the purest expressions of unifunctional toolstone extraction observed in the Eastern Periphery (Intermountain Research 1988b:152).

Most of the site is covered by a moderate density lithic scatter dominated by large opalite waste flakes and shatter, with abundant unmodified opalite cobbles and slabs. Shallow colluvial soils are juxtaposed with low exposures of bedrock throughout. Two close-set quarry pits punctuate the general scatter and host denser concentrations of debris. Both comprise elements of Feature 1.

Feature 1

The more prominent quarry pit at Feature 1 lies on the downslope margin of the principal opalite outcrop of the site; it served as the focus of our inquiry. Its surface is defined by a roughly circular depression 4 m in diameter and ca. 35 cm deep, partially encircled by a debris-rich berm along its downslope rim. The other pit is marked by a faint, shallow, lichen-encrusted undulation of the surface approximately 3 m in diameter, that apparently represents an incipient or abandoned quarry effort initiated just north of the larger excavation (cf. Figure 164); this pit was not explored.

During testing, the surface compositions of the fill and the surrounding accumulation of tailings at the larger pit were sampled by scraping 12 25 cm x 25 cm units along a baseline parallel to the slope. The transect bisected the pit and its berm, from the outcrop ledge through the talus slope below. Subsequently, a trench was excavated by hand along the baseline to expose internal structure.

Surface artifacts are limited in abundance and variety, but they are composed almost exclusively of a visually distinctive white and pink opalite of exceptional high quality. Toolstone procurement dominates the assemblage (Table 164). Among the small number of bifaces recovered (n=12), most are early and intermediate reduction products and debitage, as typical of quarry pits observed elsewhere, chiefly from the reduction of cores (cf. Chapter 10).

Table 164. Artifacts Recovered from Feature 1, 26Ek3200.

Unit No. (Type)	Surface Scrape (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces	Flake Tools	Other/ Exotic	Total
1 (SF)	0.063	1	0.7	-	-	-	0
2 (SF)	0.063	16	32.7	-	1	-	1
3 (SF)	0.063	3	59.9	-	-	-	0
4 (SF)	0.063	2	43.7	-	-	-	0
5 (SF)	0.063	24	113.3	-	-	-	0
6 (SF)	0.063	54	182.5	-	-	-	0
7 (SF)	0.063	18	17.9	-	-	-	0
8 (SF)	0.063	42	135.9	-	-	-	0
9 (SF)	0.063	39	214.1	-	-	-	0
10 (SF)	0.063	13	45.6	-	-	-	0
11 (SF)	0.063	25	146.7	-	-	-	0
12 (SF)	0.063	3	19.1	-	-	-	0
Surface Inventory	N/A	-	-	12	-	1	13
Trench Samples	N/A	-	-	-	-	1	1
Totals	0.756	240	1,012.1	12	1	2	15

(SF) = Surface Scrape

Two quarrying tools were found, as well. One of these, a large quartzite slab with battered, step-fractured edges, lay a few meters downslope from the pit. Its tabular shape and damaged edges suggest use as a digging or hoe-like implement (cf. Chapter 11). The proximal portion of a *Bison* sp. scapula recovered from the trench sidewall in the interior of the pit (cf. Chapter 14) may have been used similarly. The broad, robust form of the original unfragmented bone could have proven useful in digging or scooping liberated debris from the pit. A similar specimen was recovered from 26Ek3208 in the Western Periphery, and others have been reported in comparable quarry contexts elsewhere (cf. Ahler 1986).

The only artifact not referable directly to toolstone procurement is a scraper, recovered from the ground surface upslope of the pit.

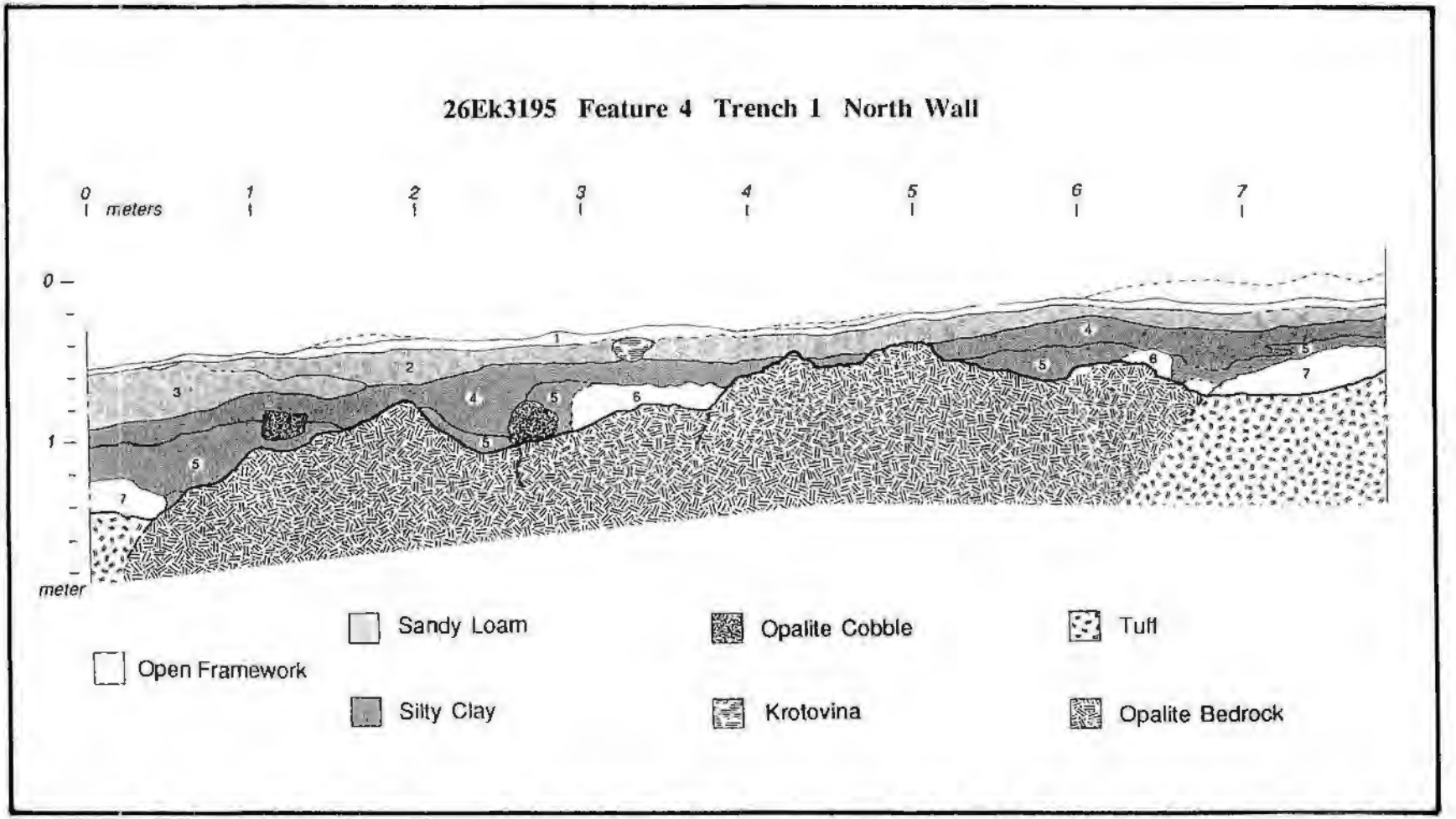


Figure 163. Description of stratigraphic units, Trench 1, 26Ek3195, Feature 4.

Figure 163. Description of stratigraphic units, Trench 1, 26Ek3195, Feature 4.

Stratum	Description
1	Brown (10YR 5/3) dry; loam; loose to weak very fine granular; common fine opalite chunks and flakes; abundant fine to medium roots; boundary clear and slightly irregular.
2	Brown to dark brown (10YR 5/3 to 4/3) dry; sandy silt loam; weak platy to moderate fine granular; common fine opalite chunks and flakes; common fine to medium roots; boundary abrupt and smooth to wavy.
3	Pale brown (10YR 6/3) dry; silt loam, possibly ashy; weak to moderate fine granular to subangular blocky; rare to common subangular opalite, tuff, and rhyolite pebbles.
4	Pale brown to yellowish brown (10YR 6/3 to 5/4) dry; clay loam; weak to moderate fine subangular blocky; abundant angular to subangular tuff and opalite clasts, rare opalite flakes; common fine roots; boundary clear and irregular.
5	Dark brown to brown (7.5 4/4 to 5/4) dry; sandy clay to sandy clay loam; moderate to strong fine subangular blocky, weak clay skins on ped faces, clay appears slightly reworked; abundant fine opalite chips, chunks, and flakes; common fine roots.
6	Dark brown to strong brown (7.5 YR 4/4 to 4/6) dry; clay; strong medium angular to prismatic, moderate clay skins on peds; common fine roots.
7	Strongly weathered tuff and opalite with some clay.

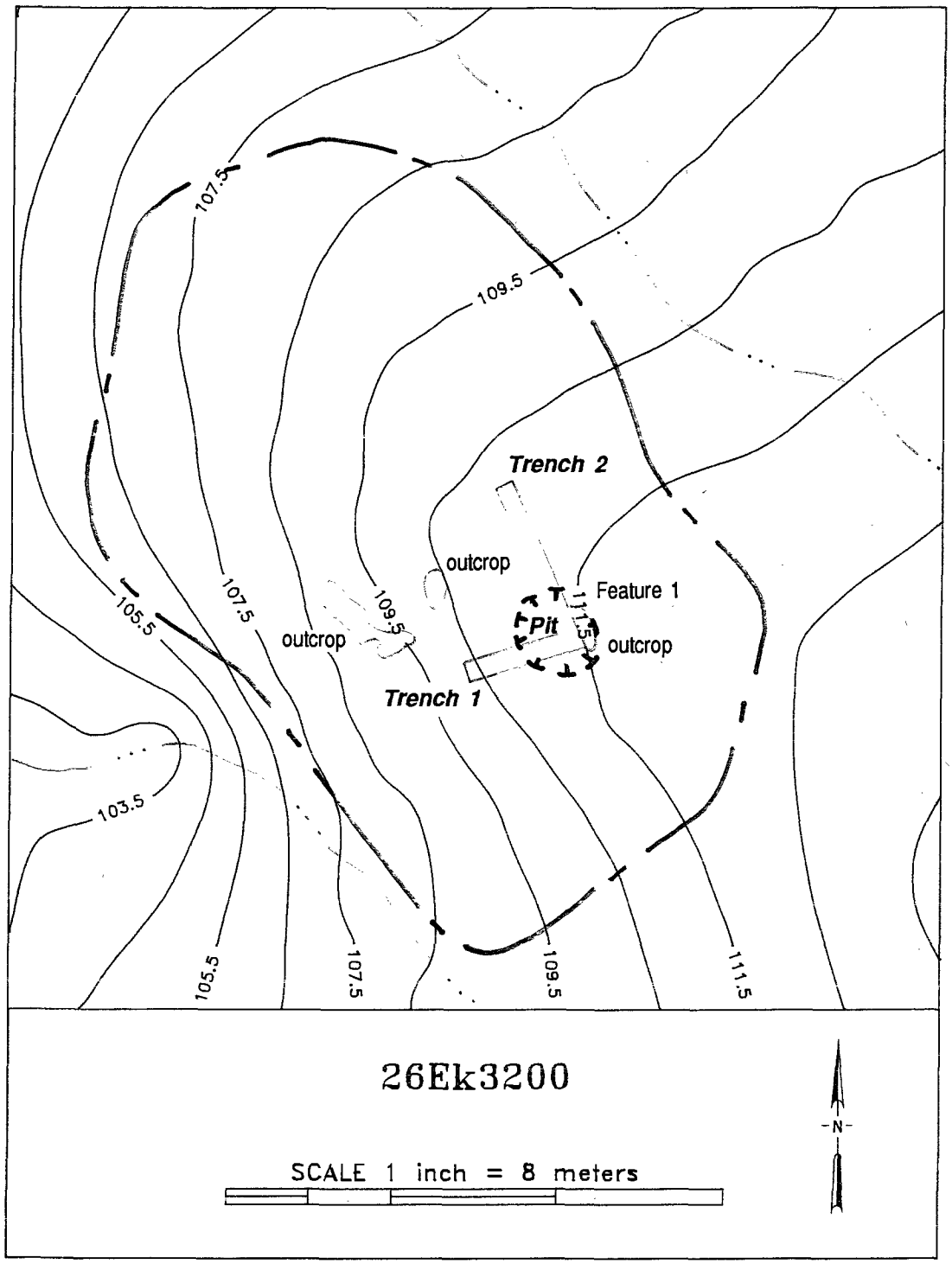


Figure 164. 26Ek3200 site map.

Stratigraphic analysis of the north trench profile pit profile was accomplished during testing. Trench expansion and excavation of an intersecting spur trench at the base of the bedrock outcrop during data recovery contributed understanding of the horizontal expression of the feature, but did not alter substantially our view of its vertical structure. The description of pit deposits presented below dates to the testing program and is borrowed from earlier documentation (Intermountain Research 1988b). The profile is depicted in Figure 162, supplemented by a planview of the pit floor in Figure 165.

> trenching exposed at least 18 distinct strata in the profile of the trench wall. These are numbered consecutively from the surface, but are not described in detail. Instead, strata are grouped into horizons and attention is devoted to the overall development of the feature.
>
> The pit was apparently excavated about 80 cm into tuff and silicified tuff bedrock. Both white and pink toolstone were extracted. The texture of strata in the pit fill alternates between fine and coarse in the manner observed in other quarry pit profiles. The sand to loamy sand fine sediments (Units 3, 5, 7, 12, 15, and 17) probably represent slopewash and eolian deposits accumulated in open pits between episodes of active quarrying. The coarser layers of angular rubble and/or cores and large flakes (Units 1, 2, 4, 6, 9, 11, 13, 14, 16, and 18) are colluvial and waste from quarrying and toolstone processing.
>
> The highly organic Unit 3, thinly mantled with a layer of flakes and angular shatter, is the present A horizon. The upslope portion appears to have been buried by mostly colluvial Units 2 and 1 in the recent past.
>
> Working upslope and into the outcrop, prehistoric quarrymen backfilled their pits as they went along. Thus, the beds are progressively younger upslope and toward the face. The pit may have been started on the fissure still present in the bottom of the oldest part of the pit.
>
> On the basis of orientation, strata can be grouped into four time-stratigraphic horizons. Horizon IV (Units 18 through 15) constitutes the oldest group. Truncated by units of Horizon II, they are short and concave upward. The outcrop face was probably near 1.4 m west of its present position. Horizon III (Units 11, 12, and 13) marks an interval when the outcrop face probably lay about 1.0 m west of its present position. These units are convex upward, preserving a portion of the pit berm. Horizon II (Units 9 through 6) marks the last intensive episode of quarrying. The profiles of these units are S-shaped, preserving both the pit floor and the berm. The outcrop face assumed its present position during Horizon II. A *Bison* sp. scapula was found in Unit 6, probably used as a digging tool. Finally, Horizon I includes the more horizontal layers subsequent to Unit 6, and suggests passive accumulations in the open pit rather than culturally generated deposits. (Intermountain Research 1988b:150-152)

Implications

26Ek3200 appears to have functioned almost exclusively as a source of high quality opalite. Lying relatively high in the landscape far removed from water or base camps, and remote from other toolstone sources, it doubtless was attractive chiefly for its extremely fine-grained and uniform quality toolstone.

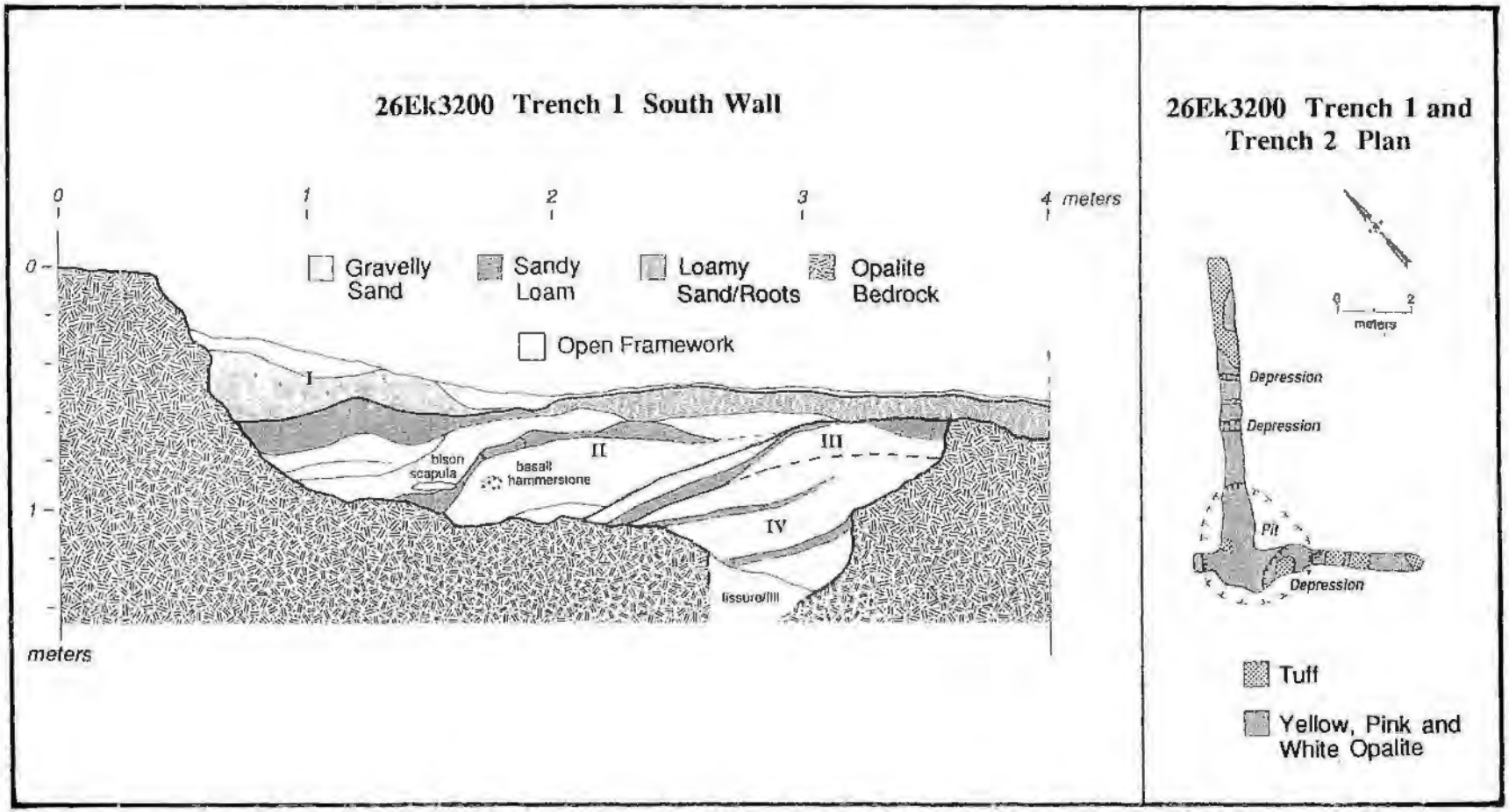


Figure 165. 26Ek3200: a. Trench 1 profile; b. Trench 1 and Trench 2 plan.

26Ek3032/Locality 19

Overlooking the middle reach of Little Antelope Creek, and some 15 m above it, Locality 19 occupies a subtle, comparatively flat bench on the otherwise steep eastern midslope of lower Holmes Ridge (cf. Figure 141). The original Tosawihi survey identified the site as a 3 m x 3 m flake scatter accompanied by a metate and, on this basis, attributed its creation to toolstone reduction and minor residential activities (Elston, Raven, and Budy 1987). Subsequent fieldwork, however, revealed the locality to be very much larger and more complex, and added a quarry pit to its attributes. Historic disturbances render the origin of the quarry pit equivocal, however.

The lithic scatter covers nearly 3000 m^2, encompassing the entire bench and extending some 50 m downslope until density falls off on the east. On the south, a minor intermittent drainage differentiates the scatter from Locality 18 (Figure 166). Site soils, like those of the surrounding area, are a clay silt loam with abundant tuff gravels; they do not appear to exceed a depth of 50 cm. A sparse open growth of low and tall sagebrush occurs sporadically across the site.

Close interval inspection revealed only one prehistoric feature in a light to moderate density background. In several places debitage densities increase subtly, possibly reflecting prior reduction episodes, but we could isolate no discrete events. Likewise, a ledge of seemingly good quality opalite at the northeastern edge of the site *appeared* battered, but equivocally so. Save a basalt metate identified in initial survey, all formed artifacts found in nonfeature contexts are products of opalite processing (Table 165).

Table 165. Artifacts Recovered from 26Ek3032, Locality 19.

		DEBITAGE		FORMED ARTIFACTS					
Unit No. (Type)	Surface Scrape (m^2)	n	wt. (gm)	Bifaces	Cores	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
Feature 1									
1-4 (SF)	4.0	11,720	24,949.8	26	2	18	-	-	46
5-8 (SF)	4.0	2,952	18,247.8	10	2	3	-	-	15
Surface Inventory	N/A	1	65.8	19	-	2	-	-	21
Nonfeature Contexts	N/A	-	-	10	1	-	2	1	14
Totals	8.0	14,673	43,263.4	65*	5	23	2	1	96

(SF) = Surface Scrape
* Includes "possible" bifaces

Feature 1

Feature 1 incorporates the small reduction scatter that initially served to identify the site. In its reconsidered form it covers ca. 500 m^2 of the central portion of the bench with a dense accumulation of lithic processing debris and other artifacts. It is distinctive in the Eastern Periphery for its mottled, multicolored pink, orange, yellow, and red opalites, and its abundance and variety of formed artifacts. The feature originally may have subsumed a quarry pit as well, but direct evidence has been obliterated by a bulldozer cut bisecting the feature (cf. Figure 166). The lithic scatter in the berm of the bladecut and surface immediately below it are the densest observed in the feature; the abundance of colorful debris and the comparatively high proportions of shatter, angular clasts, and large flakes imply primary toolstone

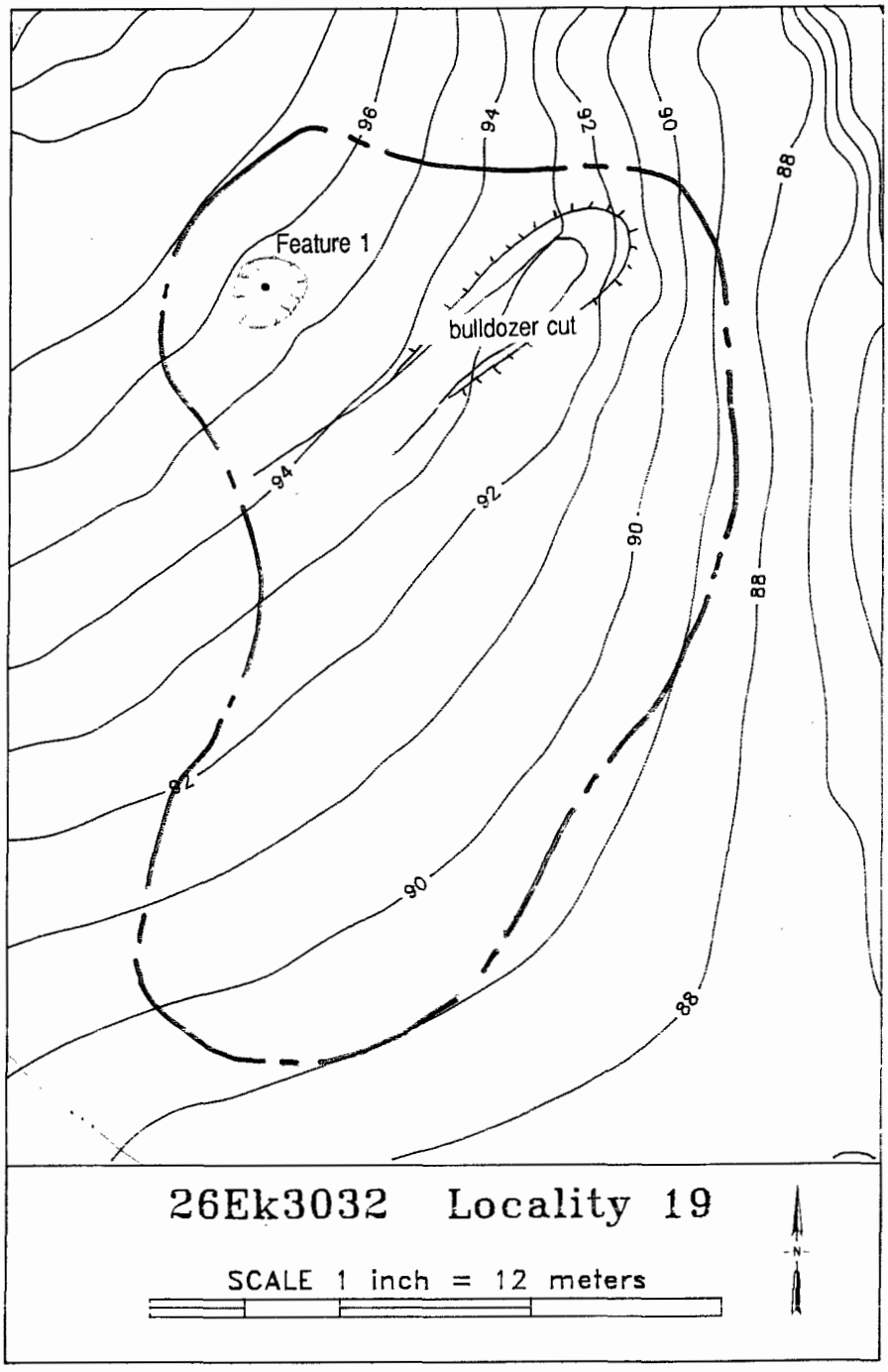


Figure 166. Locality 19 site map, 26Ek3032.

extraction. A stratigraphic profile provided by facing a segment of the cut failed to reveal clear evidence of aboriginal excavation (Figure 167). It did, however, disclose opalite bedrock just below the surface identical to the distinctive polychrome varieties dominating Feature 1. Evidence of toolstone extraction occurs as a circular, 5 m diameter depression located just above the cut; it may be a quarry pit, but its berm is nearly devoid of stone, an attribute more akin to historic prospects found in the area than to aboriginal excavations.

The remainder of fieldwork sought more to fully identify the content of the lithic scatter at Feature 1. Surface inventory recovered 19 bifaces and two flake tools from widely scattered locations. Two 16 m^2 areas were scraped, each consisting of four 1 m x 1 m units. Units 1-4 were placed immediately upslope of the bladecut; Units 5-8 sampled an area several meters below it (cf. Figure 166). The exercise revealed that the feature is confined to the surface; nowhere was it observed to intrude beneath the shovel scrapes. Unit returns were voluminous and diverse (cf. Table 165). The assemblage reflects the processing of colorful opalite presumably derived from an on-site source. Debitage chiefly is the product of core reduction, but the scores of bifaces recovered witness stages of biface production from the creation of blanks through intermediate reduction (cf. Chapters 6 and 10). Other activities are represented by twenty-one diverse flake tools were retrieved.

26Ek3197

26Ek3197 occupies 4500 m^2 of a broad peninsular shelf jutting north from the foot of Corral Fan to create a pronounced bend in the upper reach of Undine Gorge (cf. Figure 141). The shelf is bounded on the east, north, and west by the drainage; the outcrop quarry 26Ek3198 lies just upslope to the south. Extensive exposures of white and grey brecciated opalite emerge over most of its surface. Scrutiny of the site was confined to the testing phase of work.

Eleven cultural features occur; all related to opalite procurement and reduction. They are concentrated in the northwestern quadrant of the site, where toolstone extraction focused on surface and near-surface bedrock along upper and midslopes (Figure 168). Two close-set quarry pits and their associated dense lithic scatters (Features 1 and 2) share the same contour; below these, outcrop sources were exploited at Features 4 and 7. A bedrock overhang on the steep western mid-slope houses a small rockshelter (Feature 10), and a crag in the rimrock adjacent held a biface cache (Feature 5). Reduction stations (Features 6, 8, and 9) dot the gentler northern slopes and one (Feature 3) lies higher on the knoll. On the eastern flank of the shelf, an adit-like excavation (Feature 11) extends about a meter into the base of a bedrock exposure.

Site soils are undifferentiated from those of the surrounding vicinity, but they lack the pronounced loess mantle that blankets 26Ek3198 immediately upslope. Deposits at 26Ek3197 are sandy silt colluvial products containing abundant tuff and opalite gravels; the extensive on-site exposures of bedrock imply that they are generally shallow.

Nonfeature Contexts

The relatively flat, highest portion of the shelf lacks cultural features, but it is covered by a diffuse expanse of opalite debitage intermingled with a dense blanket of naturally weathered materials. Few formed artifacts lie outside feature boundaries. Inventory recovered only three opalite bifaces. Seven 1 m x 1 m surface scrape units spanned the ridge top along a common baseline, yielding sparse cultural materials (Table 166).

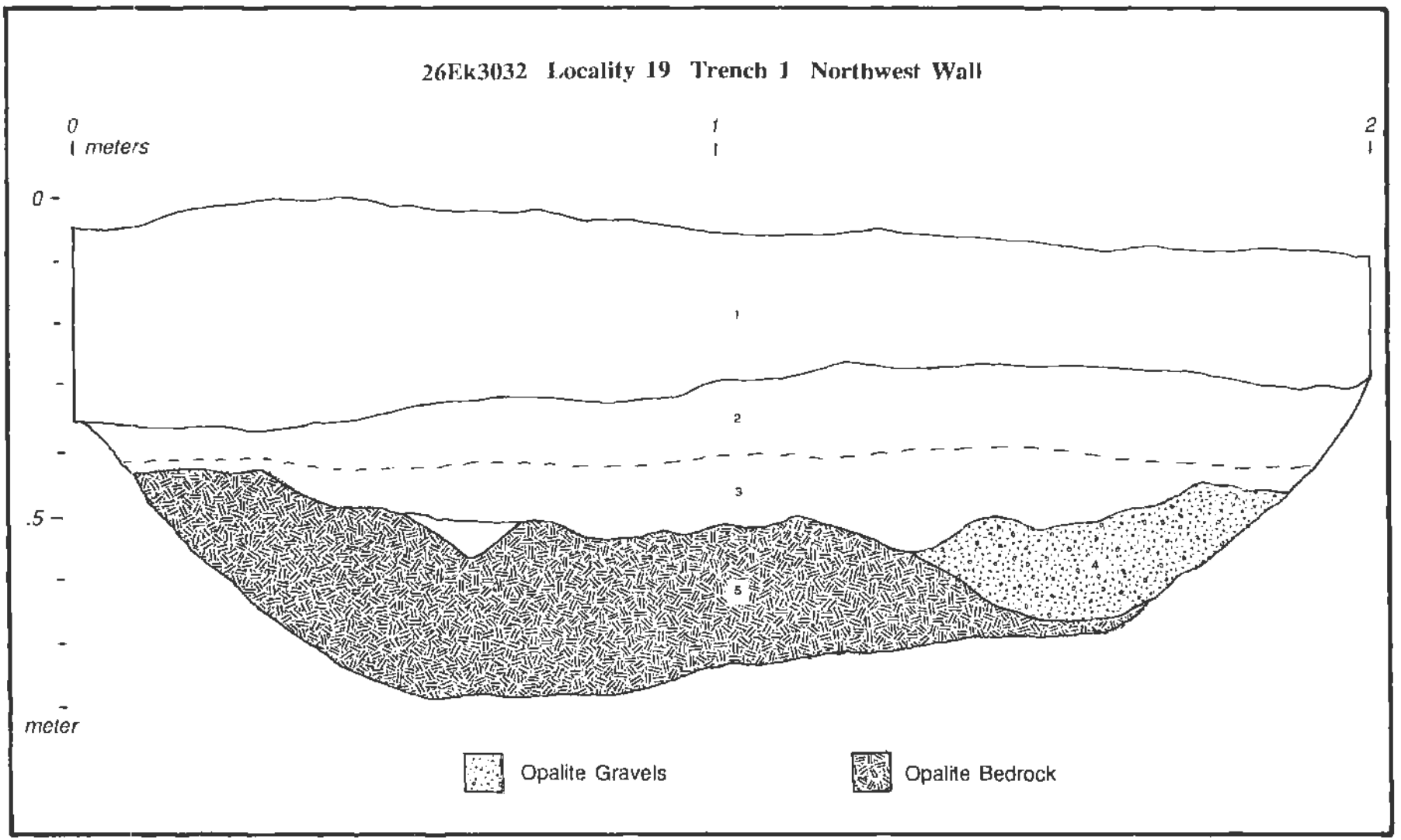


Figure 167. Description of stratigraphic units, Trench 1, 26Ek3032, Locality 19.

Figure 167. Description of stratigraphic units, Trench 1, 26Ek3032, Locality 19.

Stratum	Description
1	Brown (10YR 4/3) dry; clayey silt loam; loose to moderate fine granular; common fine to medium angular to subangular pebbles; abundant fine roots and dry organic debris; common fine to medium opalite chips and chunks, rare flakes; boundary abrupt and irregular.
2	Reddish brown (5YR 4/3) dry; sandy clay; common fine to medium angular to subangular pebbles; strong fine subangular blocky to fine prismatic; moderate clay skins on ped faces; boundary gradual and smooth.
3	Yellowish red (5YR 4/6) dry; gravely sandy clay; common fine to medium angular to subangular pebbles; strong fine to medium angular to subangular blocky; weak clay skins on ped faces; boundary gradual and irregular.
4	Angular medium to coarse clasts of weathered bedrock in clay as in unit 3.
5	White and yellow, weathered opalite and tuff bedrock with red staining and common scattered patches of gravely blue-green fine crystalline inclusions.

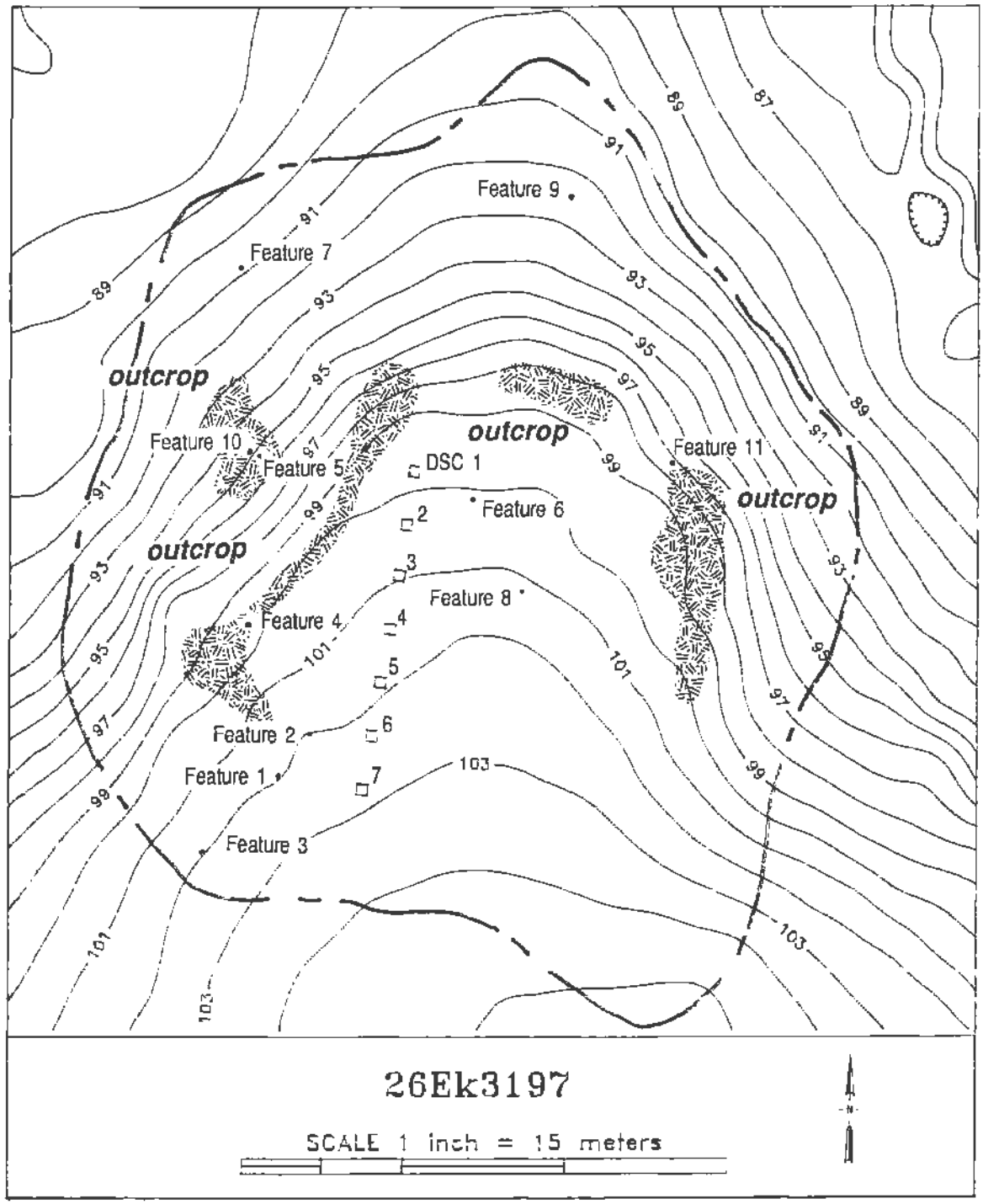


Figure 168. 26Ek3197 site map.

Table 166. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3197.

Feature	Total Area (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces	Flake Tools	Perc./ Cobble Tools	Total
1*	71	499	3,029.4	4	-	-	4
2	48	-	-	-	-	-	0
3	33	-	-	3	-	-	3
4	236	-	-	1	-	2	3
5*	49	144	1,694.4	17	1	-	18
6	88	-	-	-	-	2	2
7	17	-	-	1	-	1	2
8	154	-	-	1	-	-	1
9	37	-	-	2	-	1	3
10*	20	261	731.8	-	-	-	0
11	-	-	-	-	-	-	0
Surface Isolates	-	-	-	3	-	-	3
Other Nonfeature	-	267	1,282.4	3	-	-	3
		1,171	6,738.0	35	1	6	42

*Sample Feature

Cultural Features

Features also contain few formed artifacts (cf. Table 166). One quarry pit (Feature 1), the biface cache (Feature 5), and the rockshelter (Feature 10) were sampled.

Feature 1

Feature 1 is the larger, deeper pit. It is elliptical in plan, with diameters of 3.5 m and 2 m, and is 50 cm deep. It shares many attributes with pits examined elsewhere in the subarea, including a well developed berm along its downslope edge and a related dense lithic scatter around its perimeter. Inventory returned four biface fragments, the only formed artifacts recovered. Only the surface of the feature was scrutinized; a transect of 20 25 cm x 25 cm surface scrapes sampled a longitudinal cross-section at 1 m intervals parallel to the slope. Only opalite waste was retrieved (Botkin 1989:317-318). In contrast to the patterned variation observed in the horizontal distribution of debitage density and size at other quarry pits (cf. 26Ek3195: Feature 2; Locality 23: Feature 1), Feature 1 is homogeneous. Whether this reflects differences in manner of deposition remains unknown. We suspect, however, that post-depositional processes account for the homogeneity; greater spatial structuring may have been masked by colluvial debris from adjacent Features 2 and 3 (cf. Figure 168).

Feature 5

Feature 5 was identified by a cluster of nine opalite bifaces concentrated within 0.5 m^2 on the floor of a small sheltered crag in the rimrock (cf. Figure 168). A 1 m x 1 m excavation unit centered on the cluster revealed eight additional specimens just below the surface and just above bedrock. No stratigraphic evidence of intentional burial was observed.

Like specimens found in caches elsewhere, each of the 17 bifaces is complete. Unlike other caches, that commonly are dominated by intermediate reduction stage specimens, those of Feature 5 are chiefly Stage 2 forms (n=13); the remainder are Stage 3 (cf. Chapter 6). All are of a similar, bluish grey, coarse-grained opalite. Such material was not observed in the bedrock surrounding the cache, nor is it represented in the debitage in the vicinity. From this we infer that the cached bifaces represent a stockpile of items quarried and partially reduced elsewhere, then transported and set aside for further processing.

Feature 10

Lying 20 m west along the rim from the biface cache, Feature 10 is a small rockshelter beneath a low overhang of opalite bedrock (cf. Figure 168). Although 5 m wide, its aperture presently is only 90 cm high at the dripline; its ceiling slopes steeply downward to meet the floor just 2 m inside the outer lip. It would seem to have offered little human space; cultural remains are sparse, consisting exclusively of opalite waste (cf. Table 166).

The floor is strewn with cobbles and small roof-fall boulders, and exhibits a light, amorphous scatter of opalite debitage. Two denser accumulations of reduction debris occur on the rocky shelf just outside the overhang. A 1 m x 50 cm excavation unit straddled the dripline and was dug to bedrock (60 cm). Cultural opalite waste is scant and distributed homogeneously. The few bones recovered are of recently deceased rodents. Soils are heavily turbated, and are composed of gravelly colluvial sands dense with roof spall. They are moist, with little promise of preserved perishable remains.

Implications

Despite its size and complexity, 26Ek3197 yielded one of the smallest, least diverse collections of all sites tested in the Eastern Periphery. It appears to have attracted prehistoric use principally for its toolstone-quality opalite. Behaviors other than chert procurement and processing are little evident. The reduction of toolstone is reflected almost exclusively by quantities of opalite debitage. Bifaces (if the cache is excluded) are rare compared to their incidence at most other sites. The character of the debitage, as well as most of the biface assemblage, suggests that much of the opalite quarried on-site was reduced only to early stages, and that the vast majority then was transported elsewhere for further work.

Outcrop Quarry Sites

At six sites and at two localities of 26Ek3032, exposures of opalite bedrock constitute the sole on-site primary toolstone sources: 26Ek3191, 26Ek3193, 26Ek3196, 26Ek3198, 26Ek3201, 26Ek3203, and 26Ek3032 Localities 25 and 98. Each was tested; the results suggested that three (26Ek3198 and Localities 25 and 98) warranted revisiting for expanded sampling during data recovery. At most, outcrop quarries seem to have provided only minimal raw material; the abundant evidence of opalite reduction dominating most assemblages appears to have accrued from toolstone imported from elsewhere.

26Ek3198

26Ek3198 occupies over 12,000 m² of the crest and western slope of the principal knoll on the southern margin of Undine Gorge (Figures 169 and 141). In survey (Raven 1988) the site was designated a "Large Reduction Complex." On closer scrutiny during testing, several minor toolstone sources were discovered within its precincts, leading us to reclassify it. Still, aboriginal use appears related more to opalite reduction than to quarrying.

Shallow colluvial soils are interrupted only by several low opalite outcrops on the western rim. However, with important archaeological effect, the higher, central portion of the knoll top is mantled by an accumulation of loess.

Nonfeature Contexts

Nonfeature contexts are covered by a light to moderate density lithic scatter. Few formed artifacts occur; several bifaces and a Gatecliff projectile point were the only items found (Table 167).

Table 167. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3198.

				FORMED ARTIFACTS								
Feature	Total Area (m²)	DEBITAGE n	DEBITAGE wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Perc./ Cobble Tools	Ceramics	Other/ Exotic	Total
1*†	24	6,818	17,942.6	23	15	11	7	12	-	-	1	69
2*	0.90	598	1,939.1	-	-	1	-	1	-	-	-	2
3	22	1[a]	8.4	2	-	5	-	-	-	-	-	7
4	86	2[a]	5.2	-	-	2	-	-	-	-	-	2
5	50	2[a]	10.3	-	-	5	-	-	-	-	-	5
6	26	2[a]	7.5	-	-	5	-	-	-	-	-	5
7	123	-	-	-	-	1	-	-	-	-	-	1
8	297	3[a]	5.7	1	-	3	-	-	-	-	-	4
9*	239	107	247.2	-	-	2	-	-	-	4	-	6
10	20	1[a]	5.3	-	-	-	-	-	-	-	-	0
11	19	1[a]	1.1	-	-	1	-	-	-	-	-	1
12	4	-	-	-	-	-	-	-	-	-	-	0
13	31	1[a]	4.6	-	-	-	-	-	-	-	-	0
14*	151	707	6,140.7	-	-	8	-	-	2	-	-	10
15	33	-	-	-	-	1	-	-	-	-	-	1
16	170	1[a]	2.0	-	-	7	-	-	-	-	-	7
17	2	-	-	-	-	1	-	-	-	-	-	1
18	3	-	-	-	-	-	-	-	-	-	-	0
19	14	-	-	-	-	1	-	-	-	-	-	1
20	86	-	-	-	-	-	-	-	-	-	-	0
21	24	-	-	-	-	5	-	-	-	-	-	5
22	16	-	-	-	-	-	-	-	-	-	-	0
23	5	-	-	-	-	2	-	-	-	-	-	2
24	38	-	-	-	-	-	-	-	-	-	-	0
Surface Isolate	-	1[a]	4.9	1	-	4	-	-	-	-	-	5
Other Nonfeature	-	-	-	-	-	1	-	-	-	-	-	1
		8,245	26,324.6	27	15	66	7	13	2	4	1	135

*Sample feature
†Subsumes Feature 25 hearth
[a]Obsidian only

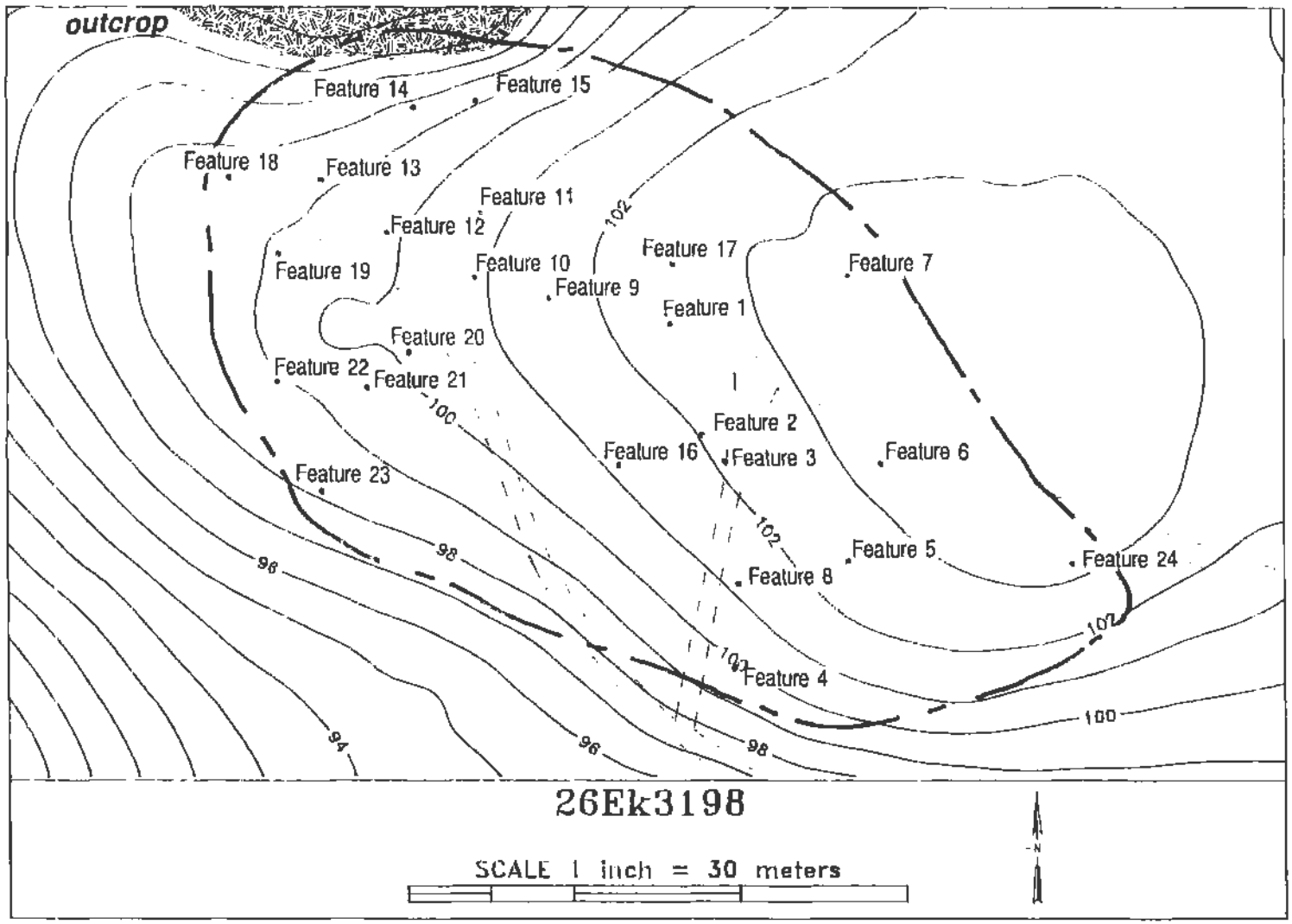


Figure 169. 26Ek3198 site map.

Cultural Features

Of 24 surface cultural features, 19 are reduction stations. Quarrying occurred at only four locations; three (Features 8, 15, and 24) reflect minor extraction efforts aimed at cobble fields while one (Feature 14) is a more extensively exploited outcrop quarry. Feature 1 stands out for its uncommon abundance of obsidian tools and debitage.

Outside Feature 1, assemblages are dominated by opalite reduction products, debitage, and bifaces; other artifacts are rare (Table 167). Several features (3-6, 8, 10, 11, 13, and 16) are augmented by scant obsidian waste. Feature 3 contained a Desert Side-notched point; another DSN and a preform were recovered from Feature 8. Several ceramic sherds dot the surface of Feature 9.

During testing, Features 1, 2, 9, and 14 were sampled; the remainder are known only from surface inventories. Results of these efforts prompted us to return to Features 1 and 14 for expanded scrutiny during data recovery. Table 167 summarizes feature contents recovered by the combined exercises.

Feature 1

Feature 1 apparently originated from activities little related to toolstone acquisition, and thus is unique among features at 26Ek3198. It is defined by two concentrations of obsidian artifacts amid an otherwise unremarkable scatter of opalite debris occupying 30 m^2 of unvegetated flat in sage on the knolltop (cf. Figure 169). We investigated it because of the large number of projectile points and other tools on the surface, and for the possibility of subsurface remains in the loess deposits.

During testing, 30 1 m x 1 m surface scrape units collected the entire visible extent of the feature; an excavation unit (Unit TS 1, Figure 170) was placed over the greatest concentration. The surface assemblage, with its abundance of projectile points, preforms, and obsidian pressure flakes, looks much like the accumulation of a hunter's small temporary camp (Table 168). Testing disclosed a deposit of comparable cultural content confined largely to the upper 10 cm (Table 169).

Table 168. Artifacts Recovered by Surface Collections from Feature 1, 26Ek3198.

Unit No. (1m x 1m)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Other/ Exotic	Total
1	114	132.1	1	-	-	-	-	1
2	337	339.2	-	-	1	1	-	2
3	88	109.9	-	1	-	-	1	2
4	239	279.0	-	-	-	-	-	0
5	194	147.8	-	-	1	1	-	2
6	19	20.2	-	-	-	-	-	0
7	209	233.6	1	1	-	-	-	2
8	16	15.4	-	-	-	-	-	0
9	7	10.7	-	-	-	-	-	0
10	6	39.7	-	-	-	-	-	0
11	58	63.9	-	-	-	-	-	0
12	150	175.7	1	1	2	-	-	4
13	52	53.5	-	-	-	-	-	0
14	144	246.7	2	2	-	3	-	7
15	105	85.3	1	-	2	1	-	4
16	45	29.8	1	-	-	-	-	1
17	1,301	305.9	5	6	1	3	-	15
18	63	107.9	3	2	-	-	-	5
19	17	61.4	2	-	1	-	-	3
20	19	35.2	-	-	-	-	-	0
21	12	9.0	-	-	-	-	-	0
22	14	17.3	-	-	-	-	-	0
23	1	2.3	-	-	-	-	-	0
24	5	6.1	-	-	-	1	-	1
25	116	142.1	2	-	-	-	-	2
26	97	60.2	-	-	-	-	-	0
27	9	10.6	-	-	-	-	-	0
28	20	26.2	-	-	-	-	-	0
29	15	9.3	-	-	-	-	-	0
30	12	6.8	-	-	-	1	-	1
Totals	3,484	2,782.8	19	13	8	11	1	52

Table 169. Artifacts Recovered from Excavation Units, Feature 1, 26Ek3198.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Total
1 (TS)[a]	0.13	1,051	135.9	3	1	1	-	-	5
2 (EU)	0.18	102	468.6	-	-	1	-	-	1
3 (EU)	0.18	33	68.9	-	-	-	-	-	0
4 (EU)[b]	0.28	261	222.3	-	-	1	-	-	1
5 (EU)	0.38	160	335.5	-	-	-	-	-	0
6 (EU)	0.18	48	89.4	-	-	-	-	-	0
7 (EU)	0.18	142	316.2	1	1	-	-	-	2
8 (EU)	0.18	152	1,111.0	-	-	-	-	-	0
9 (EU)	0.18	74	130.8	-	-	-	-	-	0
10 (EU)	0.18	78	434.9	-	-	-	-	-	0
11 (EU)	0.18	168	262.6	-	-	-	-	-	0
12 (EU)	0.20	30	55.0	-	-	-	-	-	0
13 (EU)	0.20	145	387.4	-	-	-	-	-	0
14 (EU)	0.20	75	203.1	-	-	-	-	-	0
15 (EU)	0.20	51	66.8	-	-	-	-	-	0
16 (EU)[b]	0.20	86	96.7	-	-	-	-	-	0
17 (EU)	0.20	316	1,247.0	-	-	-	3	1	4
18 (EU)	0.20	121	418.0	-	-	-	-	-	0
19 (EU)	0.20	36	137.1	-	-	-	-	-	0
20 (EU)	0.20	24	74.0	-	-	-	-	-	0
21 (EU)	0.20	19	243.4	-	-	-	-	-	0
22 (EU)	0.20	47	139.3	-	-	-	-	-	0
23 (EU)	0.20	12	809.3	-	-	-	-	-	0
24 (EU)	0.20	314	1,245.9	-	-	-	-	-	0
25 (EU)	0.20	179	2,178.0	-	-	-	-	-	0
26 (EU)	0.20	118	2,686.6	-	-	-	3	-	3
27 (EU)	0.20	460	1,246.0	-	-	-	1	-	1
28 (EU)	0.08	43	487.0	-	-	-	-	-	0
Totals	5.51	4,345	15,296.7	4	2	3	7	1	17

(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Entire unit screened with 1/8 inch mesh. Unit size reduced to 1 m x 50 cm in Level 2.
[b]Includes 50 x 50 cm 1/8 inch mesh control quadrant.

Data recovery expanded exposure of the horizontal and vertical dimension of the feature; 25 additional 1 m x 1 m excavation units were dug (cf. Figure 170). Ten of these sounded randomly selected locations within the block of surface scrapes (Units EU 2 - EU 11). An additional 15 units explored random locations within a 4 m wide perimeter peripheral to the original block (Units EU 12 - EU 26).

Excavations revealed shallow deposits and contributed few additional specimens to the formed artifact assemblage (cf. Table 169). A hearth (Feature 25) was discovered in the southeastern quadrant.

Most cultural material resides in a 20 cm, upper layer of loess. Although too loose and turbated to allow preservation of krotovina, numerous active rodent burrows suggest that it has been heavily churned. Below this zone, and differentiated from it by a weak stratigraphic contact, occurs a more compact heterogeneous clayey soil, 15 cm thick, with markedly reduced cultural content. At variable depths this overlies a dense reddish clay with abundant large fragments of natural opalite capping minimally silicified tuff bedrock. In most units bedrock was encountered at or slightly below 40 cm. The reddish clays, a mixture of a paleosol and weathered bedrock, lack cultural remains save for where rodent burrows have introduced them from higher deposits (cf. comparable stratigraphy exposed at Feature 14; cf. Figure 172).

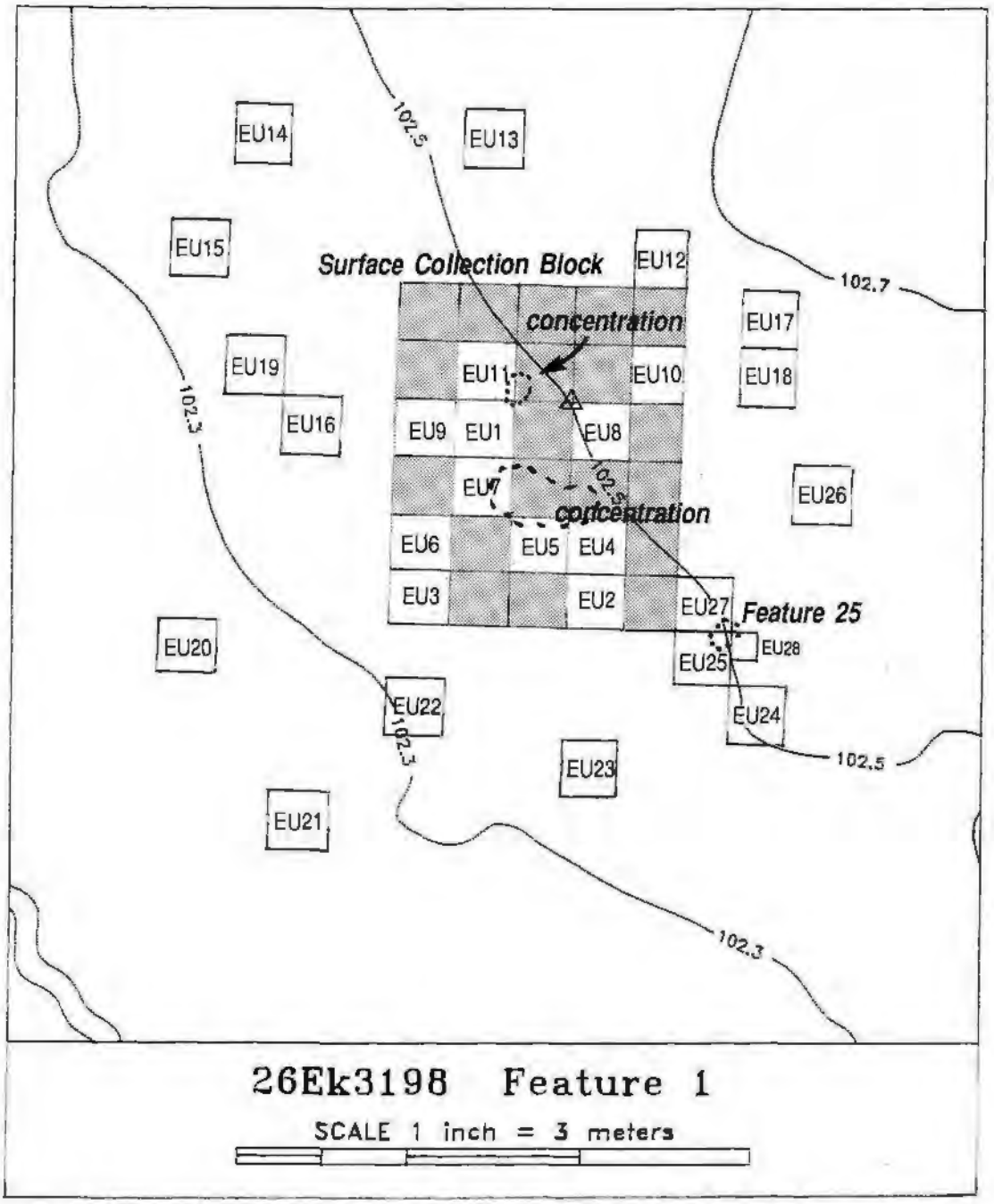


Figure 170. Feature 1 plan, 26Ek3198.

Feature 25, a hearth, was encountered in Unit 25 adjacent the southeast corner of the original block of surface scrapes (cf. Figure 170). Subsequent excavation of contiguous Units 27 and 28 resulted in its complete exposure. Lying entirely within the loess and clayey mixed deposits immediately below, the limits of the feature are clearly distinguishable from the surrounding matrix. In plan, it consists of an elliptical, 60 cm x 40 cm tightly-packed concentration of fist-sized, fire-effected tuff clasts topping and intruding a matrix of black, ashy, charcoal-rich soil. In cross-section, it is a U-shaped depression in the upper portion of the loess. The tops of the overlying rocks were encountered ca. 5 cm below surface. From ca. 10 cm below surface, the pit extends downward through the loess and the more compact soils below to intrude slightly the dense clay of the basal deposits at 25 cm. A rind of soil around the perimeter of the pit has oxidized to a bright reddish orange and deposits lining the interior are markedly more ashy than the charcoal-rich contents. Fire-cracked tuff cobbles and spalls comprise about half the volume of the pit. Radiocarbon analysis of a composite charcoal sample from the interior returned a date of 300±60 BP (Appendix L).

The function of the hearth and its relationship to other elements of the site remain unclear. Macrofossils derived from flotation disclose no use as a cooking facility (cf. Chapter 15). The position of the feature suggests affiliation with Feature 1, but no direct linkage is provided by excavations. Indirectly however, the Desert Series specimens dominating the projectile point collection from Feature 1 are congruent with the radiocarbon date obtained from the hearth.

Feature 2

Feature 2 lies 10 m south of Feature 1 and occupies the loess of the knoll top (cf. Figure 169). Its surface expression was uncommonly small (0.9 m^2), a dense scatter of opalite reduction debris. We thought the small cluster might signal a more extensive accumulation partially buried by wind-borne deposits, so we scraped three contiguous 1 m x 1 m surface units. The exercise revealed instead that the surface concentration constitutes the entire horizontal expression of the feature, confined to the upper 2 cm of deposit. A biface and a flake tool comprise the entire formed artifact assemblage; debitage chiefly reflects core functions (cf. Table 170).

Feature 9

Testing of Feature 9 was prompted by the surface occurrence of three brownware ceramic sherds that implied the possibility of diversity greater than suggested by the scatter of opalite debris. Surface scraping removed the entire feature; one additional sherd was found, together with opalite debitage indicative of early stage biface manufacture (cf. Table 170). Overall, the feature served for processing toolstone; why it contains pottery as well is unclear.

Feature 14

Feature 14 is the major opalite source within the site. Located on the northern brink of the knoll, toolstone exploitation is reflected by several dense accumulations of large fragments of opalite debris utterly blanketing the slope immediately below a series of low outcrops (Figure 171). During testing, surface scrapes sampled areas within and between concentrations; they returned formed artifacts indicative of toolstone processing (cf. Table 167) and debitage with abundant shatter and large flakes, suggestive of quarrying and initial stages of reduction (cf. Chapter 10).

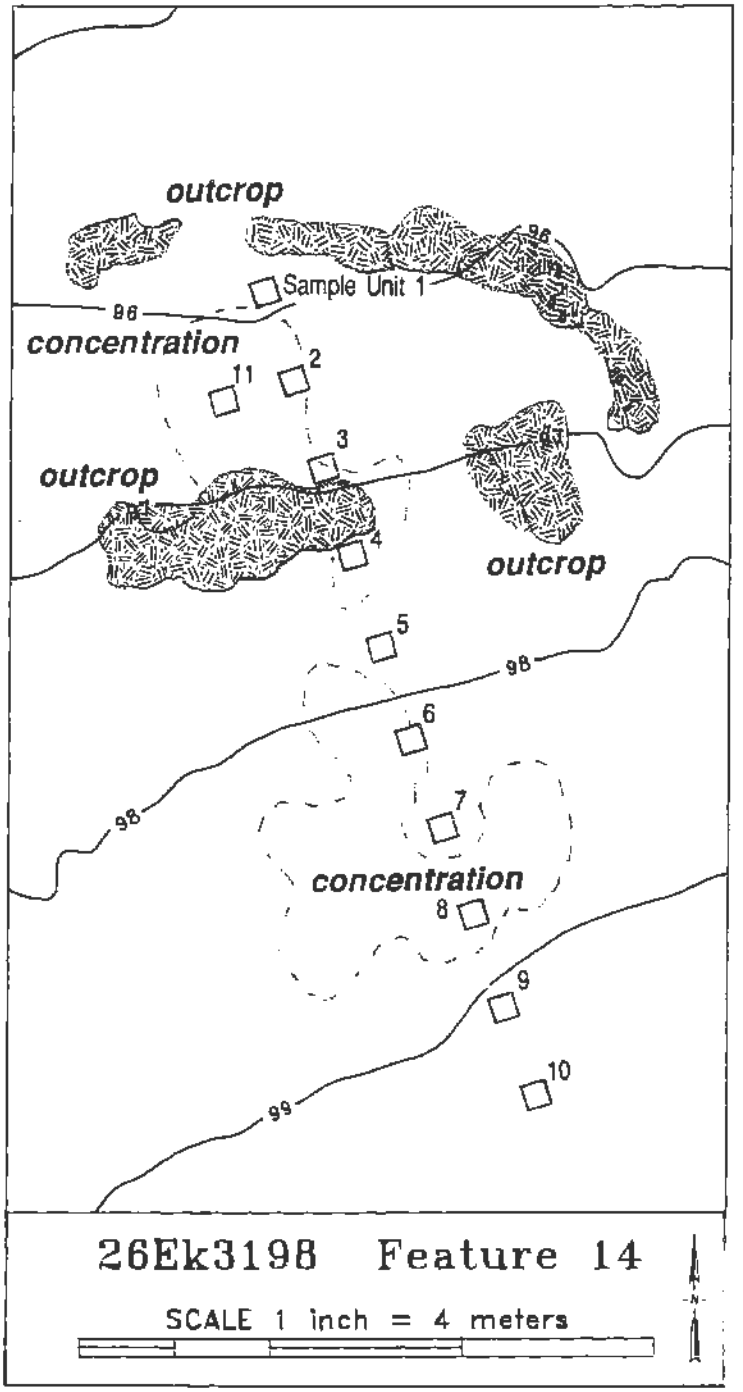


Figure 171. Feature 14 plan, 26Ek3198.

The abundance of lithic waste and the position of the debris concentrations relative to the outcrop mirror patterns observed elsewhere at quarry pits (cf. 26Ek3195; Feature 2). It seemed possible that debris might overlie and obscure quarry pits undetected during testing, or that the feature represented a very early stage of quarry formation. To explore this, a backhoe trench (Trench 1) was excavated along the surface sample transect.

The resulting profile is shallow and stratigraphically simple, with only five recognized units (Figure 172). Just above the highly irregular surface of the poorly opalized bedrock, Unit 5 consists of a reddish clay with abundant opalite and tuff fragments formed by the mixing of weathered bedrock with the overlying clay paleosol. There is no obvious cultural debris within the unit. Units 3 and 4 are clays with opalite and tuff clasts and weak to moderate prismatic soil structure. Like Unit 5, no cultural material is associated. Unit 2, a brown granular sandy loam, contains common opalite and tuff pebbles and chunks with rare opalite flakes. Unit 1, a grayish brown silt loam surface mantle, contains more opalite flakes, possibly concentrated as lag from slopewash. The clays above the bedrock indicate reworking by natural slopewash processes rather than quarrying. It appears that opalite was quarried only selectively at this feature, mostly from exposed bedrock with little (if any) digging through the soil overburden.

Implications

26Ek3198 served only minimally as an opalite source; its feature structure and artifact assemblage relate more convincingly to toolstone processing. We suspect that most opalite processed at 26Ek3198 was imported, perhaps from the neighboring, more intensively developed sources that flank it on three sides. Debitage suggests that toolstone reduced here arrived in the form of cores. From the biface collection we infer production through intermediate stages of reduction somewhat more commonly than at other quarries in the East (cf. Chapters 6 and 10).

Feature 1 appears to represent a small hunter's camp or other special purpose locus that, while not clearly associated with toolstone-orientation, nonetheless contains an assemblage of maintenance and subsistence tools perhaps reflecting tasks ancillary to, but supportive of opalite, procurement. Similar smaller and equally anomalous features occur at several other locations in the Eastern Periphery (cf. 26Ek3185, Feature 1; 26Ek3190, Feature 1; 26Ek3191, Feature 1).

26Ek3032/Locality 25

Locality 25 spans the crest of lower Holmes Ridge (cf. Figure 141). Covering 2250 m^2, it is centered on a broken rim of poor quality, reworked silicified tuffaceous sediments (Cornucopia 1987). A dense scatter of debitage and naturally fragmented opalite blankets the outcrop and its vicinity, and an anthropic talus of these materials buttresses the slopes below. Exposed bedrock dominates the surface. The sparse soils are shallow, sandy, colluvial products, dense with angular opalite cobbles; they support little tangles of low sagebrush and phlox.

Seven cultural features, all reduction stations, occur among the labyrinth of shelves, bights, and recesses in the rimrock (Figure 173). Like other outcrop quarries, exploitation of the place as a source of toolstone seems to have been minimal. Nowhere on the weathered, lichen-covered outcrop could unambiguous evidence of quarrying be found, but small quantities of locally derived debitage, distinctive for its coarse-grained, exceedingly low quality, contribute to each cultural feature as well as to the background scatter. Abundant opalite cobbles residing in the soil matrix may have provided the most commonly used on-site toolstone source.

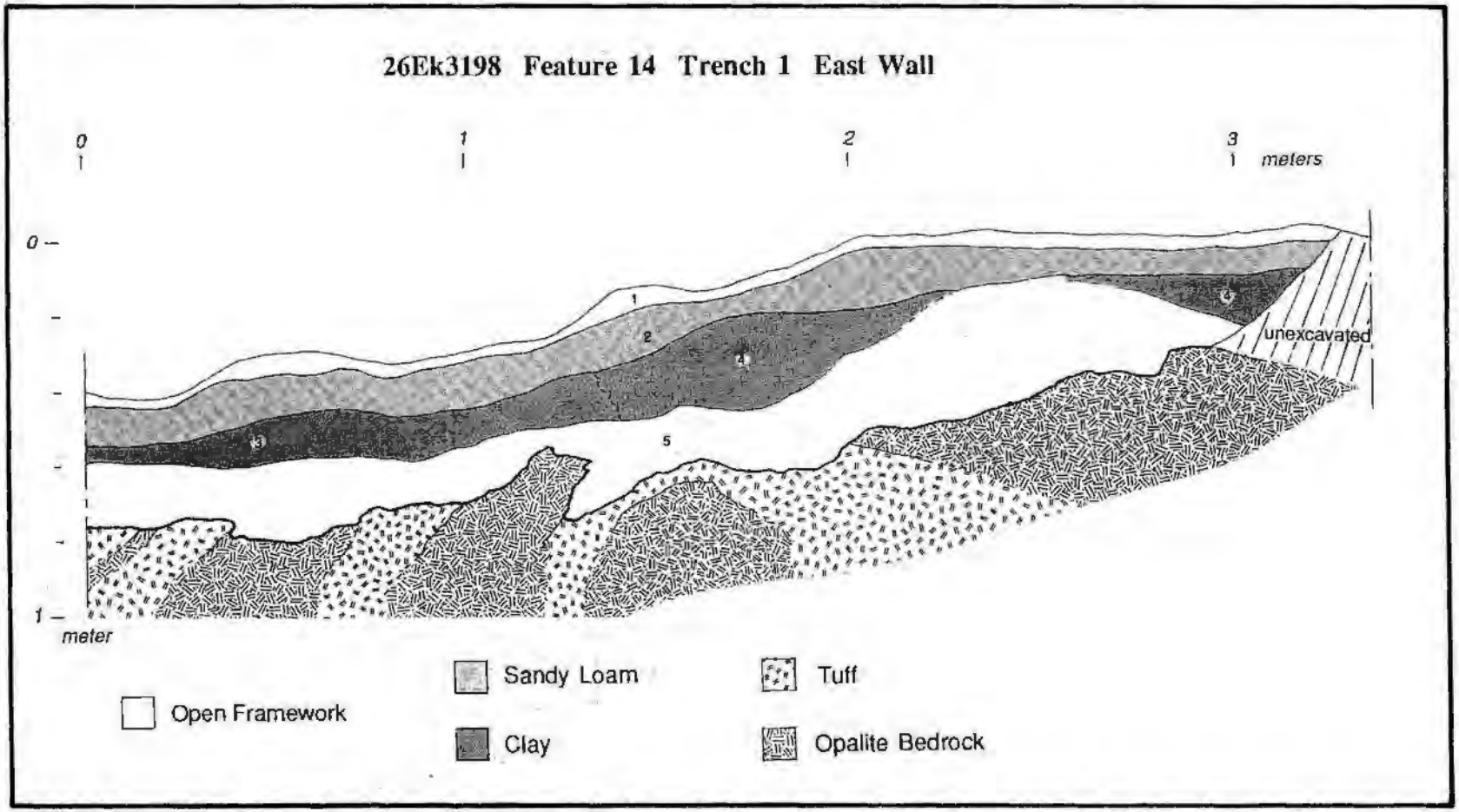


Figure 172. Description of stratigraphic units, Trench 1, 26Ek3198, Feature 14.

Figure 172. Description of stratigraphic units, Trench 1, 26Ek3198, Feature 14.

Stratum	Description
1	Grayish brown (10YR 5/2) dry; silt loam; weak fine platy; common opalite chunks; common fine roots; boundary clear and slightly irregular.
2	Brown (10YR 6/2) dry; weak fine granular; common opalite and tuff pebbles, rare opalite flakes; abundant fine roots; boundary abrupt and irregular.
3	Dark brown (7.5YR 4/4) dry; clay; moderate to strong fine angular blocky, weak clay skins; common fine subangular opalite and tuff pebbles; boundary clear and irregular.
4	Dark brown (7.5YR 4/4) dry; clay; moderate prismatic peds, moderate clay skins; rare opalite and tuff pebbles; boundary clear and irregular.
5	Strong brown (7.5YR 4/6) dry; sandy clay; weak to moderate subangular blocky; common to abundant angular to subangular fine opalite and tuff pebbles; boundary abrupt over weathered opalite and tuff bedrock.

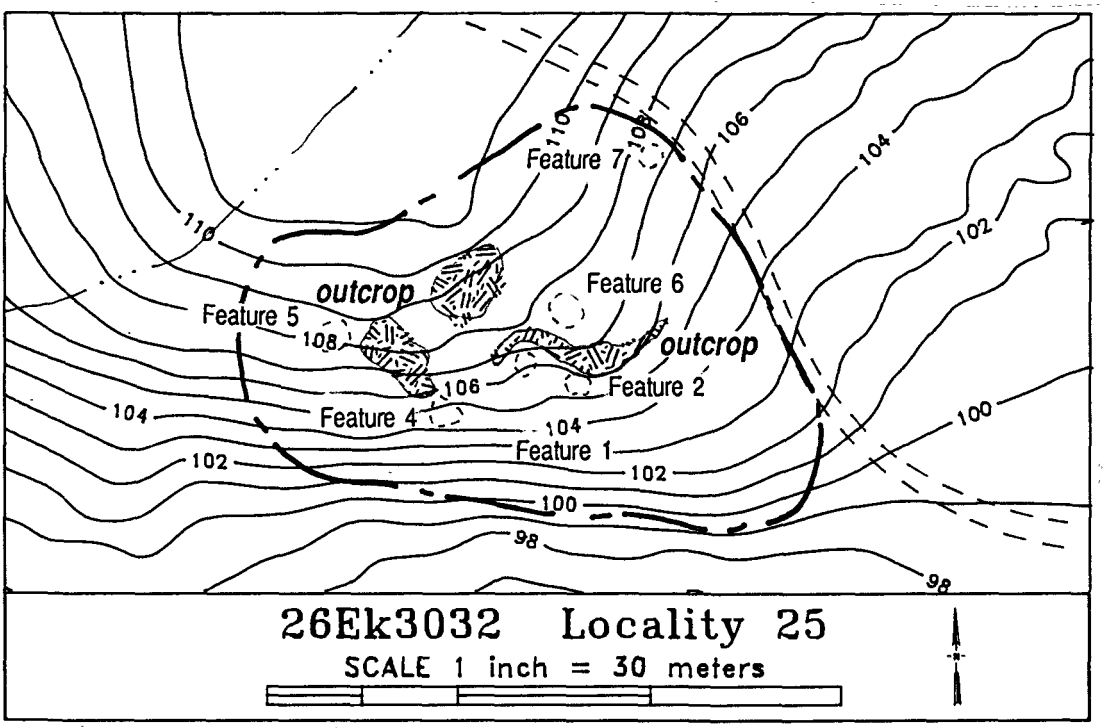


Figure 173. Locality 25 site map, 26Ek3032.

Nonfeature Contexts

Formed artifacts are scarce outside cultural features. All those found during close-interval surface inspection are direct products of opalite reduction (Table 170). Although no systematic collections of debitage were taken from nonfeature contexts, general perusal suggests that large cortical flakes and robust pieces of shatter comprise much of the waste. This, coupled with the abundance of fractured opalite cobbles and slabs, suggests that colluvial products contributed to the raw material processed at the locality.

Table 170. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3032, Locality 25.

		DEBITAGE		FORMED ARTIFACTS					
Feature	Total Area (m^2)	n	wt. (gm)	Bifaces[a]	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Total
1	7	-	-	5	-	-	-	-	5
2*	7	22,860	58,368.0	74	5	13	2	1	95
3	11	-	-	-	-	-	-	-	0
4	44	-	-	1	-	-	-	-	1
5*	23	2,856	23,011.8	13	1	-	-	1	15
6	12	-	-	-	-	-	-	-	0
7	4	-	-	-	-	-	-	-	0
Surface Isolate	-	-	-	10	-	-	-	3	13
		25,716	81,379.8	103	6	13	2	5	129

*Sample feature
[a]Includes "possible" bifaces

Cultural Features

Inventory disclosed that each of the seven reduction stations, ranging in size from 4 to 44 m^2, consists principally of concentrations of debitage and other opalite processing debris. The surfaces of most contain biface fragments; some are accompanied by cores and hammerstones (cf. Table 170). Due, perhaps, to the relatively flat surfaces and the degree to which erosion has been checked by upslope bedrock barriers, the features seem to retain high integrity. Feature 3, however, appears to have resulted from post-depositional processes; a low, neat, multi-coursed berm of large opalite waste flakes fortifies the opening of a woodrat nest at the base of a boulder. Other features are less disturbed; Features 2 and 5 were selected for sampling.

Feature 2

Feature 2 is a dense scatter of reduction debris on a pocket of sandy soil beneath a low bedrock overhang (cf. Figure 173). The 2 m high overhang could have offered shaded workspace and some wind protection; low bedrock rims upslope have virtually isolated it from erosion. Its relatively undisturbed state and the possibility of subsurface deposits led us to select it for sampling. A block of six 1 m by 1 m surface scrape units was superimposed with the aim of collecting its entire surface expression. The exercise revealed, however, that no subsurface deposit exists, the soils consisting merely of a sandy veneer over bedrock. Nevertheless, recovered artifacts include abundant opalite processing debris as well as a large and diverse assemblage of flake tools (cf. Table 170). The debitage and biface assemblages suggest that reduction tasks focused on cores and early stage bifaces (cf. Chapters 6 and 10). Numerous basalt flakes probably reflect the attrition of hammerstones (cf. Chapter 11).

Feature 5

Much larger and more open than Feature 2, Feature 5 encompasses 23 m^2 of dense reduction debris encircled by low boulders (cf. Figure 173). It was selected for sampling as a more typical representative of features at the site. Most of it lies directly on exposed bedrock, rendering standard shovel scrape techniques impossible everywhere save a small area of soil at its southern extreme. Here, a block of four 1 m x 1 m surface scrapes sampled deposits; all units revealed bedrock within 2 cm of the surface. Formed artifacts relate exclusively to opalite processing, while the debitage consists of very large waste flakes (cf. Table 170). Most of the assemblage suggests early stage reduction tasks that, as at Feature 2, involved both bifaces and cores (cf. Chapters 6 and 10).

Implications

While some on-site toolstone doubtless was exploited at Locality 25, that may not have been its principal attraction. Its ridge-top location commands a panoramic view of much of the Eastern and Western Peripheries, and it lies immediately adjacent the high quality opalite source at 26Ek3032/Locality 36. Since toolstone native to Locality 25 is inferior, the place may have served as a convenient, partially shaded reduction station.

26Ek3032/Locality 98

Locality 98 encompasses the entire 900 m^2 of a microtopographic flat on the otherwise steep eastern midslope of lower Holmes Ridge (Figure 174). It perches some 20 m above the bed of Little Antelope Creek, sharing the 5600 foot (1707 m) contour with quarry pit Locality 19 30 m south. It is separated from the reduction stations of Localities 21 and 22 on the streambank below by 50 m of 40% slope. Centered on a low opalite outcrop, Feature 1 is defined by a dense mantle of reduction by-products and naturally liberated opalite debris. This accumulation overlies soils identical to those adjacent; they are colluvial, sandy, and contain abundant unwelded tuff gravels. Although not sounded during fieldwork, site deposits seem to differ from their surroundings chiefly in the large quantity of opalite cobbles they contain and in their apparently greater depth (tall sage grows on the flat).

Cursory inspection suggested that Locality 98 was exploited for the opalite content of the low outcrop and surrounding field of cobbles. The surface of the outcrop, although weathered, appears battered as if by quarrying, and numerous split cobbles imply material assay. Fieldwork sought to clarify the relationship between the on-site toolstone source and the associated debris.

Owing, perhaps, to the abundance of material and its masking effect, close interval examination of the surface failed to discern internal differentiations in artifact densities or distribution. Several bifaces were collected from widely dispersed locations; one is heat-treated, and all are early-intermediate stage reduction products (Table 171).

The feature was bisected by ten 1 m x 1 m surface scrapes arrayed along a discontinuous baseline parallel to the slope. The exercise revealed the feature to be confined to the upper 2 cm of deposit. As anticipated by surface inspection, the sample discloses that much of the scatter consists of noncultural opalite debris and equivocal shatter. Cultural accumulations are densest in units immediately adjacent the outcrop and at the downslope

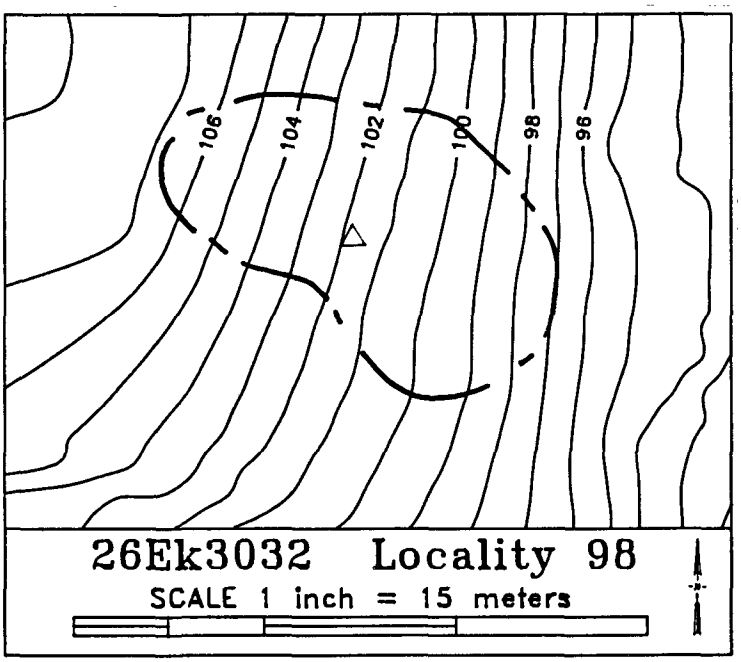


Figure 174. Locality 98 site map, 26Ek3032.

brink of the flat. Save a single flake tool and a hammerstone, the artifact content of the sample consists almost exclusively of large robust waste flakes reflecting core reduction (Table 171; cf. Chapter 10). While numerous pieces of colorful opalite, presumably of off-site origin, occur (some of this is a distinctive variety probably quarried at Locality 19), the majority of the debitage seems, from visual inspection, identical to opalite composing the outcrop and colluvial cobbles.

Table 171. Artifacts Recovered from Feature 1, 26Ek3032, Locality 98.

		DEBITAGE		FORMED ARTIFACTS			
Feature	Total Area (m^2)	n	wt. (gm)	Bifaces[a]	Flake Tools	Perc./ Cobble Tools	Total
1*	900	1,287	12,303.3	9	1	1	11

*Sample Feature
[a]Includes "possible" bifaces

The remaining outcrop quarry sites (26Ek3191, 26Ek3193, 26Ek3196, 26Ek3201, and 26Ek3203) are known only from testing. They are described briefly below, having been reported in more detail elsewhere (Botkin 1989).

26Ek3191

26Ek3191 is notable chiefly for its minimal contents. It occupies a low knoll top on the southern margin of Undine Gorge, in an area of otherwise abundant cultural remains (cf. Figure 141). Close-order reconnaissance of the 6600 m^2 comprising the site revealed one of the most sparse lithic scatters observed in the Eastern Periphery, and failed to discover any toolstone mining or processing features.

Quarrying is only weakly expressed, and lacks spatial focus. The battered appearance of the solitary low exposure of opalite on the northwestern midslope suggests that it may have provided toolstone; however, debitage is extremely sparse (<5 items/ m^2). Toolstone acquisition appears to have been directed instead toward a diffuse field of opalite cobbles weathering from colluvium on the knoll top. Some cobbles have been assayed but evidently were rejected on the spot. Sparse later stage debitage, a core, and several biface fragments recovered from widely scattered surface locations offer the only additional evidence of opalite processing (Table 172).

Feature 1, the sole feature identified, bears no clear functional relationship to opalite reduction. Isolated at the margin of the cobble field, it consists of a small cluster of obsidian artifacts scattered over 16 m^2. Surface scraping recovered its entire horizontal and vertical extent, returning an assortment of obsidian items, including an unclassifiable projectile point fragment, three flake tools, several obsidian bifaces, and numerous waste flakes. Two opalite flake tools were recovered as well, together with sparse opalite debitage (Table 172).

Table 172. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3191.

		DEBITAGE		FORMED ARTIFACTS				
Feature	Total Area (m^2)	n	wt. (gm)	Proj. Points	Bifaces	Cores	Flake Tools	Total
1*	16	23	79.3	1	7	1	5	14
Surface Isolates	-	-	-	-	4	1	-	5
		23	79.3	1	11	2	5	19

*Sample Feature

Feature 1 appears to represent a single episode of use, perhaps by hunters or others engaged in maintenance/subsistence tasks who employed imported obsidian tools and cores. Both opalite flake tools are both minimally used specimens probably selected expediently from the debris scatter.

26Ek3193

At 26Ek3193, a moderate density lithic scatter of 3610 m^2 is dotted by six reduction features and a single exploited outcrop (Figure 142). Opalite reduction, rather than extraction, appears to have engrossed most visitors. Features 1 and 4 were sampled; the contents of the remainder are known only from inventory collections (Table 173).

Table 173. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3193.

		DEBITAGE		FORMED ARTIFACTS			
Feature	Total Area (m^2)	n	wt. (gm)	Bifaces	Flake Tools	Perc./ Cobble Tools	Total
1*	226	290	1,615.3	3	-	-	3
2	112	-	-	4	-	-	4
3	14	-	-	2	-	-	2
4*	9	3,006	10,588.9	4	1	-	5
5	43	-	-	2	-	-	2
6	44	-	-	-	-	1	1
7	9	-	-	-	-	-	0
Surface Isolates	-	-	-	7	-	-	7
		3,296	12,204.2	22	1	1	24

*Sample Feature

Feature 1

A battered outcrop located on the northwestern slope suggests minimal quarrying; the outcrop and an associated dense concentration of lithic waste upslope was designated Feature 1. A discontinuous transect of surface scrapes spanned the feature, revealing its cultural content to be abundant, homogeneously distributed, and composed exclusively of opalite debitage. Individual flakes and shatter are large. The relatively high density of debris, however, probably owes not only to primary cultural deposition. The location of the feature on the midslope and the potential dam-like effect of the outcrop below it suggest that colluvial redeposition aided accumulations.

Feature 4

Feature 4, a reduction station, consists of a very dense concentration of large opalite debitage. Our initial inspection suggested it to be the product of processing cores into early stage bifaces. The moderately large debitage and the single biface fragment yielded from collection of the entire northern half of the feature seem to confirm our expectation (cf. Chapter 6).

26Ek3196

26Ek3196 occupies nearly 12,000 m^2 on the western extreme of the principal knoll along the upper reach of Undine Gorge (cf. Figure 142). It is isolated topographically from 26Ek3195 by a shallow intermittent drainage, and shares the knoll with numerous other sites slightly upslope and further east on the landform.

Seven cultural features define the site. Three of four outcrop quarries (Features 1, 2, and 7) lie on the relatively steep western slopes, and a smaller utilized bedrock exposure (Feature 4) occurs on more level, higher ground surrounded by Features 3, 5, and 6, all reduction stations. The two largest, most heavily used quarries, Features 1 and 2, were sampled systematically; other features were inventoried only.

As at other quarry sites, recovered assemblages reflect toolstone extraction and early stage biface manufacture, with a relatively high incidence of bifaces, cores and hammerstones. A single piece of groundstone of unidentifiable function and several flake tools reflect ancillary maintenance tasks (Table 174).

Table 174. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3196.

		DEBITAGE		FORMED ARTIFACTS				
Feature	Total Area (m^2)	n	wt. (gm)	Bifaces	Flake Tools	Modif. Chunks	Cobble Tools	Perc./ Ground Stone	Total
1*	905	3,340	1,192.9	-	2	4	4	-	10
2*	2,808	1,445	9,471.5	8	1	-	4	1	14
3	35	-	-	1	-	-	-	-	1
4	16	-	-	2	-	-	-	-	2
5	75	-	-	-	-	-	-	-	0
6	31	-	-	1	-	-	-	-	1
7	528	-	-	-	-	-	-	-	0
Surface Isolate	-	-	-	5	-	-	-	-	5
		4,785	10,664.4	17	3	4	8	1	33

*Sample feature

Feature 1

Feature 1 subsumes several opalite outcrops whose battered facets testify to prehistoric exploitation. A prehistoric adit, representing a somewhat different approach to quarrying, was given special scrutiny during testing (Botkin 1989:321-324).

The adit is a small concavity gouged into bedrock at the base of a low buttress on the southern flank of the knoll. Bedrock consists of high quality opalite that apparently attracted considerable expenditure of effort. The aperture of the adit is 30 cm high and 1 m wide, and the excavation extends into the outcrop about one meter. Its floor and the ground surface immediately outside are obscured by a dense accumulation of opalite debitage and non-cultural lithic debris. The ceiling of the recess appears fire-blackened and spalled. Elsewhere on the outcrop bedrock is highly weathered, softer and grainier in texture, and of lower quality than in the immediate vicinity of the adit.

A 1 m x 1 m scrape and coterminous excavation unit sampled the area immediately outside the adit. Until bedrock was encountered at a depth of 30 cm, each level yielded opalite

debris comprising almost the entire volume of the excavated sample; soils contributed only a minor intervening matrix. Debitage is quite large, and formed artifacts relate exclusively to toolstone reduction. We infer that, once freed from the adit walls, toolstone was rendered into early stage bifaces on the spot. The products were transported elsewhere for later reduction (cf. Table 174; Botkin 1989:Table 95).

Battered bedrock exposures several meters upslope of the adit appear to reflect more typical outcrop quarrying. The dense blanket of lithic debris surrounding them was sampled by a discontinuous series of surface scrapes. The cultural content of the scatter is very diffuse, but the types of reduction artifacts comprising it are essentially identical to those at the adit.

Feature 2

Feature 2 encompasses another bedrock ledge that served as a toolstone source. Two dense scatters of reduction debris indicate that material processing occurred primarily on a relatively flat bench immediately above the outcrop. Bedrock-free gaps in the ledge have allowed quantities of debris to spill downward onto the steep slopes below; this may account for the extremely large size of the feature (ca. 2500 m^2).

A discontinuous series of surface scrapes sampled both scatters as well as a more diffuse region farther upslope. Formed artifacts and debitage are essentially identical to those obtained at Feature 1, implying similar extraction and early stage reduction functions (cf. Table 174).

26Ek3201

26Ek3201 occupies the northern flank of the principal knoll at the upper reach of Undine Gorge (cf. Figure 142). It encompasses only three reduction stations and an outcrop quarry in 2474 m^2 (Botkin 1989:Figure 79). Like 26Ek3198 just to the west, the opalite source at 26Ek3201 appears little used; aboriginal occupants seem instead to have employed the site primarily as a base for toolstone reduction convenient to other nearby sources. Nonfeature areas host a moderate density opalite lithic scatter that includes a formed artifact assemblage of very limited size and variety. Each feature was sampled; the results are summarized in Table 175.

Table 175. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3201.

		DEBITAGE		FORMED ARTIFACTS				
Feature	Total Area (m^2)	n	wt. (gm)	Bifaces[a]	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
1*	102	1,282	1,529.5	13	1	1	-	15
2*	151	2,616	2,760.0	22	-	1	1	24
3*	38	24	43.3	3	-	1	1	5
4*	679	164	1,755.9	-	-	1	-	1
Surface Isolate	-	-	-	-	-	1	-	1
		4,086	6,088.7	38	1	5	2	46

*Sample Feature
[a]Includes "possible" bifaces

Feature 1

Three dense, close-set concentrations of opalite debris, interspaced by a moderate density lithic scatter, define Feature 1. One concentration which displayed several pieces of obsidian was completely collected by a 1 m x 1 m surface scrape; a second unit sampled the inter-concentration area adjacent. Testing within the concentration yielded two dozen obsidian waste flakes as well as a large assemblage of opalite debitage and reduction forms (cf. Table 175). Markedly reduced yields (a small quantity of opalite waste) were obtained outside the visible limits of the concentration, suggesting that surface distributions accurately reflect the configuration of the feature (Botkin 1989:Table 98).

Feature 2

Save the absence of obsidian and the presence of a mano fragment, Feature 2 appeared on the surface identical to Feature 1. Sampling by means of surface scrapes within and outside debris concentrations revealed, however, that surface manifestations only weakly presage distributions of artifacts lying immediately out of view (cf. Table 175; Botkin 1989:334).

Feature 3

Feature 3, a moderate density opalite debris scatter, was sampled by a 1 m x 50 cm excavation unit to collect the dozen metate fragments observed on its surface and to probe for additional buried specimens. While the groundstone hinted that activities additional to toolstone processing occurred there, results of the exercise were equivocal.

The 20 cm of deposit overlying bedrock are heavily turbated. They yielded five additional metate fragments and a small quantity of opalite debitage (cf. Table 175). In addition, a charcoal stain of ambiguous origin was exposed; it is highly diffuse, and resembles stains of clearly modern natural origin throughout the vicinity. All seventeen metate fragments pertain to the same specimen. Some are heavily fire-affected, while others, refitted adjacent burned ones, appear pristine (cf. Chapter 12). The contrasting condition of the fragments *may* reflect reuse of some of them as cooking stones. However, given the recent and certainly long history of range fires in the region, and the shallow, churned deposits, natural burning of some fragments cannot be ruled out.

Feature 4

Feature 4 is an extensive but apparently little used outcrop quarry on a shelf of rimrock overlying the 26Ek3177 rockshelter. Surface scrapes placed within debris concentrations immediately below two battered outcrops revealed only minimal cultural contents. The sample consists almost exclusively of robust debitage; a relatively high ratio of shatter to flakes is typical of outcrop quarries elsewhere in the vicinity (cf. Table 175; Botkin 1989:Table 99).

26Ek3203

26Ek3203 occupies a narrow shelf of rimrock at the brink of Italian Mesa (cf. Figure 141). Bedrock opalite appears to have seen only minor use, even in comparison to many other meager outcrop quarries. Few formed artifacts occur, all related directly to toolstone procurement and processing (cf. Table 151). They are widely dispersed within a moderately

dense scatter of naturally liberated opalite fragments and debitage strewn over the entire 8230 m^2 of the site. Close interval surface inspection failed to isolate discrete cultural features.

A discontinuous transect of surface scrapes was placed across the entire downslope axis of the site. The large size of the debitage and the comparative abundance of shatter reflect quarrying and early stage reduction. Due to colluvial processes, or perhaps to the more commodious workspace offered by the relatively flat upper portion of the site, sample units there contain a somewhat greater abundance of small debitage.

Reduction Sites

Most sites in the Eastern Periphery lack exploited toolstone sources, and are instead defined primarily by residues of opalite reduction (cf. Table 149). All were tested save 26Ek3182, omitted from our sample after close inspection revealed the eroded and rodent-disturbed state of its sparse cultural content. Testing disclosed that 26Ek3192, and Localities 20, 21, and 22 of 26Ek3032, warranted additional examination; this was accomplished in the course of data recovery.

26Ek3192

26Ek3192 encompasses 3190 m^2 of a prominent knoll rising abruptly above Undine Gorge at the northern margin of Holeplug Ridge (cf. Figure 141). It shares the landform with outcrop quarries 26Ek3193 and 26Ek3191 to the east and west. The depositional context at 26Ek3192 contrasts strongly with these neighboring sites and with that found throughout most of the Eastern Periphery.

The surface is smooth and flat; shallow intermittent drainages have isolated it from the colluvial redeposition that has disturbed most locations in the subarea. More importantly, the site is mantled by a substantial loess deposit that in some places has accumulated to a depth of 50 cm. The loess has buried portions of two cultural features (Figure 175).

Nonfeature Contexts

Owing, perhaps, to the masking effect of wind-borne silts, nonfeature surface contexts at 26Ek3192 contain relatively few cultural residues. Surfaces outside feature boundaries reveal a light density opalite debitage scatter lightly punctuated by formed artifacts. The latter include products of toolstone processing as well as items reflecting maintenance and subsistence (Table 176).

Table 176. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3192.

		DEBITAGE		FORMED ARTIFACTS										
Feature	Total Area (m^2)	n	wt. (gm)	Proj. Points	Preforms	Bifaces[a]	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
1*	19	22,971	44,829.5	5	3	143	1	51	2	3	5	89	-	302
2*	396	16,275	24,328.0	11	1	71	3	17	2	3	1	13	1	123
3	12	-	-	-	-	1	-	-	-	-	-	-	-	1
4	64	-	-	-	-	4	-	-	-	-	-	-	-	4
5	8	1[b]	9.4	-	-	3	-	-	-	-	-	-	-	3
Surface Isolates	-	-	-	-	-	9	-	1	-	-	1	1	-	12
		39,247	69,166.9	16	4	231	4	69	4	6	7	103	1	445

*Sample feature
[a]Includes "possible" bifaces
[b]Obsidian only

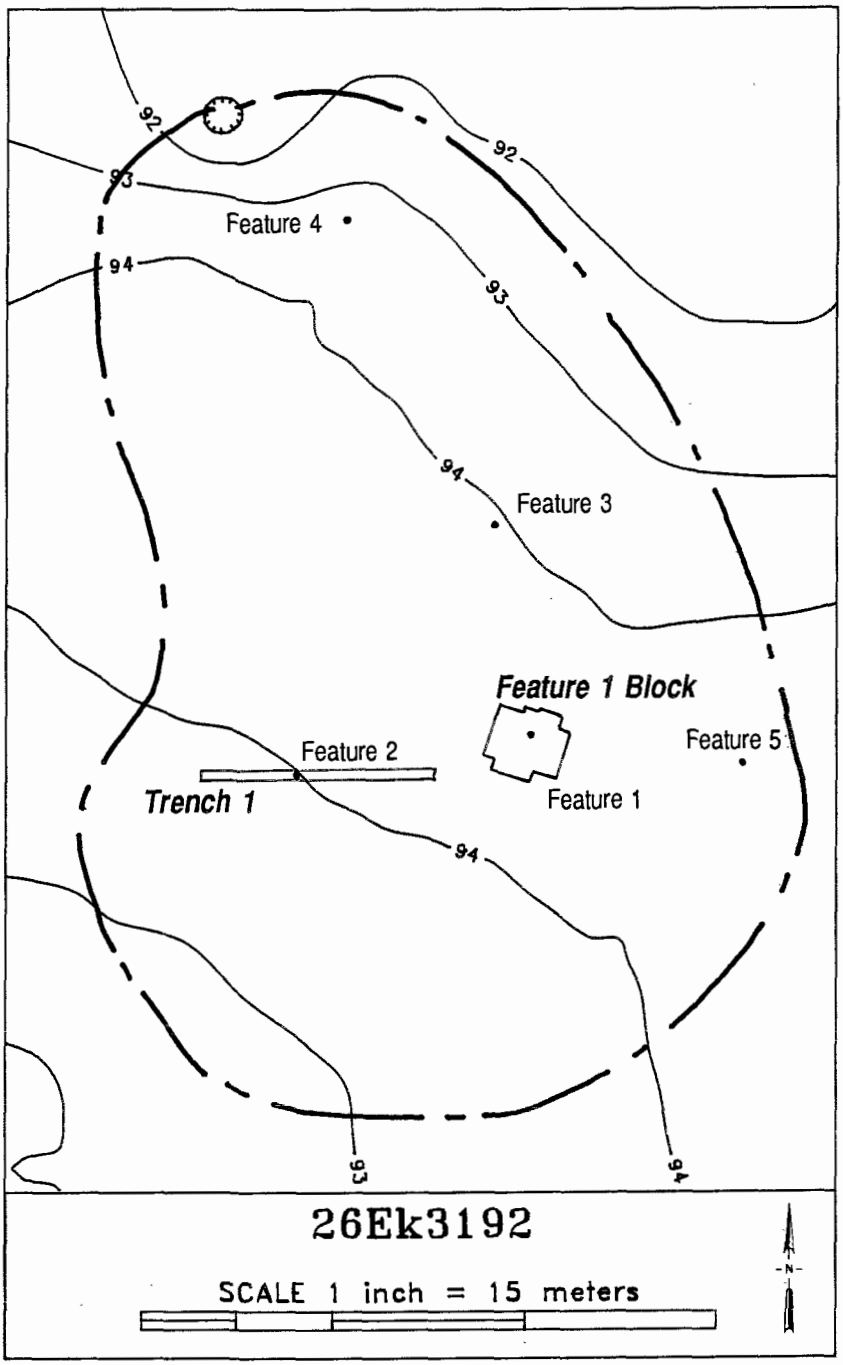


Figure 175. 26Ek3192 site map.

Cultural Features

Inventory examinations during testing suggested that three of five identified cultural features on the site periphery (Features 3, 4, and 5) are typical reduction stations. Two other features, however, contrast strikingly. Positioned just a few meters apart in the central portion of the site, Features 1 and 2 include reduction attributes but they contain as well some of the largest and most varied formed artifact assemblages encountered in the Eastern Periphery (cf. Table 176). In particular, expanded sampling during data recovery was inspired by the possibility that both features might contain buried living surfaces. Testing suggested that such surfaces might lie on the stratigraphic interface between the silty loess capping the site and an older clay horizon below.

A backhoe trench (Trench 1) was excavated through the area occupied by Features 1 and 2. The resulting profile displays the reddish clay paleosol common in the Tosawihi vicinity on both tuff and opalite lithologies (Figure 176). At 26Ek3192, the paleosol (Units 2 and 3) is developed on tuff. Unit 3 has distinct prismatic ped structure with good clay skin development; Unit 4 is a well developed calcic horizon often absent in other areas where bedrock is shallower. The strong development of the paleosol suggests a probable Pleistocene to Pliocene age.

The eolian silt loam surface mantle of Unit 1 is up to 50 cm thick. This probably is Holocene age. Large burrows, exposed at the contact between the clay of Unit 4 and the calcified tuff of Unit 5, are filled with silt of Unit 1 washed down from the above. Unit 2 is a silty clay loam with moderate to strong, granular to fine angular blocky structure with some weak clay skin development. This unit probably represents a zone of interaction between eolian Unit 1 and the underlying paleosol.

Feature 1

Feature 1 was marked on the surface by a moderate density artifact scatter covering 19 m^2 of the knoll top (Figure 177). The center of the scatter was punctuated by a tight cluster of six complete opalite bifaces, heralding what we anticipated to be a cache. Testing was begun by surface scraping the entire visible extent of the scatter in a block of 24 1 m x 1 m units. This recovered an assemblage of uncommon abundance and variety, returning, in addition to a large quantity of debitage, 37 opalite bifaces and 19 Shoshone Brownware ceramic sherds (Table 177).

A 1 m x 50 cm excavation unit centered on the biface cluster (Unit TS 1, Figure 178) confirmed our initial suspicions by returning a cache of forty-one opalite bifaces (Figure 179). The close proximity and orientation of the specimens suggests that they were placed in a basin-shaped depression ca. 50 cm in diameter and 20 cm deep. While no evidence of this pit could be detected during excavation, its presence is implied by a faint dark stain surrounding the cache visible in photographs taken through a polarizing filter. Several hundred opalite waste flakes comprise the remainder of the cultural materials occupying the loess matrix immediately around the cache (Table 178). The character of the cached bifaces is discussed in detail in Chapter 6.

Where surface scraping revealed an abundance of ceramic sherds and burned opalite flakes, a second excavation unit (Unit TS 3, Figure 178) was excavated to a depth of 10 cm to look for a hearth. Neither a hearth nor any additional ceramics were discovered, but the unit returned over 700 very small opalite waste flakes, many of them burned (Table 178).

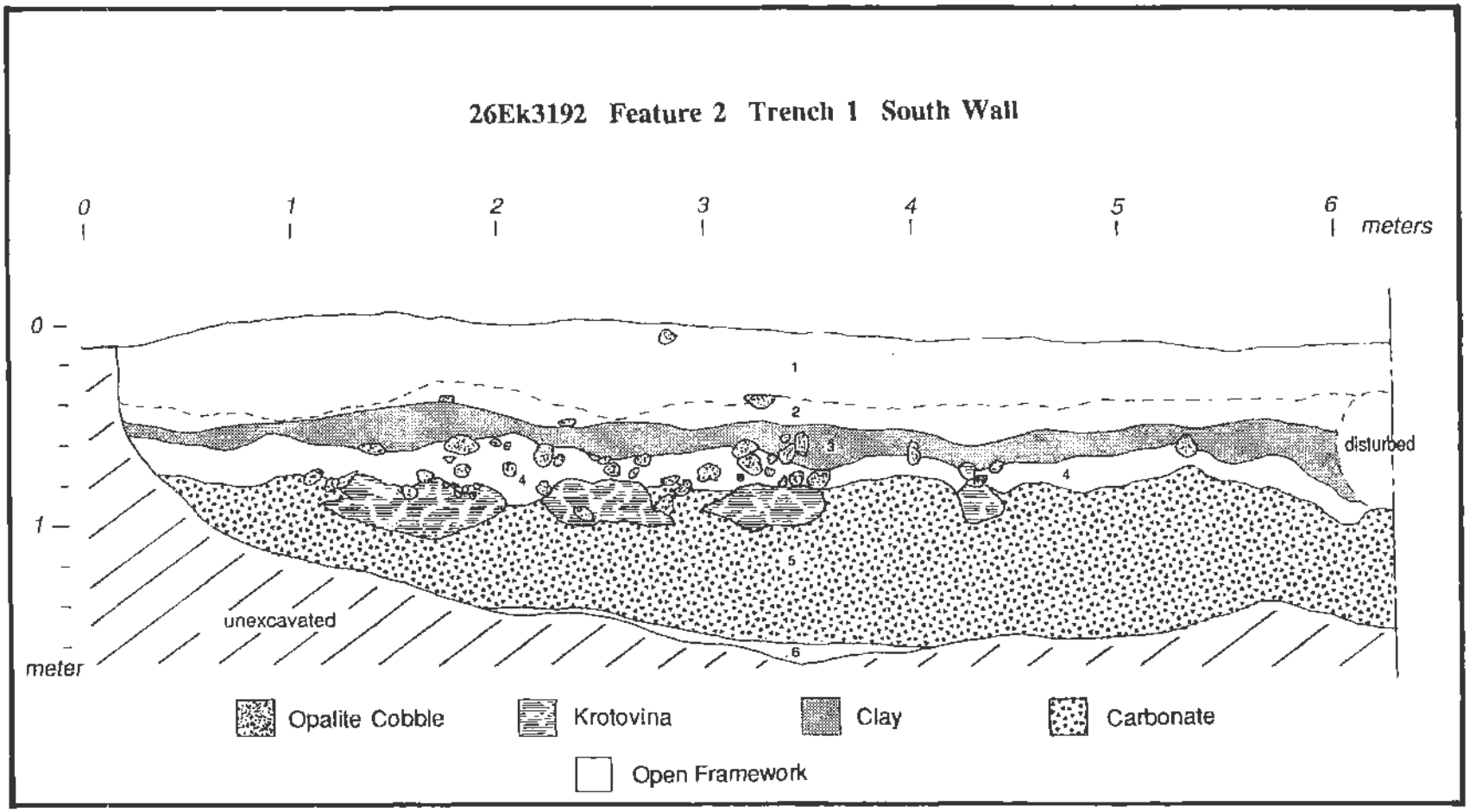


Figure 176. Description of stratigraphic units, Trench 1, 26Ek3192.

Figure 176. Description of stratigraphic units, Trench 1, 26Ek3192.

Stratum	Description
1	Light grayish brown (10YR 6/2) dry; silt loam; loose to weak granular; rare fine opalite flakes; abundant fine to medium roots; boundary gradual and irregular.
2	Brown (10YR 4/3) moist; silty clay loam; moderate to strong granular to fine angular blocky, rare clay skins on ped faces; rare angular to subangular pebbles; common fine to medium roots; boundary clear and wavy.
3	Dark brown (7.5 YR 3/4 to 4/4) moist; clay to clay loam; strong prismatic to angular blocky, abundant well developed clay skins on ped faces; rare fine subangular pebbles; common fine roots; boundary clear and irregular.
4	Strong brown (7.5 5/6 to 4/6) dry; sandy clay; abundant strongly weathered gravels and opalite cobbles; strongly calcic with incipient carbonate nodules; boundary abrupt and irregular.
5	White (10YR 8/2) dry; strongly calcified tuff, common carbonate mottling,veins, and nodules; distinct large krotovina filled with silt loam as in unit 1.
6	Dark yellowish brown (10YR 4/4) hard, non-welded tuff; minor carbonate accumulation.

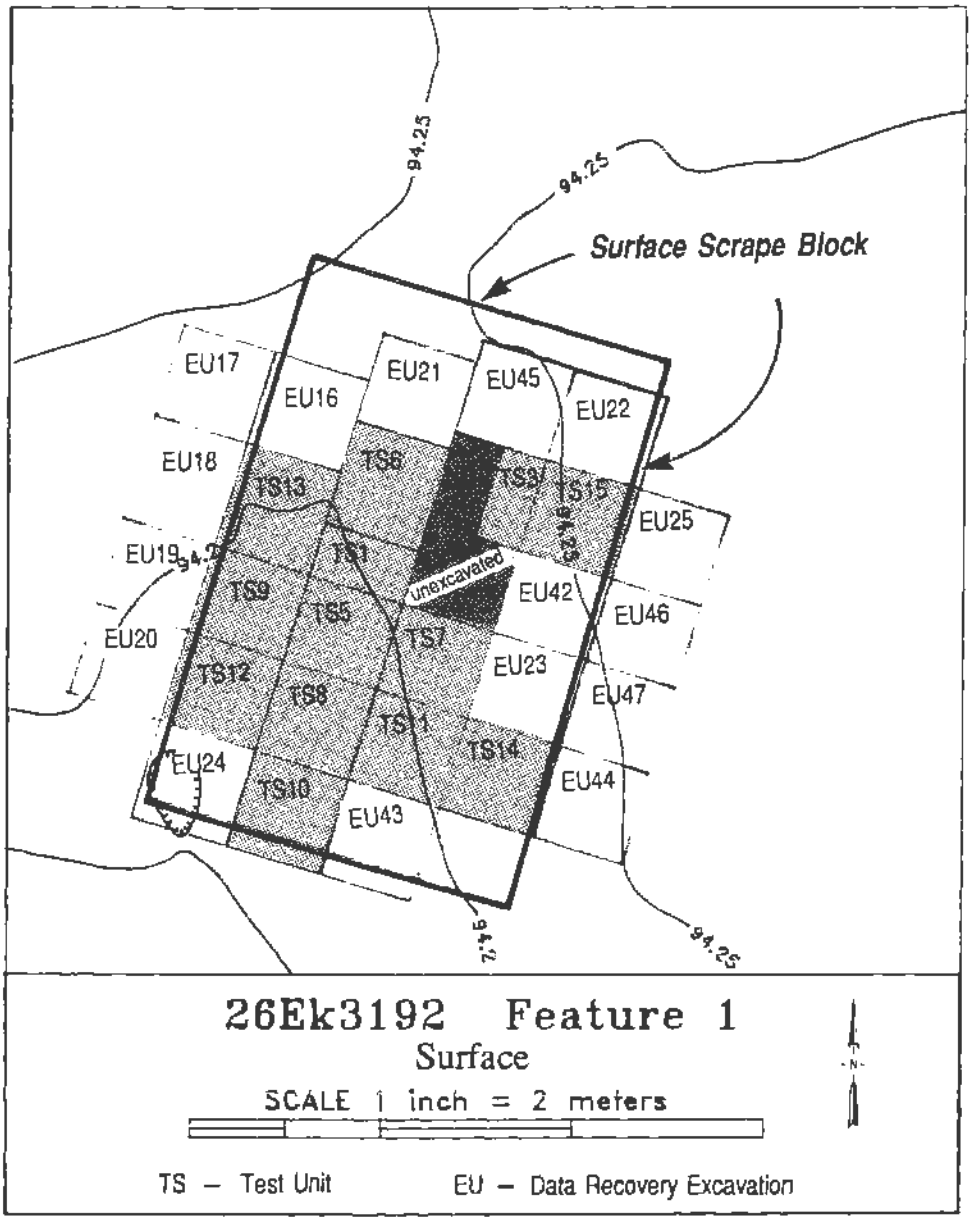


Figure 177. Feature 1 plan, 26Ek3192.

Table 177. Artifacts Recovered from Feature 1 During Test Phase Surface Collections, 26Ek3192.

Unit No. (Type)	Surface Scrape (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Preforms	Bifaces	Cores	Flake Tools	Ground Stone	Ceramics	Total
1 (SF)	1.0	48	65.6	-	-	-	-	-	-	0
2 (SF)	1.0	154	87.7	-	1	-	2	-	-	3
3 (SF)	1.0	127	147.2	-	-	-	-	-	-	0
4 (SF)	1.0	189	162.5	-	-	-	-	-	-	0
5 (SF)	1.0	348	410.6	-	1	-	1	-	4	6
6 (SF)	1.0	432	541.1	-	2	-	-	-	-	2
7 (SF)	1.0	338	373.3	-	1	-	1	-	3	5
8 (SF)	1.0	397	352.0	-	1	1	-	-	-	2
9 (SF)	1.0	342	627.1	1	4	-	-	-	-	5
10 (SF)	1.0	382	540.5	-	10	-	1	-	-	11
11 (SF)	1.0	164	263.3	-	1	-	1	-	-	2
12 (SF)	1.0	478	517.2	-	6	-	1	-	-	7
13 (SF)	1.0	439	483.4	-	-	-	-	-	-	0
14 (SF)	1.0	563	1,081.8	-	5	-	3	-	-	8
15 (SF)	1.0	722	693.1	-	2	-	5	1	-	8
16 (SF)	1.0	312	778.1	-	2	-	1	-	1	4
17 (SF)	1.0	117	168.8	-	-	-	-	-	-	0
18 (SF)	1.0	397	681.8	-	1	-	-	-	-	1
19 (SF)	1.0	94	92.4	-	-	-	-	-	-	0
20 (SF)	1.0	190	433.0	-	-	-	-	-	-	0
21 (SF)	1.0	496	783.8	-	-	-	2	-	-	2
22 (SF)	1.0	252	446.8	-	2	-	2	-	10	14
23 (SF)	1.0	66	83.6	-	-	-	1	-	-	1
24 (SF)	1.0	45	88.9	1	1	-	-	-	1	3
Totals	24.0	7,092	9,903.6	2	40*	1	21	1	19	84

(SF) = Surface Scrape

*Includes "possible" bifaces

Table 178. Artifacts Recovered from Excavation Units, Feature 1, 26Ek3192.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Total
2 (TS)[a†]	0.06	906	1,716.4	-	-	34	1	-	-	-	-	35
3 (TS)[a]	0.04	673	143.0	-	-	-	-	-	-	-	-	0
5 (TS)	0.28	745	2,135.1	-	-	5	1	-	-	-	-	6
6 (TS)	0.28	1,101	1,323.1	-	-	3	3	-	-	-	1	7
7 (TS)	0.38	1,054	3,708.7	1	-	3	6	-	1	-	-	11
8 (TS)	0.28	513	1,263.7	-	-	-	-	-	-	-	-	0
9 (TS)	0.28	254	580.8	-	-	1	1	-	-	-	-	2
10 (TS)	0.28	180	180.4	-	-	-	1	-	-	-	-	1
11 (TS)	0.28	1,147	2,123.1	1	-	6	2	-	-	-	-	9
12 (TS)	0.28	276	730.2	-	-	-	-	-	-	-	-	0
13 (TS)	0.28	516	1,109.0	-	-	2	1	1	-	-	-	4
14 (TS)	0.18	584	1,139.9	-	-	10	-	-	-	-	18	28
15 (TS)	0.23	1,177	1,949.0	-	-	9	1	-	-	-	1	11
16 (EU)	0.28	330	395.7	-	-	1	-	-	-	-	-	1
17 (EU)	0.30	254	482.0	-	-	-	-	-	-	-	-	0
18 (EU)	0.30	370	650.5	-	-	1	1	1	-	-	-	3
19 (EU)	0.30	357	640.9	-	-	-	-	-	1	-	-	1
20 (EU)	0.30	295	835.6	-	-	1	1	-	-	-	-	2
21 (EU)	0.28	661	823.1	-	-	2	1	-	-	-	-	3
22 (EU)[b]	0.38	722	854.2	1	-	2	-	-	-	1	-	4
23 (EU)[b]	0.28	1,402	2,531.1	-	1	4	-	-	-	1	7	13
24 (EU)	0.38	377	451.2	-	-	1	-	-	-	-	-	1
25 (EU)	0.30	332	587.8	-	-	-	-	-	-	-	7	7
42 (EU)[c]	0.21	699	4,591.0	1	-	8	5	-	-	-	3	17
43 (EU)	0.28	229	476.3	-	-	1	2	-	-	-	1	4
44 (EU)	0.30	230	737.1	-	-	-	1	-	-	-	-	1
45 (EU)	0.38	250	776.5	1	-	4	1	-	-	1	-	7
46 (EU)	0.30	282	712.9	-	-	3	1	-	1	-	24	29
47 (EU)	0.30	236	1,184.9	-	-	1	-	-	-	-	8	9
Misc.[d]		-	-	-	-	1	-	-	-	1	-	2
Totals	8.00	16,152	34,833.2	5	1	103*	30	2	3	4	70	218

(TS) = Test Excavation Unit
(EU) = Excavation Unit
†Includes biface cache
*Count includes "possible" bifaces

[a]Unit size = 1 m x 50 cm; 1/8 inch mesh only
[b]Includes 50 x 50 cm 1/8 inch mesh control quadrant
[c]Unit size = 1 m x 75 cm
[d]Artifacts from rodent backdirt, Feature 1 exposure

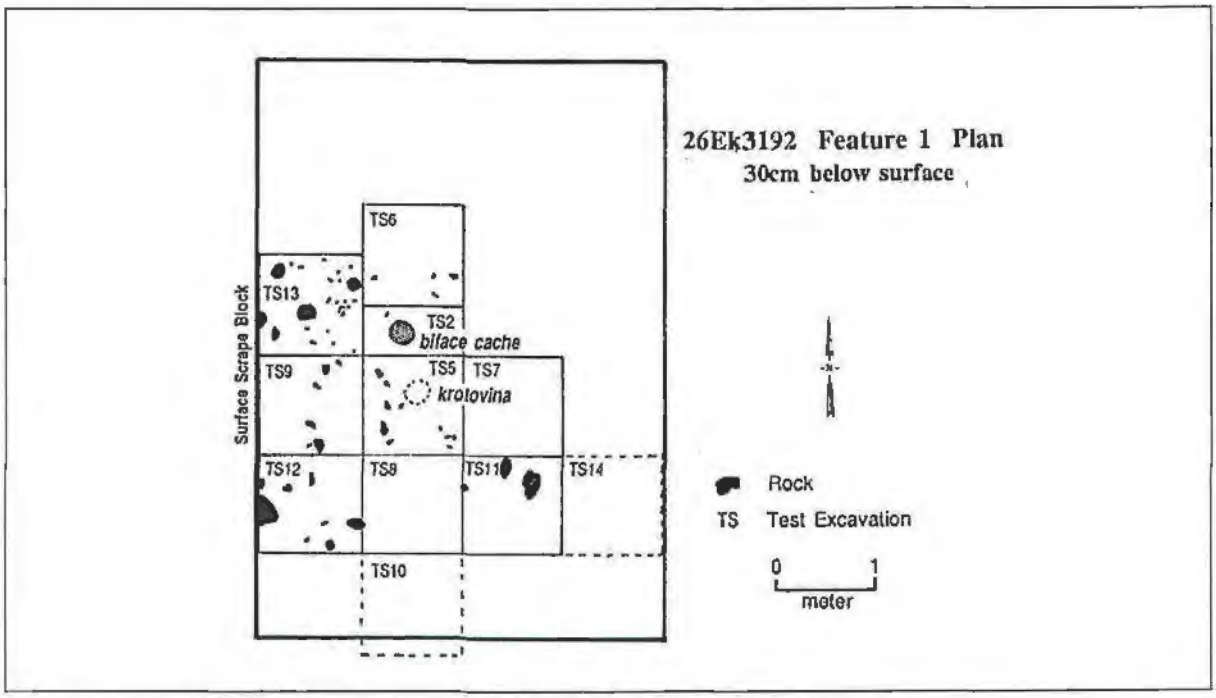


Figure 178. 26Ek3192, Feature 1 Plan. a. surface; b. subsurface.



Figure 179. Feature 1 biface cache, 26Ek3192.

Subsequent to excavation of these two units, we opened a broad, contiguous exposure around the biface cache, excavating an additional 26.5 m^2 to depths of between 20 cm and 40 cm (Figures 178a, 178b). By the close of data recovery, Feature 1 had yielded over 250 formed artifacts, including 142 opalite bifaces (41 constituting the cache), a core, a pair of hammerstones, scores of flake tools and ceramic sherds, and five projectile points including Desert Side Notched and Humboldt specimens (cf. Table 176). Opalite debitage was correspondingly abundant, accompanied by small numbers of obsidian, jasper, and basalt flakes (cf. Table 176; Table 178). The block excavation returned numerous bones as well, slightly over half of them burned; although distributed throughout the deposit, most were recovered from the silt loam matrix of Level 2 in Unit 42. The character of the faunal assemblage suggests that it represents human subsistence refuse (cf. Chapter 14).

Subsurface soils are heavily turbated and similar in structure throughout the area sampled. The profile of the north wall of Excavation Unit 22 typifies the deposit of Feature 1 (Figure 180). The exposure is approximately 35 cm deep by 110 cm wide, and exhibits three stratigraphic units. Unit 1 is a loose, brownish gray silt loam. Unit 2, also a silt loam, is slightly more yellowish and clayey. Unit 3 is very similar to Unit 2, but has very weak clay skins on blocky ped surfaces. Although the eolian origin of these silts makes separate depositional episodes within them probable, the units defined above are pedogenically distinct rather than depositional.

Most subsurface cultural materials were obtained from the upper 30 cm of the deposit, within the zone of undifferentiated mixed silts of Soil Units 1 and 2 (cf. Figure 180). However, an anomalous accumulation of lithic material occurs at the contact between these deposits and the more clayey and compact Soil Unit 3. Here, at an average depth of 26 cm, and throughout the horizontal extent of the unit, occurs a diffuse lithic scatter composed of chiefly large opalite flakes, several biface fragments, and many unmodified opalite cobbles and slabs (cf. Figure 178a). This accumulation apparently is unstructured and, lacking cultural features or other evidence for human modification of the clay surface itself, origins of the scatter remain ambiguous. The shared stratigraphic position of the material suggests perhaps its deposition

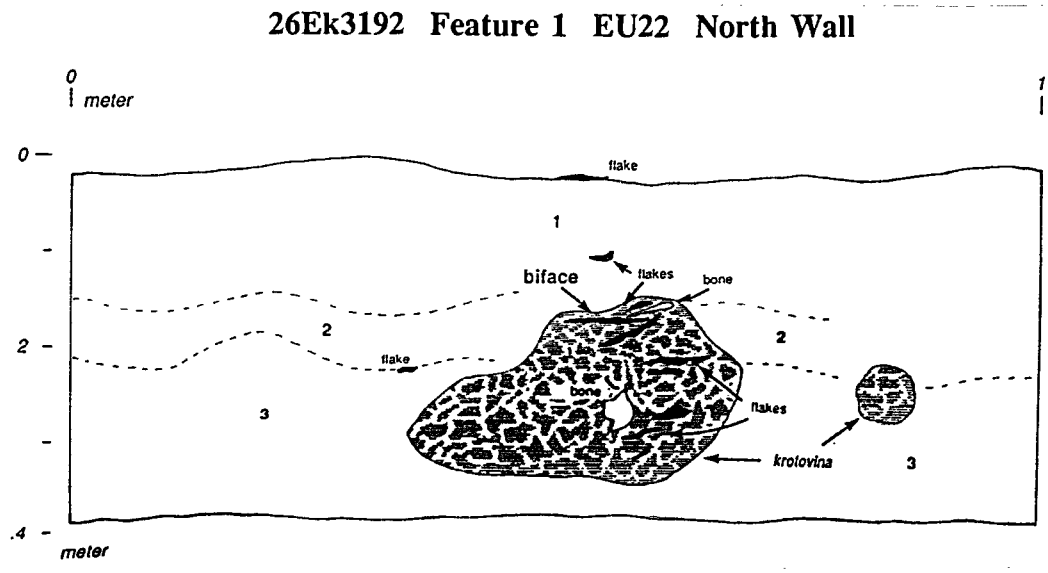


Figure 180. Feature 1 profile, 26Ek3192.

on an ancient ground surface subsequently buried by eolian silts. Alternatively, however, the comparatively large size and weight of the items, coupled with their accumulation atop soil deposits of markedly greater density than those above, suggests that foundering may account for the concentration of massive pieces.

Feature 2

Located 10 m west of Feature 1, Feature 2 is manifest on the surface by a pair of dense lithic concentrations within a more diffuse scatter covering some 12 m^2 (Figure 181). The artifact content of its surface resembles that of Feature 1, absent a biface cache. In addition to the dominant opalite debris, obsidian, basalt, and jasper flakes are visible within the concentrations and surrounding scatter. Surface inventory revealed numerous bifaces and flake tools, a Shoshone Brownware sherd, and an incised stone cylinder. The surface assemblage also includes a pair of steep-edged, high-domed end scrapers and a basalt Great Basin Stemmed Series projectile point (Table 179). As well, there occur several basalt biface fragments that, although too highly fragmented to be identified unequivocally, may represent an additional Stemmed Series point specimen. The presence of these scrapers and projectiles characteristic of the pre-Archaic period in the Great Basin, coupled with the possibility of buried, potentially early deposits prompted selection of Feature 2 for sampling.

Table 179. Artifacts Recovered from Feature 2, 26Ek3192.

		DEBITAGE		FORMED ARTIFACTS										
Unit No. (Type)	Surface Scrape (m^2)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
1-20 (SF)	5.00	2,527	3,330.9	2	-	3	-	3	-	-	-	-	-	8
Surface Inventory	N/A	3†	11.9	3	-	23	-	3	-	-	-	1	1	31
Surface Total		3,530	3,342.8	5	-	26*	-	6	-	-	-	1	1	39
	Volume Excav. (m^3)													
1 (TS)[a]	0.075	1,123	608.3	-	-	1	-	1	-	-	-	-	-	2
4 (TS)	0.80	3,756	5,068.4	5	1	16	2	3	1	2	1	-	-	31
26 (EU)[b]	0.50	1,726	3,257.4	1	-	8	-	2	-	-	-	3	-	14
27 (EU)	0.40	509	810.2	-	-	1	-	1	1	-	-	-	-	3
28 (EU)	0.40	887	1,255.6	-	-	3	-	-	-	-	-	-	-	3
29 (EU)	0.50	772	1,420.8	-	-	5	-	-	-	-	-	3	-	8
30 (EU)	0.40	366	783.3	-	-	1	-	-	-	-	-	-	-	1
31 (EU)	0.40	1,077	1,452.5	-	-	2	1	1	-	-	-	-	-	4
32 (EU)	0.40	327	488.9	-	-	1	-	1	-	1	-	-	-	3
33 (EU)	0.30	154	298.8	-	-	-	-	-	-	-	-	-	-	0
34 (EU)	0.30	412	1,188.2	-	-	2	-	1	-	-	-	-	-	3
35 (EU)	0.20	224	341.1	-	-	-	-	-	-	-	-	-	-	0
36 (EU)	0.50	473	822.8	-	-	-	-	-	-	-	-	-	-	0
37 (EU)	0.20	135	364.4	-	-	-	-	-	-	-	-	-	-	0
38 (EU)	0.30	69	89.7	-	-	-	-	1	-	-	-	-	-	1
39 (EU)	0.40	181	494.6	-	-	-	-	-	-	-	-	2	-	2
40 (EU)	0.50	1,535	2,212.8	-	-	5	-	-	-	-	-	3	-	8
41 (EU)	0.50	22	39.3	-	-	-	-	-	-	-	-	-	-	0
Subsurface Total	7.075	13,748	20,997.1	6	1	45*	3	11	2	3	1	11	-	83
Feature Total		17,278	24,339.9	11	1	71*	3	17	2	3	1	12	1	122

(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Unit Size = 1 m x 50 cm; entirely 1/8 inch mesh
[b]Includes 50 x 50 cm 1/8 inch mesh control quadrant
†Obsidian only
*Includes "possible" bifaces

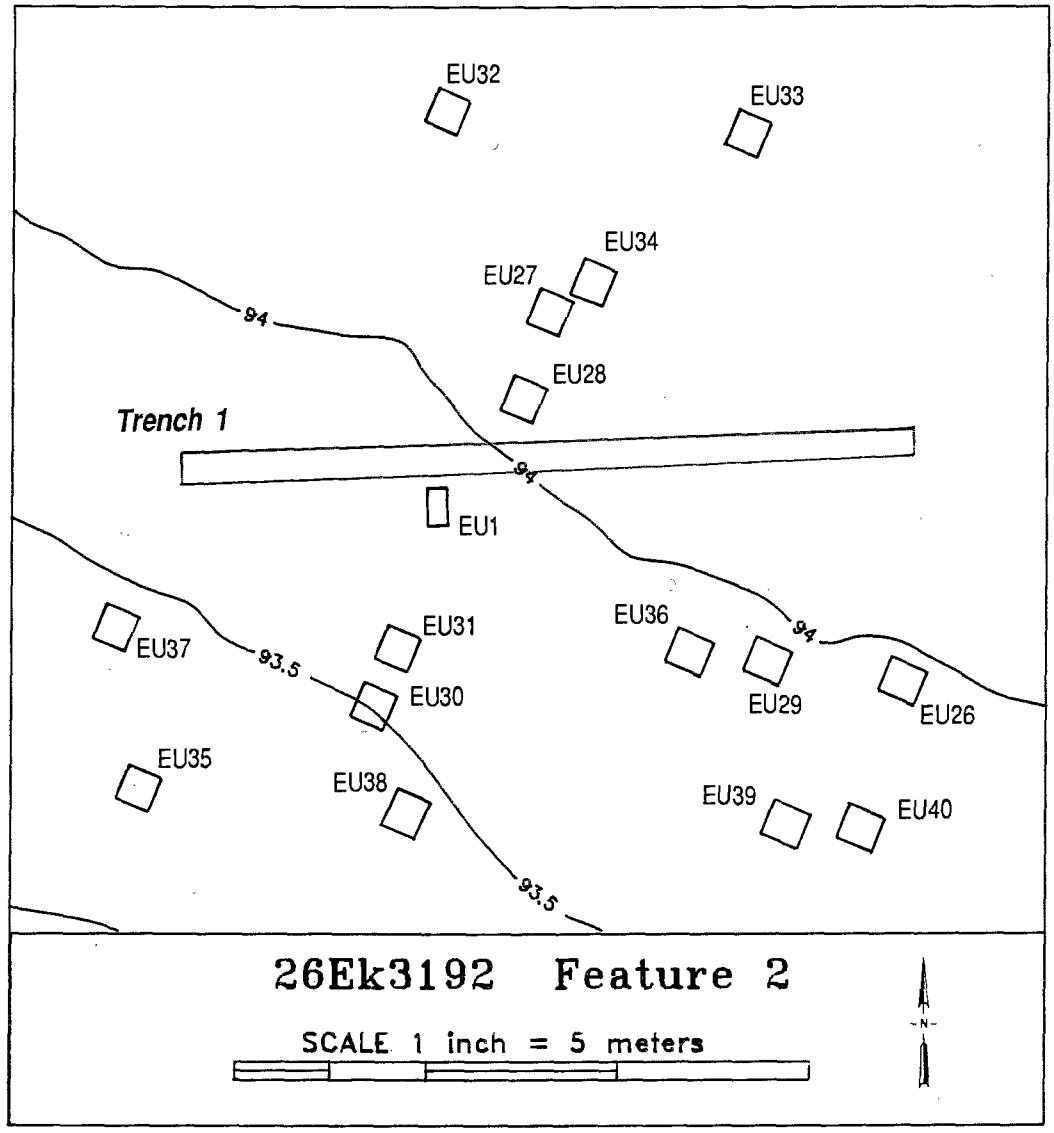


Figure 181. Feature 2 plan, 26Ek3192.

A discontinuous series of 20 50 cm x 50 cm surface scrapes was placed along a baseline bisecting the principal artifact concentration and extending into the lithic scatter beyond. The configuration of the concentration visible on the surface defines its full horizontal extent; units falling outside its visible limits yielded substantially fewer artifacts than those within it. The sample returned a large quantity of opalite waste, several obsidian flakes, and a pair of projectile point fragments (cf. Figure 181; Table 179). No additional artifacts suggesting pre-Archaic occupation were returned; both projectile fragments proved typologically non-diagnostic (cf. Chapter 8).

During testing, two excavation units explored the subsurface where debitage was found to be densest. Both revealed deposits stratigraphically comparable to those of Feature 1 and essentially identical to those of Trench 1 described above (cf. Figure 176). Unit 1 (1 m x 50 cm) was dug to a depth of 20 cm where excavation was terminated when cultural material fell off sharply and the loose silt of the upper stratum became increasingly burdened with clay.

Excavation Unit 4 (1 m x 1 m) was intended to probe the full vertical extent of the deposit; it was dug to a depth of 80 cm, well into a mixed stratum of dense clay and weathered tuff bedrock. The loose silt of the upper 10 cm proved to contain the densest cultural material, yielding abundant opalite reduction debris, a Desert Side Notched projectile point, four non-diagnostic point fragments, a mano, and several obsidian waste flakes. Subsequent levels returned diminishing numbers of artifacts. Below ca. 50 cm, roughly at the contact between the mixed upper silts and the more clayey paleosol, virtually all cultural materials were recovered from krotovina; a Cottonwood Triangular projectile point was found between 60 and 70 cm below surface (cf. Table 179).

Data recovery sought to clarify the content and structure of the subsurface deposit. As at Feature 1, work focused on exploring the relationship between cultural content of the deposits and the possible living surface at the contact between upper eolian silts and clay paleosol. This was initiated by excavation of Backhoe Trench 1, spanning the central portion of the site from the excavation unit block at Feature 1 westward across all of Feature 2 (cf. Figure 175).

Before unit excavation, the area surrounding Trench 1 was probed by a series of 88 soil core samples at 2 m intervals along seven parallel baselines spaced 5 m apart. The paleosol was encountered at depths between 21 cm and 85 cm throughout the feature; most probes hit clay between 31 cm and 40 cm below surface. The area subsequently was subdivided into six sampling strata based on depth of the paleosol. Ten 1 m x 1 m excavation units (Units 32 through 41) were distributed proportionally among the sampling strata, selected by random draw. Six additional units (Units 26 through 31) were deployed to explore more fully locations returning promising results (cf. Figure 181). In each unit digging was halted at the silt-clay interface in order to assess possible use of the ancient surface. Table 179 presents artifact recoveries on a unit by unit basis.

Unit excavation revealed subsurface deposits structured much like those exposed by Trench 1. They vary most in the depth at which paleosol (Soil Unit 4) is encountered, apparently a function of natural undulations in the bedrock substrate. Regardless of depth of the clay, the upper eolian silts (Soil Units 1 and 2) everywhere are heavily churned; krotovina and active mammal burrows abound. Cultural content of the deposit is undifferentiated horizontally, and much of its artifactual component resides in the upper 10 cm. As at Feature 1, the assemblage includes a wide range of artifact types, but it is proportionally smaller and somewhat less dense. Also, the clay contact exposed in several units in Feature 2 revealed sparse accumulations of large opalite debitage and unmodified cobbles of tuff and opalite. No subsurface features were found; in several places diffuse ash stains and charred soil reflect only burned rootballs of grasses and sage. The question of whether an ancient living surface lies beneath the silt cap remains unresolved.

Implications

The magnitude of field efforts notwithstanding, Features 1 and 2 returned assemblages among the largest and most varied of any recovered in the Eastern Periphery (cf. Chapter 23). That they also witnessed a very early occupation prior to the deposition of the loess mantle remains equivocal. Although distributed without apparent pattern, time-sensitive artifacts imply some early human presence; they reflect virtually the entire reach of Great Basin prehistory.

Antiquity and depositional context aside, the most abundant (and probably most recently accrued) remains occur on the surface as artifact concentrations relating directly to the processing of opalite and, as evidenced by the cache in Feature 1, the storage of reduced, portable products. Debitage from early stage biface reduction predominates, and bifaces reflect nearly the entire range of reduction (cf. Chapter 6). Maintenance and subsistence implements abound, suggesting activities ancillary to and supportive of toolstone processing.

26Ek3032/Locality 20

Locality 20 lies on the western flank of Ramadan Ridge, just downslope of 26Ek3170 and 6 m higher than the bank of Little Antelope Creek (cf. Figure 141). It is differentiated from its immediate surroundings by a moderate to high density lithic scatter encompassing ca. 200 m^2. Like most of the adjacent hillside, low lying, highly weathered opalite bedrock occurring throughout the site appears not to have attracted use. Intervening shallow, gravelly soils support a patchy growth of low sage, inviting little accumulation of subsurface cultural remains. Close interval surface reconnaissance revealed three small, spatially discrete concentrations of reduction debris (Figure 182). Elsewhere, extra-feature contexts were defined almost exclusively by opalite debitage (Table 180).

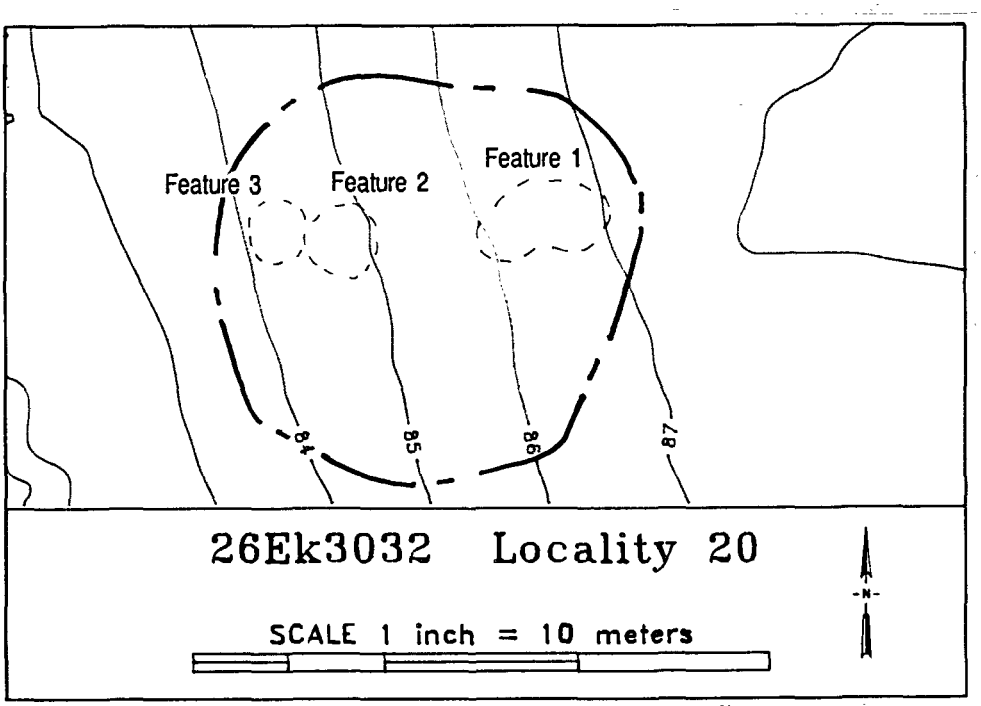


Figure 182. Locality 20 site map, 26Ek3032.

Table 180. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3032, Locality 20.

Feature	Total Area (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	FORMED ARTIFACTS Bifaces[a]	FORMED ARTIFACTS Cores	FORMED ARTIFACTS Flake Tools	Total
1*	7	6,448	21,523.0	-	11	-	3	14
2*	5	1,092	4,315.1	1	2	3	3	9
3*	13	2,047	7,145.4	-	4	1	-	5
Surface Isolates	-	-	-	-	4	-	-	4
		9,587	32,983.5	1	21	4	6	32

*Sample Feature
[a]Includes "possible" bifaces

Features 1, 2, and 3 cover 7 m^2, 5 m^2, and 13 m^2, respectively. Each is a rather typical reduction station; they differ chiefly in size and density. Each was sampled by surface scrape units centered on the densest concentrations. The exercise revealed that all are confined to the upper 2 cm of deposit, and that most of their cultural contents consist of opalite reduction products (cores and bifaces) and by-products. Flake tools occur in assemblages from Features 1 and 2; the latter also yielded an Elko projectile point (cf. Table 180).

26Ek3032/Localities 21 and 22

Separated by only 30 m, Localities 21 and 22 dot the west bank of Little Antelope Creek immediately adjacent a series of boulder-lined vernal pools (cf. Figure 141). Both localities are small, ca 100 m^2 and 30 m^2, respectively, and each contains a single reduction feature. They occupy the narrow, most recent stream terrace elevated barely half a meter above the active creek bed; they are backed by the steep (40%) footslope of Holmes Ridge (Figure 183). Opalite occurs abundantly both as cobbles in the stream bed and as large, colluvially deposited clasts on the terrace. The localities were scrutinized to see whether these low quality, rarely used source types were exploited.

Close interval inspection at Locality 21 revealed few formed artifacts, all of them opalite reduction products. The sole feature (Feature 1) lies amid a cluster of low opalite boulders; it consisted of a dense, 2 m^2 accumulation of opalite debitage and numerous unmodified stream cobbles. The apparent density of the feature owes to the robustness of individual waste flakes and the co-occurrence of much non-cultural debris. The surface of the feature was collected by a pair of 1 m x 1 m surface scrape units that yielded abundant debitage, a small assemblage of formed reduction artifacts, and a flake tool (Table 181). A 1 m x 1 m excavation unit probed subsurface contexts beneath the scrape until bedrock (apparently the top of a large stream boulder) was met at a depth of 30 cm. Cultural materials occur throughout, but the unstratified sandy, alluvial matrix containing them comprises less than half excavated volume of each level. Large unmodified cobbles, angular opalite debris, and near-surface bedrock occupy most of the deposit. Artifact retrievals reflect those obtained from the surface (Table 181).

Table 181. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3032, Localities 21 and 22.

Feature	Total Area (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Bifaces[a]	FORMED ARTIFACTS Cores	FORMED ARTIFACTS Flake Tools	FORMED ARTIFACTS Modif. Chunks	Total
Locality 21								
1*	0.60	1,794	39,896.1	3	8	2	3	16
Surface Isolates	-	-	-	4	-	-	1	5
Total		1,794	39,896.1	7	8	2	4	21
Locality 22								
1*	9	2,067	13,681.6	6	2	1	-	9
Surface Isolates	-	-	-	-	1	-	-	1
Total		2,067	13,681.6	6	3	1	0	10

*Sample Feature
[a]Includes "possible" bifaces

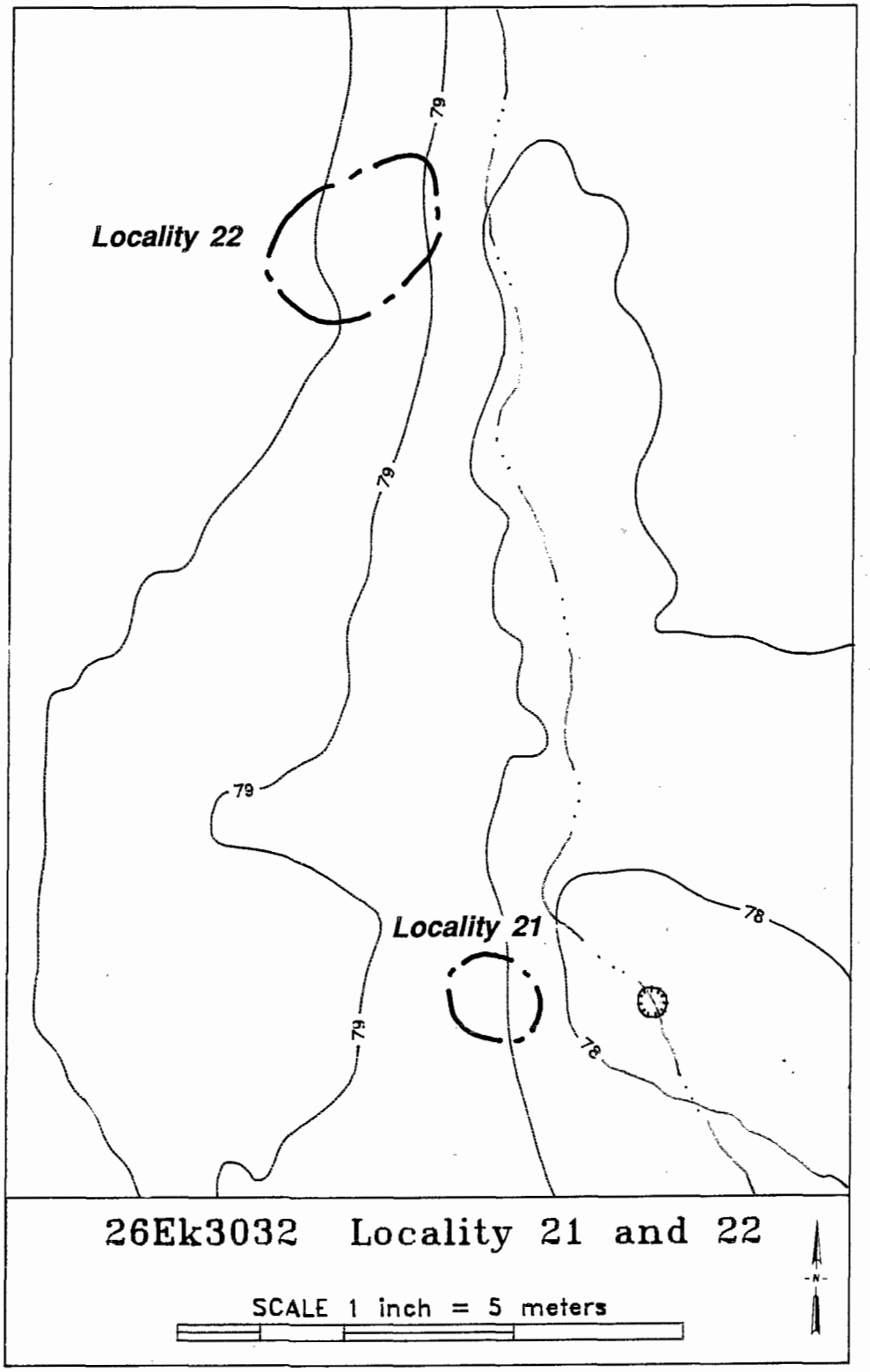


Figure 183. Localities 21 and 22 site map, 26Ek3032.

The lithic scatter at Locality 22 is less dense than that at Locality 21, but Locality 22 similarly consists of a concentration of opalite debitage and unmodified opalite debris over an area of ca. 2 m^2. Six 1 m x 1 m scrapes removed the entire surface component, and resulted in artifact recoveries comparable to those yielded by Locality 21 (cf. Table 181). In the densest zone, a 1 m x 1 m excavation unit was dug until an impenetrable stratum of stream cobbles halted work at a depth of 20 cm. Cultural material is most abundant in the upper 10 cm. Artifact returns from excavation swell the size of the collection, but add nothing new.

Analysis of the collections from Localities 21 and 22 confirm our original assumption that they represent comparatively rare instances of the use of opalite stream cobbles as sources of lithic raw material (cf. Chapters 6 and 10).

Other Reduction Sites

The balance of the reduction sites (n=16) are known only from data obtained during testing. Half of them were sampled systematically; the remainder were examined only by surface inventories (cf. Table 150).

Rarely exceeding 500 m^2 in area, and confined primarily to microtopographic flats on Ramadan and Holeplug Ridge, relatively distant from toolstone sources, these sites are defined by from one to as many as eleven culture features. Feature composition generally is equivalent to that of reduction features composing toolstone processing components at most other sites in the subarea. Remains are confined almost exclusively to surface contexts (≤ 2 cm depth) and, save exceptional features at 26Ek3185 and 26Ek3190, assemblages consist of items dominantly related to toolstone processing. For sites conforming to these generalizations, descriptions of testing procedures and results are relegated to tabular summation (cf. Tables 150 and 182) and earlier documentation (Botkin 1989). The exceptions (26Ek3185 and 26Ek3190) warrant brief separate consideration because they also exhibit non-reduction attributes.

Table 182. Artifacts Recovered from Feature and Nonfeature Contexts, Miscellaneous Eastern Periphery Reduction Sites.

			DEBITAGE		FORMED ARTIFACTS								
Site	Feature	Total Area (m^2)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Ground Stone	Ceramics	Total
26Ek3172	1*	6	1,258	1,969.9	-	-	-	-	-	-	-	-	0
	2	5	-	-	-	-	-	-	-	-	-	-	0
	3	6	-	-	-	-	-	-	-	-	-	-	0
	4	8	-	-	-	-	1	-	-	-	-	-	1
	5	14	-	-	-	-	-	-	-	-	-	-	0
	6	2	-	-	-	-	-	-	-	-	-	-	0
	Surface Isolates		2[a]	17.0	-	-	5	-	-	-	-	-	5
26Ek3173	1*	25	3,856	8,704.5	2	-	6	1	2	-	-	-	11
	2	17	-	-	-	-	-	-	-	-	-	-	0
	3	60	-	-	-	-	-	-	1	-	-	-	1
	4	24	-	-	-	-	1	-	-	-	-	-	1
	Surface Isolates		-	-	-	-	2	-	1	-	-	-	3
26Ek3174	1	82	-	-	-	-	-	-	-	-	-	-	0
	2	102	-	-	-	-	1	-	-	-	-	1	2
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3175	1	85	-	-	-	-	1	-	-	-	-	-	1
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3178	1*	44	3,737	6,463.7	2	-	13	-	-	1	-	-	16
	2	64	-	-	1	-	-	-	-	-	-	-	1
	3	10	-	-	-	-	-	-	-	-	-	-	0
	4	8	-	-	-	-	-	-	-	-	-	-	0
	Surface Isolates		-	-	-	-	1	-	-	-	-	-	1

Table 182, continued.

Site	Feature	Total Area (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Ground Stone	Ceramics	Total
26Ek3179	1*	6	1,219	1,421.5	-	-	1	-	3	-	-	-	4
	2	2	-	-	-	-	-	-	-	-	-	-	0
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3180	1	12	-	-	-	-	1	-	-	-	-	-	1
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3181	1*	19	3,585	6,297.8	-	-	11	-	5	-	1	2	19
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3183	1*	8	2,175	2,454	-	-	4	-	-	-	-	-	4
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3186	1	55	-	-	-	-	-	-	-	-	-	-	0
	2	19	-	-	-	-	1	-	-	-	-	-	1
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3187	1	49	-	-	-	-	-	-	-	-	-	-	0
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3188	1	110	-	-	-	-	-	-	-	-	-	-	0
	Surface Isolates		-	-	-	-	-	-	-	-	-	-	0
26Ek3189	1	19	-	-	-	-	1	-	-	-	-	-	1
	2	49	-	-	-	-	-	-	-	-	-	-	0
	3	9	-	-	-	-	-	-	-	-	-	-	0
	4	16	-	-	-	-	-	-	-	-	-	-	0
	Surface Isolates		1[a]	4.0	-	1	1	-	-	-	-	-	2

*Sample features
[a]Obsidian only

26Ek3185 and 26Ek3190

26Ek3185 lies immediately adjacent and above 26Ek3184 on the lower slopes of Holeplug Ridge (cf. Figure 141). Occupying just over 900 m^2, seven reduction features and an intervening moderate density lithic scatter define the site. Each feature consists of typical, dense accumulations of opalite debitage; Feature 1 is distinguished by numerous formed reduction artifacts and a variety of maintenance/subsistence tools (projectile points, preforms, flake tools, and groundstone). Surface scrapes (20 m^2) recovered its entire horizontal and vertical expression, yielding a diverse assemblage of formed artifacts and abundant reduction debris (Table 183).

Table 183. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3185.

Feature	Total Area (m^2)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
1*	16	2,117	3,199.9	5	3	8	9	2	1	28
2	14	-	-	-	-	3	-	-	-	3
3	6	-	-	-	-	-	-	-	-	0
4	13	1[a]	1.6	-	-	1	-	1	-	2
5	26	-	-	-	-	4	-	-	-	4
6	12	-	-	-	1	1	2	-	-	4
7	5	-	-	-	-	-	-	-	-	-
Surface Isolates	-	-	-	3	-	5	2	-	-	10
		2,118	3,201.5	8	4	22	13	3	1	51

*Sample feature
[a]Obsidian only

Although more extensive (4241 m^2), and containing more cultural features, 26Ek3190 is similar. Here, on the knoll top immediately east of 26Ek3184, eleven features display concentrations of opalite reduction debris (cf. Figure 142). The surface of Feature 1, however, is augmented by numerous tools and non-opalitic waste (obsidian and basalt debitage). A block of surface scrape units collected the full 28 m^2 expression of the feature and, where surface density proved highest, an excavation unit probed deposits to a depth of 20 cm. Toolstone processing products and by-products dominate (opalite debitage, biface fragments, etc.), but maintenance/subsistence tools are abundant (Table 184); they include several projectile points, a preform, and a dozen flake tools. They are accompanied by waste flakes of obsidian, basalt, and jasper.

Table 184. Artifacts Recovered from Feature and Nonfeature Contexts, 26Ek3190.

		DEBITAGE		FORMED ARTIFACTS							
Feature	Total Area (m^2)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Ground Stone	Other/ Exotic	Total
1*	31	5,873	6,761.8	7	1	30	1	12	-	1	52
2*	9	3,002	4,467.0	-	-	13	-	2	-	-	15
3	4	-	-	-	-	-	-	-	-	-	0
4	60	1[a]	2.4	-	-	5	-	-	-	-	5
5	19	-	-	-	-	2	-	1	1	-	4
6	69	1[a]	5.8	-	-	4	-	1	-	-	5
7	14	-	-	-	1	2	-	-	-	-	3
8	12	1[a]	2.4	1	-	-	-	-	-	-	1
9	2	-	-	-	-	-	-	-	-	-	0
10	50	1[a]	9.4	1	-	-	-	-	-	-	1
11	43	-	-	-	-	1	-	-	-	-	1
Surface Isolates	-	2[a]	8.3	-	-	12	1	1	-	-	14
		8,881	11,257.1	9	2	69	2	17	1	1	101

*Sample feature
[a]Obsidian only

In artifact content and horizontal dimension both features resemble the hunters' camps or special task loci identified in Feature 1 at 26Ek3191, Features 1 and 2 at 26Ek3192, and Feature 1 at 26Ek3198. In contrast to the latter two, however, the special purpose features at 26Ek3185 and 26Ek3190 appear to lack subsurface components.

Diffuse Lithic Scatters

The remaining open sites (26Ek3176, 26Ek3194, and 26Ek3199) are diffuse lithic scatters occupying low ridge tops on the midslope of Corral Fan (cf. Figure 141). None was tested. Although covering 4240 m^2, 8840 m^2, and 1180 m^2 respectively, they exhibit low densities of cultural materials and discernible features (Raven 1988). Their assemblages consist exclusively of opalite reduction products.

Rockshelters

Five rockshelters occur in the northern portion of the Eastern Periphery. Most occupy low overhangs on the mid-elevation contours of Italian Mesa and one occupies a recess above the southern margin of the upper reach of Undine Gorge (cf. Figure 141). Testing was performed at 26Ek3177, 26Ek3202, and 26Ek2304; the latter was sampled further during data recovery. Testing focused on interior subsurface deposits. 26Ek3205 and 26Ek3206, exhibiting only sparse cultural materials, were not tested.

26Ek3204

The largest rockshelter, 26Ek3204, exhibits the greatest intensity of aboriginal use. Beneath a broad, overhung shelf of brecciated opalite bedrock on the south facing midslope of Italian Mesa, the site lies 23 m above the stream bed of Undine Gorge; it is accessible from it only across a steep (ca. 30%), boulder-strewn talus slope (cf. Figure 141; Figure 184).

The 18 m^2 within the drip line is flat and is covered with an unbroken pavement of opalite debitage punctuated by opalite bifaces, hammerstones, flake tools, and numerous obsidian waste flakes. In several places the bedrock walls are silicified and seem, from their gouged and hammered appearance, to have been exploited at least minimally for toolstone. Most opalite processed at the shelter, however, is of markedly higher quality than that of the surrounding outcrop. Immediately outside the dripline, the apron is littered with a similar, but less dense accumulation; cultural material and naturally weathered opalite have accrued in an extensive talus, gradually diminishing over 12 m from the mouth of the shelter.

Deposits in both the interior and exterior of the shelter appeared to hold considerable potential for buried cultural remains. Moreover, the silt loam deposits within the dripline appeared to be largely dry, although two small grassy patches near the rear wall indicated some localized collection of moisture. Seepage through roof fissures after the snowfall of June 1988 dampened these areas, but most of the interior seemed to provide dry, protected contexts likely to preserve perishable remains (Intermountain Research 1988b:151).

Testing commenced with the surface collection. Following this, subsurface deposits were probed by 2 1 m x 50 cm excavation units. Excavation Unit 1, in the interior, was dug to a depth of 60 cm. Excavation Unit 2 was placed on the upper apron outside the dripline, and excavated to 40 cm. Both units terminated where bedrock or immovable roof fall was encountered. To link stratigraphic units, a trench (Trench 1) was dug by hand from the apron to the rear wall, positioned to join and extend the excavation units (cf. Figure 184).

Excavation returned numerous formed artifacts, and an astonishing volume of debitage (Table 185); the ca. 1 m^3 sample yielded over 73,000 flakes, the vast majority of which are opalite but which include as well jasper, obsidian, basalt, and quartzite. By contrast, perishable remains are rare, and no non-lithic tools, hearths, or other facilities were encountered.

Table 185. Artifacts Recovered from Feature 1, 26Ek3204.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Total
1 (TS)[a]	0.30	71,324	31,077.4	3	1	14	-	2	-	1	-	21
2 (TS)[b]	0.20	2,370	7,070.2	-	-	8	1	3	1	-	-	13
3 (EU)[c]	0.40	50,221	35,842.4	3	3	20	-	14	1	1	-	42
Surface Inventory	N/A	-	-	-	1	42	1	1	4	5	-	54
Trench Samples	N/A	-	-	-	-	6	-	1	-	2	1	10
Totals	0.90	123,915	73,990.0	6	5	90	2	21	6	9	1	140

(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]All levels, 1/8 inch mesh
[b]Only 0-2 cm 1/8 inch control; all other levels 1/4 inch mesh
[c]All levels include 50 cm x 50 cm 1/8 inch mesh control quadrant

Also, opalite spalls derived from the exfoliation of the shelter ceiling and surrounding outcrop abound, creating deposits literally packed solid with lithic debris. Soils occupying the interstices of this matrix consist of fine silt loams, and numerous krotovina and active rodent burrows evidence prolonged and extensive mixing. Charcoal is abundant, but occurs only as minute particles scattered throughout the deposit. A composite charcoal sample derived from the 20-30 cm level in Excavation Unit 1 returned a date of 40±50 B.P. which, given ambiguities in curves for very young samples, *could* indicate an age between ca. 272 B.P. and 0 B.P. on the two sigma basis (Appendix L).

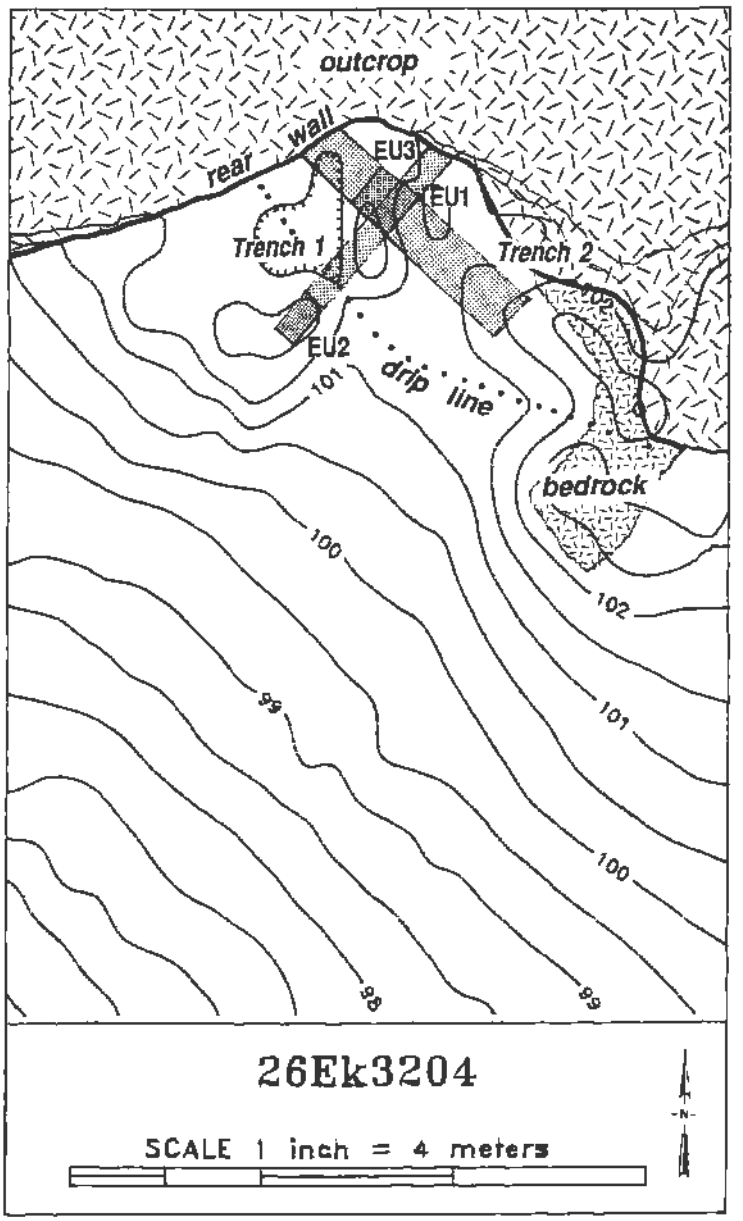


Figure 184. 26Ek3204 site map.

Data recovery expanded sampling of the interior, largely in hopes of discovering intact hearths that would allow dating discrete events of shelter use. As well, more extensive stratigraphic exposures were desired to clarify processes of site formation. An additional trench (Trench 2) was excavated perpendicular to and crossing the original trench. To obtain a controlled sample of subsurface contexts near the rear wall, a 1 m x 50 cm excavation unit (Unit 3) was extended into the northern sidewall of the new trench and dug 80 cm to bedrock (cf. 17.40).

Unit 3 returned cultural material comparable in abundance, variety, and distribution to that disclosed by Unit 1 (cf. Table 185). Neither the excavation unit nor Trench 2 revealed hearths or other subsurface cultural features.

The resulting exposures reveal only a limited depth of sediments over the bedrock surface or roof fall, which are difficult to distinguish (Figure 185). Five stratigraphic units are discernible in the profiles. Unit 5 is a slightly calcareous, yellowish brown sandy clay with common fine angular opalite spall from the shelter roof. Cultural debris is absent. Unit 4 is a brown sandy loam with common opalite gravels, some from roof spall, and some possibly washed from slopes adjacent the shelter. Cultural debris is rare. A loose brown loam with abundant opalite debris comprises Unit 3. Most of the opalite is roof spall; cultural debris is rare. Unit 2 is a dark grayish brown loam with abundant opalite roof spall and common lithic debris. Unit 1 consists of a relatively high concentration of opalite roof spall and lithic debris.

Implications

Although dominated by the debris of opalite processing, numerous flake tools and maintenance and subsistence implements suggest that 26Ek3204 may have served occasionally as shelter for small groups. Thus we sought to find hearths, perishable materials, and other data classes not commonly preserved at Tosawihi. These goals were only partially realized. Indeed, results offer no convincing evidence suggesting that non-toolstone directed activities occurred at the shelter any more than at many open-air sites in the Eastern Periphery.

Of the hundreds of bones recovered, there is little evidence for cultural origins. The assemblage consists chiefly of rodents, with a few specimens of artiodactyls, miscellaneous reptiles, and fish. Only 4% are burned, while ca. 40% exhibit diagnostic traits (e.g. pitting, rounding of fractured surfaces) marking them carnivore scat bones (Schmitt and Juell 1989). Most of the remainder appear to be recent inclusions, probably representing rodent burrow deaths (cf. Chapter 14).

The copious debris of toolstone processing, however, implies intensive use of the place as a reduction station; absent unambiguous chronological controls, the intensity of use remains unresolved. The abundance of cultural material may reflect actual relative magnitude of use or may be illusory, the product of exquisite preservation absent post-depositional colluvial processes.

The debitage assemblage, while dominated by debris of early stage opalite biface production, reflects lithic tasks ranging from core reduction to the edge maintenance of tools. Opalite bifaces, are commensurately abundant (n=81) and varied (cf. Chapter 6). As at many other sites, most specimens are intermediate stage reduction forms (Stage 3, n=49); most of the remainder are Stage 2 specimens (n=18).

Overall, most remains at 26Ek3204 suggest that it attracted use as a weather-protected workshop for the processing of imported opalite toolstone. Evidence for its use as a campsite is no more compelling than that observed at several features in open settings throughout the Eastern Periphery (cf. Chapter 24).

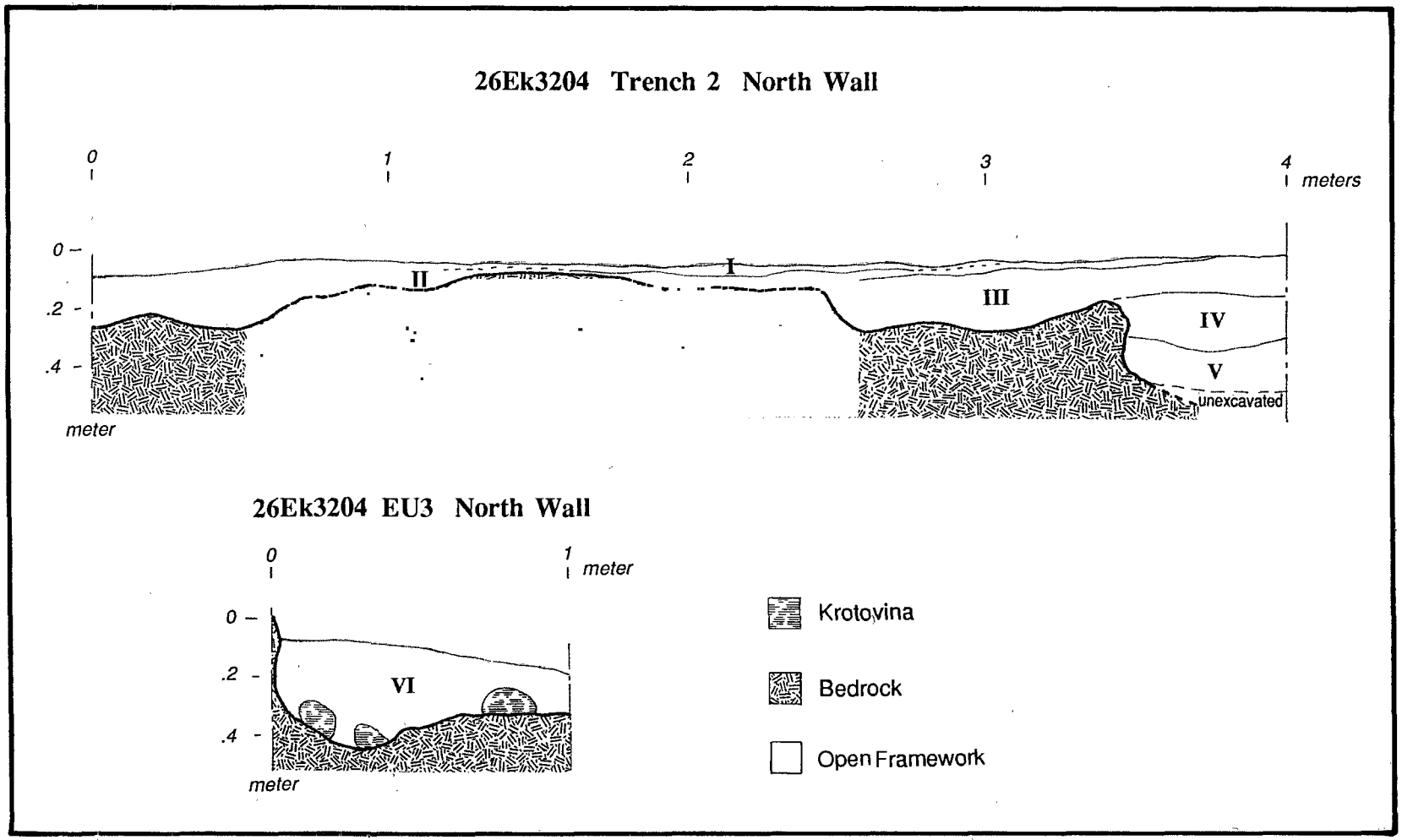


Figure 185. Description of stratigraphic units, Trench 2 and EU3, 26Ek3204.

Figure 185. Description of stratigraphic units, Trench 2 and EU 3, 26Ek3204.

Stratum	Description
1	Opalite debris and flakers from roof spall and lithic reduction, with rare to common silt matrix.
2	Dark grayish brown (10YR 4/2) dry; loam; loose to fine granular; abundant opalite roof spall and lithic reduction flakes.
3	Brown (10YR 5/3) dry; loam; loose to fine granular; common opalite roof spall and rare opalite flakes.
4	Brown (10YR 5/3) dry; sandy loam; medium subangular blocky; common opalite pebbles; very rare opalite flakes.
5	Light yellowish brown (10 YR 6/4) dry; clay with sand; strong coarse angular blocky; common fine opalite roof spall; no cultural debris; moderate dispersed carbonate.

26Ek3177 and 26Ek3202

The smallest rockshelters sampled, 26Ek3177 and 26Ek3202 enclose only 5 m^2 and 8 m^2, respectively. Both surface contexts are defined by moderate density opalite lithic scatters confined to areas within driplines and the aprons immediately outside. The battered appearance of the walls at 26Ek3177 suggests possible (but unsubstantiated) use as a toolstone source. One 1 m x 50 cm excavation unit probed subsurface contexts within the sheltered portion of each shelter. The units reached depths of 20 cm and 50 cm, respectively, when digging was halted due to opalite bedrock or large slabs of roof-fall. Deposits in both sites are essentially identical in composition and cultural content; unstratified silt loam soils are heavily turbated, lack cultural features, and are wet throughout. Most cultural materials occur in the upper 10 cm, and most artifacts were recovered by surface scrapes prior to excavation. The assemblages are exclusively of opalite, and are composed almost entirely of debitage. A pair of bifaces was retrieved from each site and these, together with a hammerstone and two unclassifiable projectile point fragments from 26Ek3177, constitute the entire formed artifact assemblages (cf. Table 151). Both appear to have seen comparatively ephemeral use as minimally sheltered reduction stations.

Chronology

By the completion of data recovery, field efforts had garnered three classes of chronological data: relative dates provided by the classification of temporally diagnostic artifact types (projectile points and ceramic sherds), radiocarbon assay of charcoal, and evaluation of obsidian hydration rim values. As elsewhere at Tosawihi, analytical results reveal a range of human use of the Eastern Periphery spanning the past 10,000 years, but the majority of the time markers reflect relatively recent prehistoric use to a somewhat greater degree than in the Western and Northern subareas (cf. Chapter 19). Figure 186 summarizes the chronological indicators recovered from the East on a site by site basis.

Projectile points are the most widely distributed time sensitive artifacts found in the East. Of 102 specimens, over half are unclassifiable with reference to Thomas's (1981) key, due to fragmentation (n=45) or deviant morphology (n=8, cf. Chapter 8).

Within the classifiable assemblage (n=49), the majority appear to have accumulated during relatively late prehistoric times; over 61% are Desert Series specimens post-dating A.D. 1300 (Desert Side-notched: n=20; Cottonwood: n=10). Similarly, although derived from only five vessels and occurring in only four sites, the bulk of the 117 ceramic sherds recovered (n=109) are Shoshone Brownware specimens, also implying occupation during Desert times (cf. Chapter 13).

Radiocarbon analyses of charcoal samples mirror and, at least indirectly, corroborate the implied stylistic chronology (cf. Appendix L). As well, unlike time sensitive artifacts, most of which are from surficial contexts linked only circumstantially to toolstone acquisition, most radiocarbon samples relate directly to quarry pit excavation. One of these is from Feature 2 at 26Ek3171, and three others date discrete episodes of pit excavation in Feature 2 at 26Ek3195 (Appendix L). Each returned readings post-dating A.D. 1300; they span the period from (roughly) A.D. 1490 to A.D. 1670. The hearth underlying, and plausibly contemporaneous with, the obsidian scatter of Feature 1 at 26Ek3198 is also attributable to post A.D. 1300, as is the ambiguously young sample derived from composite charcoal of the general matrix in 26Ek3204.

Evidence for earlier use is provided exclusively by temporally diagnostic artifacts, chiefly projectile points. Visitation ca. A.D. 700 - A.D.1300 is suggested by a pair of Rosegate Series

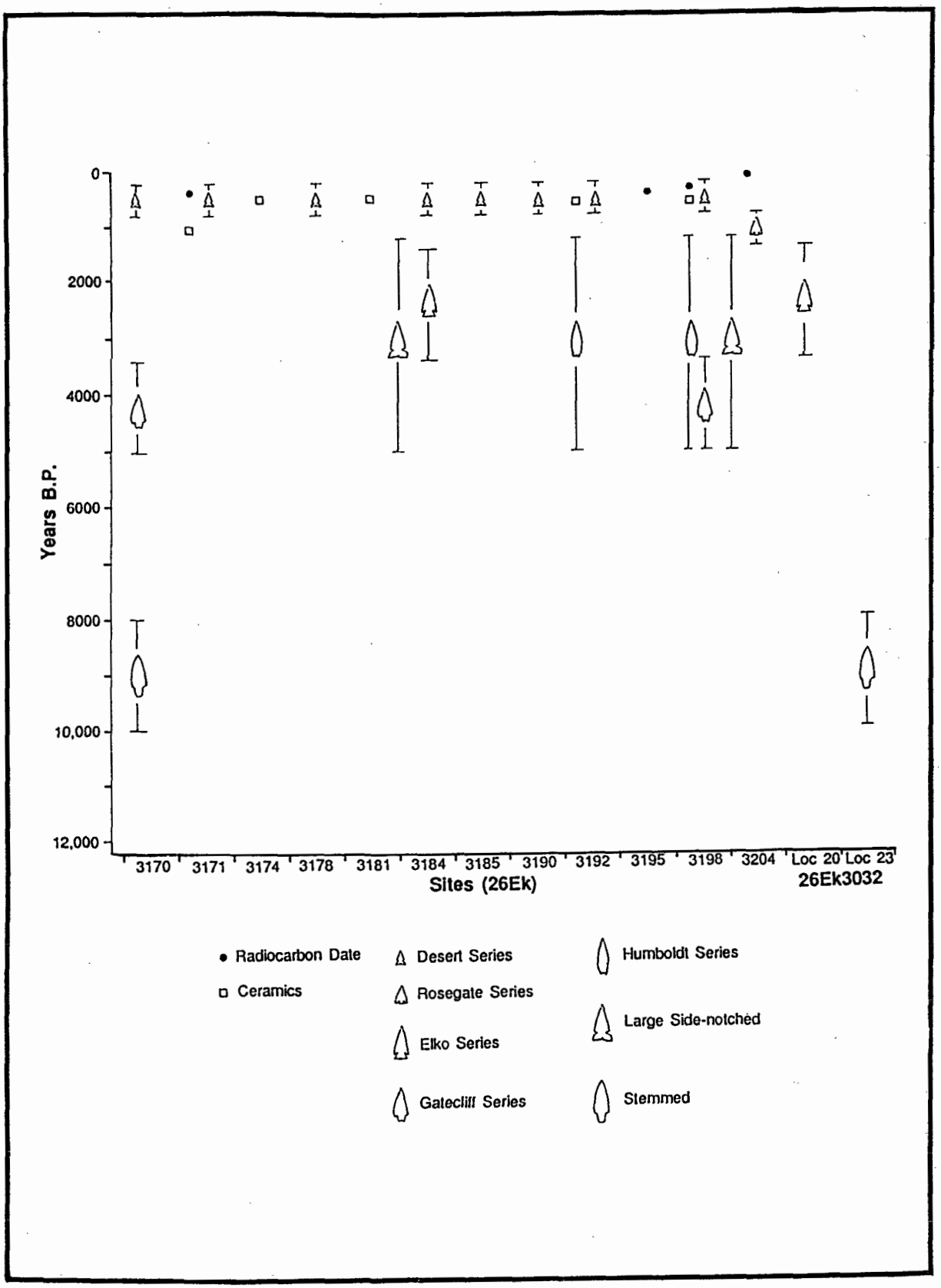


Figure 186. Chronology of the Eastern Periphery.

points from the shelter at 26Ek3204 and by eight Fremont Grayware sherds deposited at 26Ek3171 between perhaps A.D. 500 and A.D. 1300 (cf. Chapter 13). Two Large Side-notched points, ambiguous time markers in the Great Basin, could have been introduced into deposits at any time over the long period from ca. 5000 B.C. to A.D. 1300. More reliably, three Elko Series points and a pair of Gatecliff Split-stem specimens imply use between ca. 1300 B.C. - A.D. 700 and 3000 B.C. - 1300 B.C., respectively. Three Humboldt Series projectiles may have been deposited during this period as well (cf. Chapter 8).

The earliest projectile point discard, occurring perhaps between ca. 8000 B.C. - 6000 B.C., is disclosed by seven Great Basin Stemmed Series points. Stemmed specimens constitute the most populous type of classifiable point pre-dating the Desert Series in the subarea. Save a single specimen recovered from Feature 2 at 26Ek3192, all occur in sites on lower Ramadan Ridge (three within Locality 23, three at 26Ek3170). As well, two specimens occur immediately outside the boundary of the Eastern Periphery; one was found in isolation on the western flank of Ramadan ridge, and one was recovered at Locality 27 at the toe of the ridge (Leach and Botkin 1991). The distribution of stemmed points in the Eastern Periphery suggests that earliest uses of the area focused chiefly on riparian portions of the landscape (cf. Chapter 20). That toolstone may also have been of interest in early times is equivocal given the information at hand. Direct chronometric evidence and the bulk of the temporally diagnostic artifacts suggest that aboriginal focus on opalite acquisition, or at least the excavation of quarry pits, occurred considerably later.

Chapter 18

ARCHAEOLOGY OF THE NORTHERN CORRIDOR

Dave N. Schmitt and Daniel P. Dugas

The Northern Corridor occupies 6.5 km along Ivanhoe Creek, where elevations range from 5,215 ft. (1,590 m) to 5,560 ft. (1,695 m). From Willow Creek on the north, the corridor traverses a series of low stream terraces before entering Perron Canyon (Figure 187). The canyon, characterized by steep slopes containing occasional outcrops of rhyolite and welded tuff, likely served as a natural low elevation thoroughfare for access to and from the heart of the Tosawihi Quarries. Big Butte, the preeminent Tosawihi landmark, visible from some perspectives for more than 60 km, looms approximately 5 km southeast of the head of the canyon.

As the corridor continues south from the head of Perron Canyon, it enters the gently rolling terrain of Ivanhoe Creek Valley, an area is characterized by small knolls, grassy meadows, and the alluvial slopes and stream terraces flanking Ivanhoe Creek. At the south end of the corridor, where the headwaters of Ivanhoe Creek rise from numerous springs and ephemeral drainages, the topography is dominated by inset fans and craggy finger ridges along the lower slopes of Big Butte.

Local vegetation is comprised largely of big sage and low sage communities, with a sparse to dense bluebunch wheatgrass and cheatgrass understory. Big sage is most common in deeper soils, especially in alluvial sediments along stream channels, while low sage dominates shallow colluvial deposits. Both communities include rabbitbrush, Great Basin wildrye, fescue, squirreltail, and lupine. Observed fauna include marmot, ground squirrel, white-tailed and black-tailed jackrabbit, red-tailed hawk, common raven, black-billed magpie (*Pica pica*), and numerous domestic cows and sheep; faunal indicators (e.g., tracks, scatological droppings) reflect visits by coyote and deer. Aside from the road paralleling Ivanhoe Creek, historic disturbances to Northern Corridor sites have been minimal; a few bulldozer cuts and cattle trampling in Ivanhoe Creek Valley, and a recent a sheepherder camp in Perron Canyon were observed.

Centered on Ivanhoe Creek Road, a 30 m wide swath was surveyed and 14 archaeological sites identified (cf. Figure 187; Drews 1988; Schmitt 1989b). Of these sites, eight contained lithic reduction features, multifunctional toolkits, and/or light-to-moderate density lithic scatters demanding further investigation via systematic surface collection and subsurface excavation; discussions presented here focus only on these sites.

Descriptive Site Summary

Occupying a terrace above the north bank of Willow Creek (at 5,215 ft. [1,591 amsl]), 26Ek3251 represents the northernmost site in the corridor (cf. Figure 187). Initially recorded as "diffuse lithic scatter" (Drews 1988:8) with secondary and tertiary reduction debris, further scrutiny of the surface revealed ground stone, preforms, bifaces, and flake tools within and adjacent six discrete feature concentrations. Approximately 450 m south of 26Ek3251, 26Ek3234, a diffuse, undifferentiated lithic scatter, is located on a terrace riser overlooking Willow Creek and Ivanhoe Creek (cf. Figure 187). At the northern mouth of Perron Canyon, 26Ek3231 and 26Ek3232 are represented largely by diffuse lithic scatters, each containing a single lithic reduction feature (Table 186).

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Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

Table 186. Descriptive Summary, Northern Corridor Sites.

Site No.	Type of Investigation	No. Quarry Loci	No. Non-Quarry Features	Elevation (ft.)	Site Area (sq. m)
26Ek3228	T	-	2	5,460	4,750
16Ek3229	S	-	-	5,450	100
26Ek3230	S	-	-	5,320	100
26Ek3231	T	-	1	5,320	2,100
26Ek3232	T	-	1	5,330	1,590
26Ek3233*	S	-	-	5,360	N/A
26Ek3234	T	-	-	5,262	4,200
26Ek3235*	S	-	-	5,350	N/A
26Ek3236*	S	-	-	5,390	N/A
26Ek3237	D	-	5	5,560	42,000
26Ek3238	T	-	2	5,520	22,500
26Ek3239	T	1	1	5,560	12,800
26Ek3240	S	-	-	5,480	15,000
26Ek3251	D	-	6	5,215	15,000

* isolate

Type of Investigation
S = Survey
T = Test
D = Data Recovery

The remaining four sites occupy stream terraces, ballenas, or ancient inset fans along Ivanhoe Creek in Ivanhoe Creek Valley; 26Ek3228, a small reduction complex, lies in the northern portion of the valley, and three large sites (26Ek3237, 26Ek3238, and 26Ek3239) cluster on the valley bottom near its southern reach (cf. Figure 187). Each contains at least one concentration of debitage and fragmentary bifaces surrounded by a light-to-moderate scatter of lithic debris.

Testing and Data Recovery Results

Excavations in the Northern Corridor were designed to characterize surface assemblages and to explore the extent of subsurface deposits (Table 187). When present, data were collected from feature concentrations, but, unlike surface expressions in the Eastern and Western Peripheries, discrete features are rare in the Northern Corridor; consequently, excavation often was directed toward the retrieval of tools and debitage from large, undifferentiated scatters.

Table 187. Summary of Collection Procedures, Northern Access Corridor.

	FEATURES RECORDED		FEATURE CONTEXT		NONFEATURE CONTEXT	
Site Number	Total (n)	Sampled (n)	Surface Scrape (m^2)	Subsurface Excavation (m^3)	Surface Scrape (m^2)	Subsurface Excavation (m^3)
26Ek3228	2	2	8.00	0.09	-	-
26Ek3231	1	1	4.00	-	-	-
26Ek3232	1	1	4.00	-	-	-
26Ek3234	0	0	-	-	2.00	-
26Ek3237	5	4	25.00	6.33	9.00	11.05
26Ek3238	2	1	8.00	-	2.00	0.65
26Ek3239	1	1	4.00	0.15	-	-
26Ek3251	6	3	34.00	8.22	-	2.30

Archaeological data recovered from sites in the corridor are described, with discussion of the methods and rationale motivating field investigations and, where appropriate, inferences on chronology and site function.

The six sites subject only to test excavations are presented first, followed by detailed discussions of the two larger, more complex sites revisited for extensive data recovery.

26Ek3228

Toward the northern reach of Ivanhoe Creek Valley, 26Ek3228 is situated on the western terrace of Ivanhoe Creek at an elevation of 5,460 ft. (1664 m; cf. Figure 187). Field reconnaissance in the southern portion of the site disclosed two discrete lithic concentrations (Locus A; Features 1 and 2) situated approximately 5 meters apart. The northern portion of the site is defined roughly by Locus B, a sparse lithic scatter encompassing approximately 700 m^2; although no systematic excavations were undertaken in Locus B, two small biface fragments were collected from the surface.

Features 1 and 2 were sampled by scraping a block of 4 contiguous 1 m x 1 m units in the center of each concentration (cf. Table 187). Feature 1 yielded 132 pieces of off-white opalite debitage and a metate exhibiting faint use wear (Table 188). To explore the subsurface contents of the feature, a 1 m x 50 cm unit (within a surface scrape unit) was excavated to a depth of 20 cm; the test found the feature to consist largely of a surface manifestation, as only 5 flakes were recovered from the uppermost 10 cm of excavated deposits. Overall, most of the flakes are small (mean weight/item = 0.36 gm; including a number of biface thinning flakes) suggesting that the feature served as a late stage biface reduction locus (cf. Schmitt 1989b). Similarly, the paucity of flakes in so small an area (diameter ca. 2.2 m) suggests a brief, single reduction episode.

Table 188. Artifacts Recovered from Sites in the Northern Corridor.

	DEBITAGE		FORMED ARTIFACTS										
Site Number	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
26Ek3228	497	356.5	-	-	8	-	-	-	-	1	-	-	9
26Ek3231	254	176.6	1	1	3	-	-	-	-	-	-	-	5
26Ek3232	78	180.4	-	-	6	1	-	-	-	-	-	-	7
26Ek3234	11	3.6	-	-	2	-	-	-	-	-	-	-	2
26Ek3237	12,509	13,510.1	45	17	215	4	28	3	7	8	-	1	328
26Ek3238	3,387	2,554.2	5	-	34	1	1	-	1	1	-	-	43
26Ek3239	1,822	1,491.1	2	3	31	-	4	-	5	-	2	-	47
26Ek3251	23,270	10,606.6	45	63	169	-	38	-	3	18	2	1	339
Totals	41,828	28,879.1	98	84	468	6	71	3	16	28	4	2	780

Surface scraping in Feature 2 returned 360 pieces of opalite debitage and four fragmentary bifaces representing various reduction stages. These artifacts, together with large secondary interior flakes and small biface thinning flakes, suggest that a more diverse array of bifacial reduction/ thinning occurred at Feature 2 than at Feature 1. Like Feature 1, however, Feature 2 is a small, ovate configuration (approximately 2 m in diameter), probably representing a single, intensive reduction event.

26Ek3231 and 26Ek3232

26Ek3231 and 26Ek3232 occupy a gravelly stream terrace bordering the eastern bank of Ivanhoe Creek in Perron Canyon (elevation 5,325 ft. [1623 m]; cf. Figure 187). Each contains a single lithic reduction feature characterized by a small (ca. 2 m x 2 m), light density scatter of opalite flakes and fragmentary bifaces. To explore their contents, each feature was sampled by shovel scraping a contiguous block of four 1 m x 1 m units. Collections at 26Ek3231 yielded 254 small pieces of opalite debitage, an obsidian preform, and two biface fragments (each manufactured on high quality opalite) indicative of latter stage reduction. Conversely, early stage reduction occurred at 26Ek3232, evidenced by numerous large, secondary interior flakes (n=78; mean weight/item = 2.3 gm) and two early Stage 3 bifaces. Additional non-feature collections at these sites include biface fragments and a core (cf. Table 188), and a Rosegate Series projectile point approximately 10 m north of Feature 1 at 26Ek3231, signalling Late Archaic use of Perron Canyon.

26Ek3234

26Ek3234 consists of a sparse lithic scatter situated near the toeslope of an inset fan at an elevation of 5,262 ft. (1604 m); the site spans some 4000 m^2, overlooking Willow Creek to the north and Ivanhoe Creek to the west (cf. Figure 187). Due to the lack of discrete features and overall paucity of lithic debris, the site was investigated only via surface collections and the scraping of eight 50 cm x 50 cm units at 5 m intervals along a north-south transect (Schmitt 1989b). Although these latter investigations retrieved only 11 flakes, surface collections recovered a heat-treated, Stage 3 opalite biface fragment and an obsidian biface.

26Ek3238

Located on the west terrace of Ivanhoe Creek, 26Ek3238 is a large light-to-moderate density lithic scatter containing a cairn (Feature 2) and a dense concentration of debitage (Feature 1); both features lie in the northern portion of the site, just south of the terrace on an elevated northern toe of an inset fan. While no features were identified in the southern site area, surface reconnaissance discovered 10 biface fragments, a projectile point tip, and a mano.

At Feature 1 we skimmed two disjunct blocks of 2 m x 2 m units, retrieving 2,961 pieces of debitage and eight opalite bifaces. The wealth of debitage and debitage types (both in reduction stage and material [including basalt and jasper]), and the presence of early and late stage bifaces suggest that the feature reflects multiple reduction episodes.

Approximately 20 m west of Feature 1, Feature 2 consists of a partially collapsed rock pile covering a 1.8 m x 2.2 m area. The subangular rhyolitic cobbles (average diameter ca. 35 cm) used in its construction are locally available; their number suggests that the feature may have been five courses high. Absent associated prehistoric or historic artifacts, its age remains unknown; it may be a claim marker associated with historic mining in the Tosawihi Quarries vicinity (cf. Zeier 1987), or it may represent a prehistoric hunting feature or locational marker (cf. Pendleton and Thomas 1983).

In order to sample non-feature contexts on the terrace, eight 50 cm x 50 cm were skimmed along a baseline parallel to Ivanhoe Creek, and three 1 m x 1 m units were excavated to explore subsurface deposits; these investigations disclosed lithic tools and debitage, but found them to be relatively scarce and largely restricted to the uppermost 15 cm of the

deposits (Schmitt 1989b:131,135). Additional, non-systematic surface collections on the terrace identified a cobble tool, a core, and a host of biface fragments (cf. Table 188).

Surface collections from 26Ek3238 returned four projectile points, including a Large Side-notched and a Gatecliff Split stem, denoting an occupation sometime around 1500 B.C. Two specimens of square, edge-ground basal fragments of Great Basin Stemmed points date between 8000 and 6000 B.C.

26Ek3239

26Ek3239 occupies the top and gradual slope of a low north-trending ballena just south of Ivanhoe Creek (elevation 5,560 ft. [1695 m]; cf. Figure 187). Its western and northern boundaries are marked by an ephemeral drainage flowing into Ivanhoe Creek. On the northern toeslope of the ballena and extending down into the drainage, a cobble field (ca. 1600 m^2 in extent, designated Locus A) contains numerous reddish-brown, subangular, jasper-like nodules; the diffuseness of culturally modified lithics led us to characterize the area as a "locus" rather than a feature. Although the material is of poor quality (e.g., most cobbles contain weathering cracks and/or quartzite inclusions), a few assayed pieces, flakes, and angular pieces of shatter were observed; two hammerstones also were observed, and were mapped and collected.

We found a single lithic concentration (Feature 1) on a small flat near the crest of the ridge. The feature is a 6 m x 4.5 m, light-to-moderate density scatter of opalite debitage containing late stage bifaces (most of which display evidence of heat-treatment), preforms, and a flake tool (cf. Table 188). A four m^2 surface scrape in Feature 1 yielded 1,360 flakes and 14 additional formed artifacts, including a highly modified side-scraper.

Feature 1 was explored further by an excavation unit within the scraped area. Although the deposits are shallow, 462 flakes, three bifaces, and two pot sherds were collected. In sum, the recovered toolkit and associated fire-cracked rock suggest that the feature served as a short term camp where subsistence activities were pursued in conjunction with lithic fabrication and maintenance.

Time markers at 26Ek3239 include an Elko Corner-notched point and a Rosegate Series point; both were discovered on the surface in non-feature contexts, but their presence indicates visits between 1300 B.C. and A.D. 1300. Further, although not identified to specific type, pot sherds recovered from Feature 1 signal occupation sometime between A.D. 500 and historic contact (cf. Chapter 13).

26Ek3237

26Ek3237 is the largest site in the Northern Corridor, subsuming three discrete activity loci on the fan remnants, low ridgelines, or stream terraces bordering Ivanhoe Creek in the southern portion of Ivanhoe Creek Valley (cf. Figure 187). In the eastern portion of the site, Locus A rests on a low terrace of Ivanhoe Creek (Figure 188). Characterized by a sparse-to-light scatter of tools and debitage, the locus is bounded on the east and north by an ephemeral drainage flowing into Ivanhoe Creek, and on the west by the gentle slope of an unnamed ridgeline. Approximately 100 m west of Locus A, Locus B occupies the gradually sloping toe of an unnamed ridge (Figure 188); the area is characterized by a 720 m^2, light-to-moderate scatter containing numerous late stage bifaces. Finally, Locus C is situated on remnants of an inset fan and stream terrace in the westernmost portion of the site, bounded on the north by Ivanhoe Creek and on the east by a deep ephemeral drainage channel. Surface manifestations in Locus C include debitage and tools, including projectile points, bifaces, and simple flake tools.

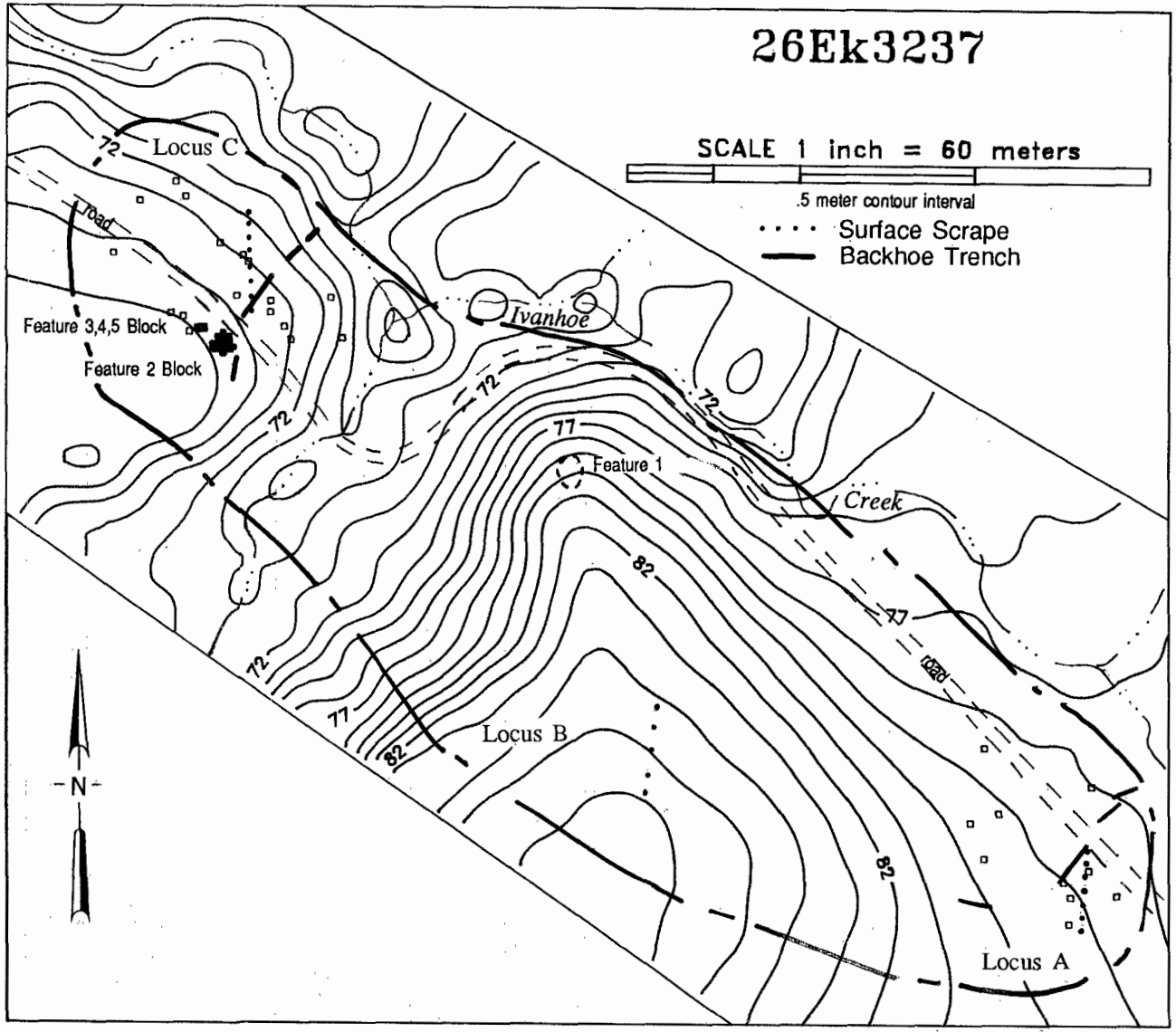


Figure 188. 26Ek3237 site map.

Geomorphic Analyses

In order to examine internal stratigraphy and investigate areas outside our excavations for buried cultural features, backhoe trenches were placed on the flanks of two low ridges adjacent ephemeral tributaries of Ivanhoe Creek (cf. Figure 188). Although no subsurface features were encountered, stratigraphic analyses of trench profiles revealed some intimate aspects of local geomorphic processes. Because soil profiles were found to be quite similar, two profiles (Trench 7, Locus A [cf. Figure 193] and Trench 1, Locus C [cf. Figure 195]) were selected for detailed description, as they serve to exemplify the stratigraphic history of the site.

Beginning with the poorly sorted sand and gravel of Unit 6 (Trench 1; Figure 189), underlain by silty clay loams in Units 5 and 4 interfingered with the sand and gravel Units 7, 8, and 9, it is apparent that this profile shows a series of interbedded coarse alluvial channel deposits with fine grained deposits of either alluvial, colluvial, or eolian origin. The minor sand and pebble component in the silty Units 2 and 3 may also be partly of alluvial origin.

Evidence for soil development in these sediments provides the best means of determining if stable surfaces previously existed here. The moderately well developed blocky soil structure and color of Units 2, 3, and 4, their relatively high degree of leaching in the iron and aluminum versus silica weathering ratios, and the increasing base content of this series (Figure 190) all suggest that soil development has occurred. The higher concentration of phosphorus in Unit 3 may indicate enrichment at the old surface level. The underlying Units 5 through 9 experienced this pedogenesis to a lesser degree, as indicated by the clay and weak soil structure in Unit 5 and the strongly weathered appearance of other gravel units. Although Unit 2 and those below appear to form a complete soil profile, it is possible that an erosional surface break may have occurred at the irregular upper boundary of Unit 4. Chronologically, Units 4 through 9 are probably pre-middle Holocene in age; the erosional surface on Unit 4 is possibly a product of middle Holocene erosion.

In a nearby cutbank of modern Ivanhoe Creek, an erosional surface directly underlying units of Mazama ash (6,800 years B.P.) may be equivalent to the Unit 4 erosional surface. Although no evidence of Mazama ash was found in Units 2 or 3, some may be mixed in with these probably middle Holocene silts. The loose, bioturbated, silty Unit 1, which overlies the soil surface on Unit 2, has only weak soil development like much of the general eolian mantle of the Tosawihi area. A series of brief stable surface episodes, no longer stratigraphically visible, may have occurred during deposition of this unit, probably in the mid-to-late Holocene.

At Locus C, Trench 1 (cf. figures 17-2 and 17-9) exhibits the most complete and detailed summary of the geomorphic history of the site; similar profiles also occur in Trenches 2, 3, and 4. Units 4 and 5 (Figure 191) are a set of olive and reddish brown, very clayey, deposits probably resulting from the in-place weathering of volcanic debris; they may be as old as middle Tertiary age. On an irregular surface overlying these clays, moderately well-sorted sands and pebbles of Unit 3 were deposited. These are similar to the sand and gravel units in Trench 7 (cf. Figure 189), and may be contemporaneous with them. The phosphorus concentrations here may have resulted from enrichment at the former surface or through later redeposition along with iron (Figure 192). On the eroded surface of Unit 3, the silt-dominated Units 2 and 1 were deposited. In texture, color, and chemistry, Units 1, 2, and 3 of Trench 1 are very similar to the same Units in Trench 7. Units 1 and 2 probably are late Holocene in age, given their associated radiocarbon dates.

Overall, evidence from trenches at Loci A and C indicate a similar history. Both of the interfluves on which they are situated are probably composed of a core of weathered Tertiary volcanic debris, as in Units 4 and 5 in Trench 1. Both, then, experienced alluvial deposition of sand and gravel, probably between the Pleistocene and middle Holocene. The overlying silts date to late to middle Holocene and younger, as suggested by the types and locations of time markers recovered from excavations.

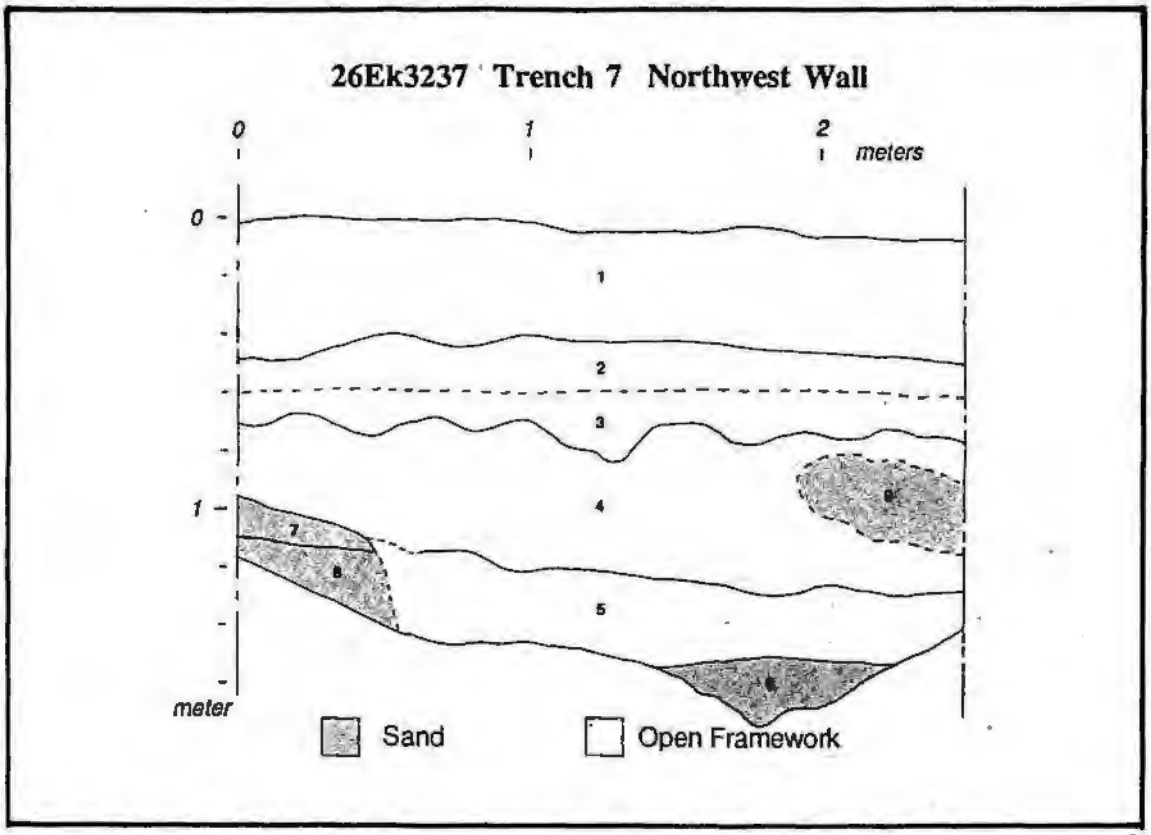
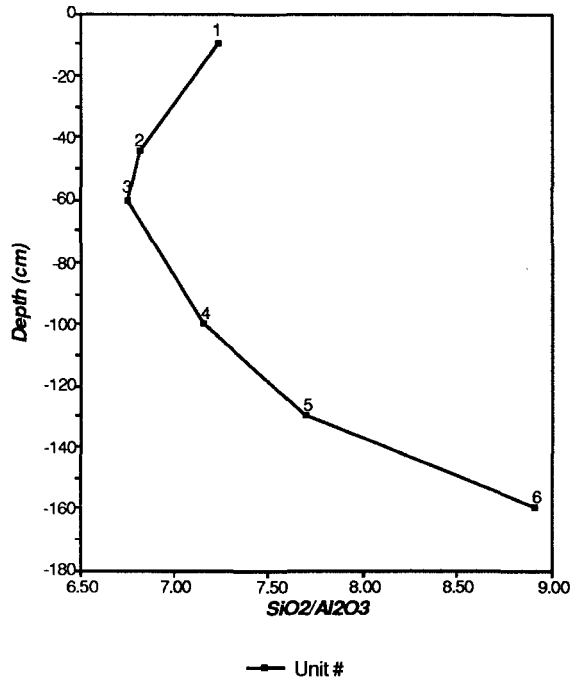
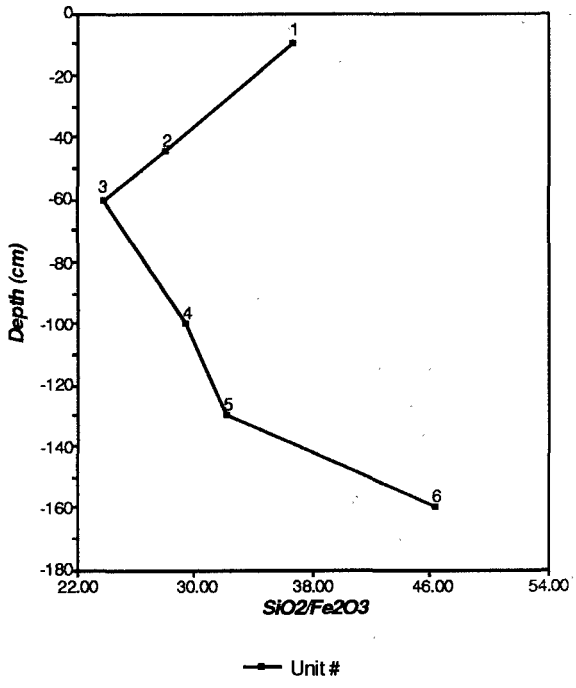


Figure 189. Stratigraphic profile of Trench 7, Northwest Wall, 26Ek3237.

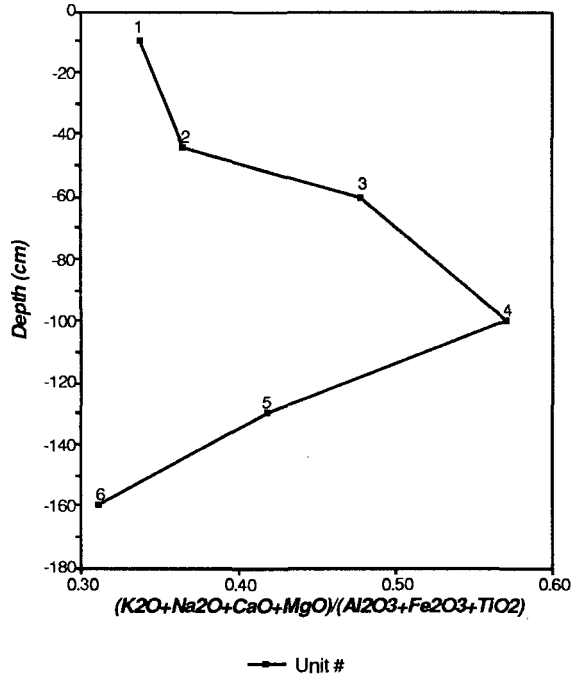
Stratum	Description
1	Dark brown (10YR 4/3) slightly moist; silt loam; loose to very weak fine platy; rare to common fine subangular to subrounded gravels; abundant fine to medium roots, rare fine pores; boundary clear and smooth to wavy.
2	Very dark brown (10YR 2/2) moist; silty clay; moderate medium angular to subangular blocky; common subangular to subrounded medium pebbles; abundant fine roots; distinct clay skins on ped surfaces; boundary gradual to clear and smooth.
3	Dark yellowish brown (10YR 4/4) moist; silty clay loam; weak to moderate, fine to medium subangular blocky; common subangular to subrounded fine sand to fine gravel; common fine roots and very fine pores; distinct clay skins on ped surfaces; boundary clear and irregular.
4	Brown (10YR 5/3) slightly moist; silty clay loam; moderate medium subangular blocky to slightly prismatic; rare to common fine subrounded pebbles; rare to common fine roots; distinct clay skins on ped surfaces; moderate to strong acid reaction on carbonate filaments grading downward to well cemented, fairly massive carbonate accumulation; boundary clear and smooth to wavy.
5	Brown (10YR 5/3) dry; silty clay loam; weak to moderate fine angular blocky; rare to slightly common subangular to subrounded pebbles; very weak acid reaction on carbonate filaments; boundary clear.
6	Poorly sorted angular to rounded, fine sand to medium gravels, some showing strong weathering boundary unexposed.
7	See description of Unit 6.
8	Moderately well sorted fine to medium subangular to subrounded sand.
9	See description of Unit 6.



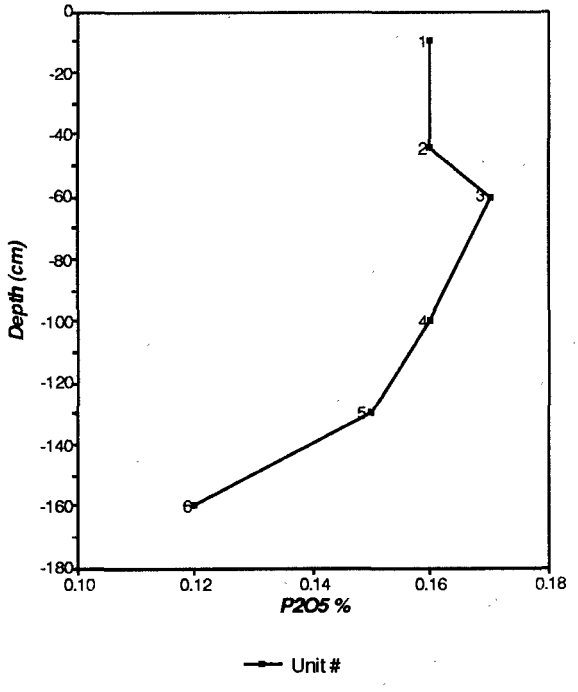
a.



b.



c.



d.

Figure 190. Molecular weathering ratios for 26Ek3237, Trench 7 profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, and (d) weight percent phosphorus.

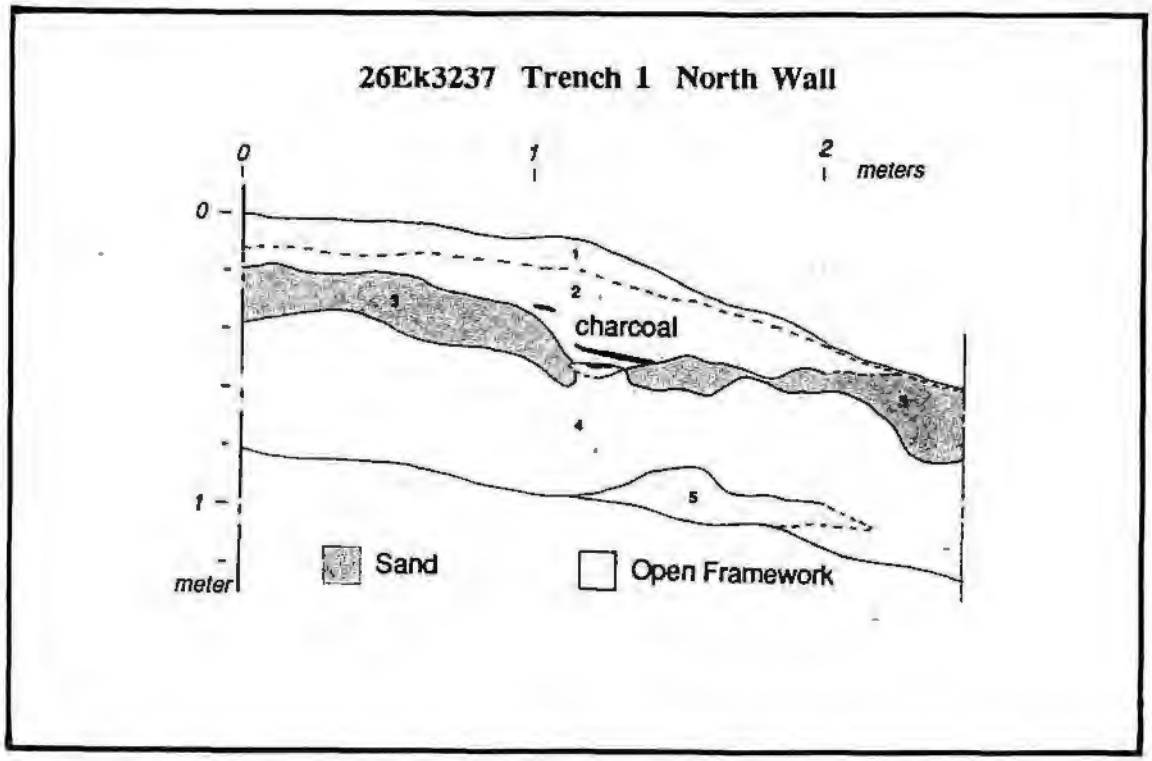
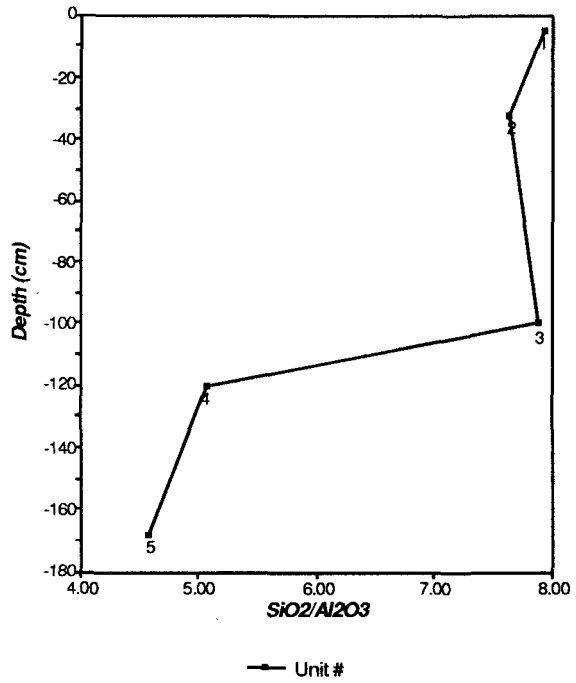
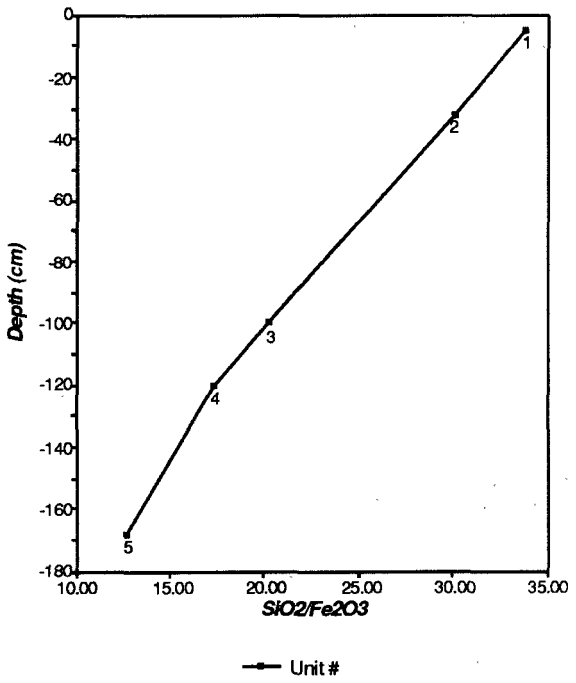


Figure 191. Stratigraphic profile of Trench 1, North wall, 26Ek3237.

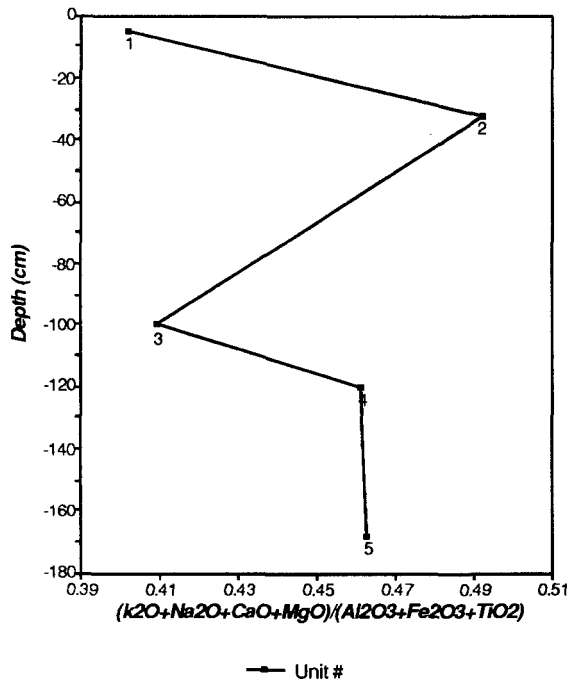
Stratum	Description
1	Dark yellowish brown (10YR 3/3) slightly moist; silty clay loam; weak medium platy to weak medium to coarse granular; rare to common fine subrounded pebbles; abundant fine to medium roots; common fine pores; boundary clear and slightly wavy.
2	Olive brown (2.5YR 4/4) slightly moist; clay loam; weak medium to coarse granular to subangular blocky; common fine roots and pores; thin clay skins on pore surfaces and some ped faces; Moderate acid reaction on abundant fine carbonate veins in lower half of unit; boundary clear and wavy.
3	Moderately well sorted, angular to subrounded, medium to coarse sands with minor clay matrix, yellowish brown (10YR 4/6) slightly moist; rare medium to coarse gravels; moderate acid reaction on fine to medium caliche veins and soft fine slightly nodular patches; boundary clear and wavy.
4	Olive brown (5YR 5/4) slightly moist; volcanic tuff, strongly weather to massive clay; faint to distinct mottling, possibly drab haloed root traces, light olive brown (5YR 4/3) slightly moist; and dark reddish brown ((5YR 3/2) slightly moist; strong acid reaction on fine to medium carbonate filaments and fine to medium nodules; boundary clear and wavy to irregular.
5	Dark reddish brown (10YR 3/30 slightly moist; volcanic tuff, strongly weathered to massive clay; faint to distinct mottling, possibly drab haloed root traces, pale olive to olive (5YR 6/3 to 5/4) slightly moist; and more patchy mottling, brownish yellow (10YR 6/8) slightly moist; carbonates as in unit 5; this unit appears to be a lens within Unit 4; boundary unexposed.
6	Poorly sorted mixture of Units 2 and 3; possibly part of a krotovina.



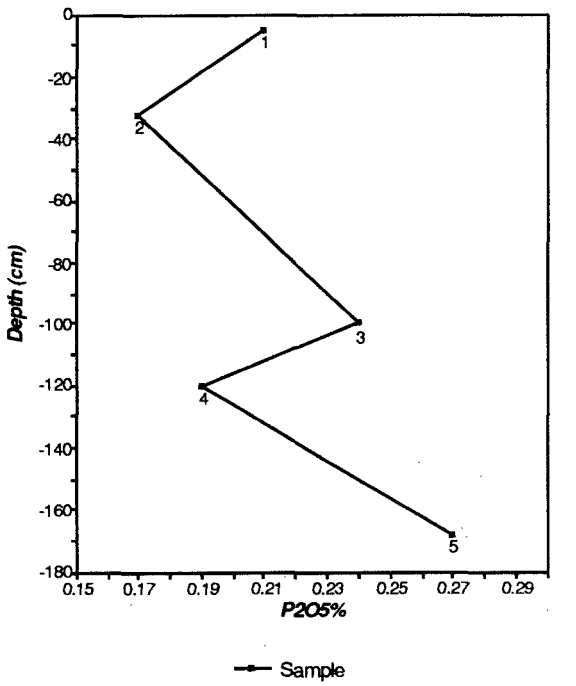
a.



b.



c.



d.

Figure 192. Molecular weathering ratios for 26Ek3237, Trench 1 profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, and (d) weight percent phosphorus.

Nonfeature Contexts

Surface collections from inter-locus, nonfeature contexts of 26Ek3237 recovered 51 formed artifacts; most were recovered north of Locus B on the toeslope of a low ridge and from areas immediately adjacent Locus C. They include 37 bifaces (most are Stage 3 fragments; cf. Chapter 6), four flake tools, two cores, two preforms, two metate fragments, a chopper, and three projectile points including a Large side-notched, an obsidian Great Basin Stemmed basal fragment, and a tip.

Locus A

Initial investigations at Locus A involved surface reconnaissance in close interval transects. Although no discrete concentrations were observed, we identified a multifunctional toolkit intermixed with hundreds of waste flakes. Recovered artifact classes include a preform, a Gatecliff Split Stem projectile point, a hammerstone, a scraper, and numerous opalite bifaces (cf. Table 189). In order to sample surface materials further and to explore buried deposits on the terrace, eight disjunct 50 cm x 50 cm surface scrape units were placed along a linear baseline, and two 1 m x 1 m units were excavated. Cultural deposits are shallow, but lithics are much more abundant than expressed by surface densities. Although no additional formed artifacts were recovered, the relative wealth of debitage and the diverse toolkit collected from the surface prompted our revisit for additional collections and excavations (Intermountain Research 1988d).

Table 189. Artifacts Recovered from Locus A Nonfeature Contexts, 26Ek3237.

		DEBITAGE		FORMED ARTIFACTS							
Unit No. (Type)	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Total
1-8 (SF)[a]	0.04	119	90.7	-	-	-	-	-	-	-	0
1 (TS)2[b]	0.25	241	133.9	-	-	-	-	-	-	-	0
4 (TS)	0.30	145	125.4	-	-	-	-	-	-	-	0
46 (EU)	0.30	66	117.3	-	-	1	-	-	-	-	1
47 (EU)	0.50	196	241.6	1	-	-	1	-	-	-	2
48 (EU)	0.30	41	46.7	-	-	-	-	-	-	-	0
49 (EU)	0.40	48	53.7	-	-	-	-	-	-	-	0
50 (EU)[b]	0.20	11	22.4	-	-	-	-	-	-	-	0
51 (EU)	0.40	194	196.9	1	-	1	-	-	-	1	3
52 (EU)	0.40	163	141.6	-	-	2	-	-	-	-	2
53 (EU)	0.10	17	45.9	-	-	1	-	-	-	-	1
54 (EU)	0.40	192	220.4	-	-	-	-	-	-	-	0
55 (EU)	0.40	102	112.5	-	-	-	-	-	-	-	0
Surface	N/A	-	-	1	1	13	2	1	1	2	21
Totals	3.99	1,535	1,549.0	3	1	18*	3	1	1	3	30

(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a] Eight 50 x 50 cm units combined
[b] Includes a 25 cm x 25 cm 1/8 inch mesh control quadrant
* Includes 2 "possible" bifaces

Supplementary data recovery at Locus A involved recordation and collection of surface artifacts and excavation of 10 randomly placed 1 m x 1 m units (Figure 193); surface survey identified additional bifaces and a retouched flake, as well as two metate fragments (cf. Table 189) adjacent a small ephemeral drainage near the northern boundary.

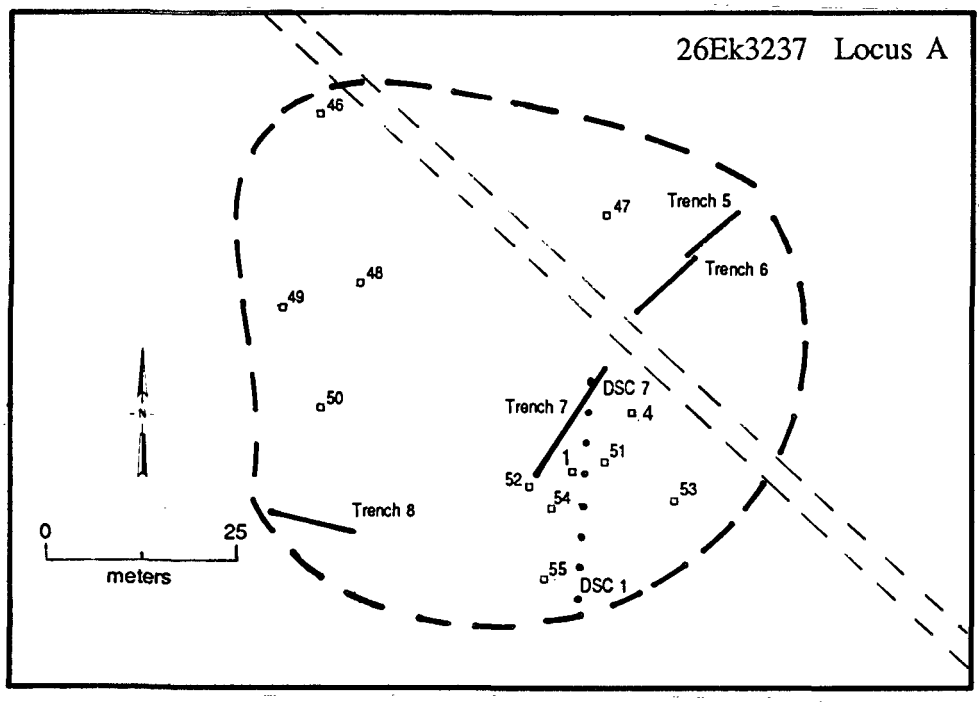


Figure 193. Location of surface and subsurface units, and backhoe trenches in Locus A, 26Ek3237.

Subsurface excavation of 10 1 m x 1 m units retrieved 1030 pieces of opalite debitage and 9 formed artifacts (Units 46-55; cf. Table 189). Debitage types are dominated by large secondary interior and biface thinning flakes (mean weight/item = 1.2 gm), suggesting early stage biface reduction was paramount; a few episodes of later stage reduction also occurred, revealed by a few small, heat-treated biface thinning flakes. Artifact densities are highest in the southern portion of the locus, especially in neighboring Units 51, 52, and 54, where a host of flakes, three bifaces, a metate fragment, and an Elko-eared projectile point were recovered (cf. Figure 193; Table 189). In the northern portion, Unit 47 also yielded high artifact returns, including a retouched flake tool and a large Gatecliff Split Stem point.

Overall, debitage types and the wealth of bifaces suggest that Locus A served primarily as a diurnal task area where early stage opalite bifaces were reduced, probably to facilitate transport to areas northwest of the quarries. The presence of flake tools and ground stone, however, reflects other uses of the area, probably as a short-term campsite where subsistence activities were undertaken in conjunction with lithic maintenance; regardless of task duration, the recovery of two Gatecliff Series points and an Elko Series point suggests these episodes occurred between 3000 B.C. and A.D. 700.

Locus B

Data recovery at Locus B involved surface collection of formed artifacts and limited surface scrapes, due, in part, to light debitage densities and shallow (colluvial) deposits (Schmitt 1989b). A total of 64 formed artifacts was recovered from the surface, including two preforms, four flake tools, two projectile points (a Rosegate Series specimen and a nondiagnostic tip), and 56 bifaces (88% of the assemblage).

Systematic surface collections involved scraping five 1 m x 1 m units at 5 m intervals along a linear transect. Four hundred sixty-one pieces of debitage were recovered, most (n=353;

77%) retrieved from the two northernmost units; Unit 4 (cf. Figure 188) yielded 243 flakes and a Rosegate Series point. The abundance of small, often heat-treated flakes (mean weight/item = 0.8 gm) associated with numerous late stage bifaces suggests the area served largely as a late stage biface reduction/manufacture locus. Two Rosegate Series points indicate visits during the Late Archaic (ca. A.D. 700 - A.D. 1300).

Locus C

Encompassing approximately 4,000 m^2, Locus C is situated atop a scoured inset alluvial fan in the easternmost portion of 26Ek3237 (elevation 5,560 ft. [1695 m]); the locus commands a vast view of Ivanhoe Creek Valley (cf. Figure 194). Although partially truncated by the Ivanhoe Creek Road (Figure 194; also cf. Figure 188), most of the locus remains undisturbed; initial surface scrutiny disclosed the presence of a light-to-moderate density debitage scatter (containing opalite, obsidian, and basalt) and several artifact classes.

Testing included scraping eight 50 cm x 50 cm units and excavating two 1 m x 1 m units placed intuitively in areas of high surface density. A total of 723 artifacts was recovered, including 718 flakes and five tools (Table 190). Surface collections retrieved 23 additional formed artifacts, including bifaces, flake tools, a core, a hammerstone, an Elko Series point, and a Humboldt point (cf. Table 190; Schmitt 1989h). Finally, a test unit was excavated adjacent the road near the southern edge of the locus to explore subsurface deposits in an area exhibiting sparse surface materials. Cultural materials are relatively few, but the unit bisected a discrete, basin shaped hearth (Feature 2) containing numerous fire-cracked rocks; contents of the feature and its vicinity as well as results of radiocarbon assay are discussed below.



Figure 194. Overview of Locus C, 26Ek3237, looking northwest down Ivanhoe Creek Valley.

Table 190. Artifacts Recovered from Locus C Nonfeature Contexts, 26Ek3237.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Cores	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
1-8 (SF)[a]	0.04	119	85.3	-	-	-	-	1	-	-	1
2 (TS)	0.20	168	121.5	-	-	1	-	-	-	-	1
3 (TS)[b]	0.25	431	275.0	1	-	2	-	-	-	-	3
31 (EU)	0.30	36	43.6	-	-	1	-	1	-	-	2
32 (EU)	0.30	44	60.3	-	-	-	-	-	-	-	0
33 (EU)	0.20	13	28.6	-	-	-	-	-	-	-	0
34 (EU)	0.60	297	358.2	1	-	1	-	-	-	-	2
35 (EU)	0.50	303	466.4	1	1	-	-	-	-	-	2
36 (EU)[b]	0.30	210	125.0	-	-	1	-	-	-	-	1
37 (EU)	0.20	57	57.3	-	-	-	-	-	-	-	0
38 (EU)	0.40	204	154.5	1	-	5	-	1	-	-	7
39 (EU)	0.30	29	46.3	-	-	-	-	-	-	-	0
40 (EU)	0.20	34	21.3	-	-	-	-	-	-	-	0
41 (EU)	0.30	100	66.4	-	-	-	-	-	-	1	1
42 (EU)	0.20	59	34.6	-	-	1	-	-	-	-	1
43 (EU)	0.10	52	48.4	-	-	-	-	-	-	-	0
44 (EU)	0.20	29	39.5	-	-	-	-	-	-	-	0
45 (EU)	0.30	51	40.6	-	1	-	-	1	-	-	2
Surface	N/A	-	-	9	-	37	2	5	2	1	56
Totals	4.89	2,236	2,072.8	13	2	49	2	9	2	2	79

(SF) = Surface Scrape
(TS) = Test Excavation Unit
(EU) = Excavation Unit

[a]Eight 50 x 50 cm units combined
[b]Includes a 25 x 25 cm 1/8 inch mesh control quadrant

Diversity of artifact classes, a hearth, and toolstone variety prompted our return to Locus C in order to investigate its contents and antiquity more fully (Intermountain Research 1988d); these supplementary investigations incorporated surface collections, 15 random 1 m x 1 m excavation units, block excavation adjacent the Feature 2 hearth, and, based on the results of these investigations, the intuitive placement of additional units. As discussed below, the latter revealed the most informative (and dramatic) artifactual remains discovered in the Northern Corridor.

Although relatively few in number, 15 random 1 m x 1 m excavation units recovered a number of functional artifact classes in association with an abundance of lithic debitage (cf. Table 190). Lithic debris is concentrated largely in the upper 20-30 cm of the deposits, but some concentrations of tools and detritus occur, probably representing partially buried activity areas; artifacts are most abundant in neighboring Units 34 and 35 (including Elko Corner-notched and Gatecliff Series points), and in Unit 38 (ca. 18 m south) where five bifaces, a notched flake, and a Humboldt point were recovered (cf. Figure 195; Table 190).

Perhaps the most striking artifact recovered from the Tosawihi vicinity is a fragmentary Clovis point preform discovered near the southern boundary of Locus C. Initially skeptical of its typological classification, due to its surface provenience and because a large portion of its base was missing, we centered a 2 m x 2 m block of excavation units over the point in the hope of finding additional pieces. These collections not only recovered the basal fragment which secured the point typology (cf. Chapter 8, Figure 53), but also disclosed a dense concentration of lithic tools and debitage in an area marked by very few surface artifacts. Further, as excavations progressed, three buried features were encountered, including two hearths and a rock pile (Features 3, 4, and 5, discussed below).

That entrenchment of Ivanhoe Creek recently has exposed sediments of pre-Mazama age bears implications regarding the Clovis preform discovered on the surface. Specifically, while the

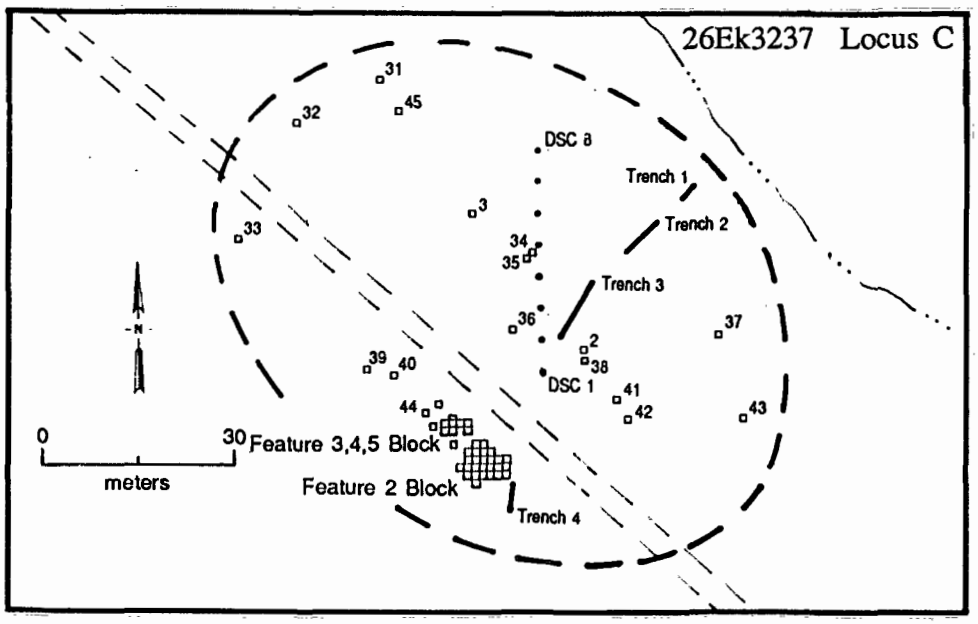


Figure 195. Location of surface and subsurface units, and backhoe trenches in Locus C, 26Ek3237.

artifact may have been collected by later peoples and transported from a distant location, it *may* have been discovered in an arroyo in the vicinity of the site; some of the stemmed points may have similar histories. If so, Late Pleistocene/Early Holocene cultural deposits may await discovery in the Tosawihi vicinity.

Feature 1

A single lithic reduction feature (Feature 1) was identified midway between Locus B and the break in slope near the base of the ridgeline (cf. Figure 188). Although no systematic collections were made, numerous large, secondary opalite flakes and angular shatter were recorded in association with three early stage biface fragments, suggesting the area served as an early stage (probably single episode) biface reduction locus.

Feature 2

A basin-shaped, rock-lined fire hearth (Feature 2) was encountered seven cm below the existing ground surface during subsurface testing in Locus C (Unit 5); associated artifacts include opalite debitage, an obsidian preform, and a ground and shaped chalcedony nodule (Table 191; cf. Schmitt 1989b:140-141). Measuring ca. 60 cm in diameter and 14 cm in depth, the hearth yielded a few flakes (some of them burned), but disclosed no direct evidence of use as a heat-treating structure; similarly, flotation analysis (cf. Chapter 15) found it devoid of subsistence residues. The hearth alone enticed our return; we were interested particularly in the deposits immediately encompassing it, since a radiocarbon date of 150 ± 60 years B.P. (Beta-28314) signaled a unique opportunity to examine regional lithic technologies associated with late prehistoric/protohistoric occupation.

Table 191. Artifacts Recovered from the Feature 2 Block, 26Ek3237.

Unit Type	No. Units	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Ground Stone	Total
TS	1[a]	0.20	106	51.0	-	1	-	-	1	2
SF	15	0.30	534	647.1	2	-	3	1	-	6
EU	10[b]	2.30	1,201	1,548.4	1	-	8	1	-	10
Surface	N/A	N/A	-	-	-	-	1	-	-	1
Totals	26	2.80	1,841	2,246.5	3	1	12	2	1	19

(TS) = Test Excavation Units
(SF) = Surface Scrapes
(EU) = Excavation Units

[a]Includes a 25 x 25 cm 1/8 inch mesh control quadrant
[b]Includes 2 units containing a 25 x 25 cm 1/8 inch mesh control quadrant

To acquire a larger data set and explore deposits surrounding the feature, a block of 25 adjoining 1 m x 1 m units (ca. 4 m N-S x 6 m E-W) was centered on the hearth; 15 units were scraped, and 10 (placed randomly throughout the block) were excavated. We recovered 1,860 artifacts, including 19 stone tools (cf. Table 191). Bifaces dominate the tool assemblage (n=12), especially Stage 3 fragments (n=10), followed by a few flake tools, projectile points, and a ground stone fragment. The debitage assemblage consists primarily of large, secondary interior flakes suggesting early stage reduction, but a diverse array of flake types and lithic materials (including small, heat-treated biface thinning flakes) indicate multiple reduction episodes.

Feature 2 probably served as a warming hearth or biface heat-treating facility; radiocarbon assay suggests use sometime during the mid-to-late Nineteenth Century. While the hearth's integrity remains largely intact, deposits in its immediate vicinity reflect repeated aboriginal site use, most occurring *prior* to hearth construction; the undulating veneer of debitage, the diversity of lithic materials and flake types, and the incidence of Elko and Large Side-notched point types suggest that most associated artifacts are products of previous occupation.

Features 3, 4, and 5

Approximately eight meters northwest of Feature 2, block excavations in Units 56-66 disclosed two hearths (Features 3 and 4) and a discrete rock pile or cairn (Feature 5) surrounded by thousands of flakes and numerous formed artifacts (Table 192). Although no discrete strata could be defined, the features are spatially distinct, allowing us to assign probable artifact-feature associations relative to arbitrary 10 cm levels (Table 192). The following discussion of feature "contents" incorporates these post hoc associations from units within and adjacent the Feature 3-5 block (Figure 196; Table 192); some analytical discussions elsewhere in this volume have presented some of these specimens as "nonfeature" artifacts (cf. Chapter 6).

Feature 3, a circular, basin-shaped fire hearth, was encountered 16 cm below surface in Units 61 and 66 (Figure 196); it measures 45 cm in diameter and 16 cm at its maximum (ca. central) depth. Interior excavations disclosed ash and dense charcoal, and approximately 25 fire-altered basalt cobbles, most lining the base. Associated artifacts include bifaces, cobble tools, flake tools, preforms (cf. Table 192), and a projectile point assemblage containing two Desert Side-notched, a Large Side-notched (found immediately adjacent the hearth), and an Elko Corner-notched. A larger projectile point aggregate was recovered *above* Feature 3 in Level 1 (cf. Table 192), where Desert Series points were most abundant (n=6).

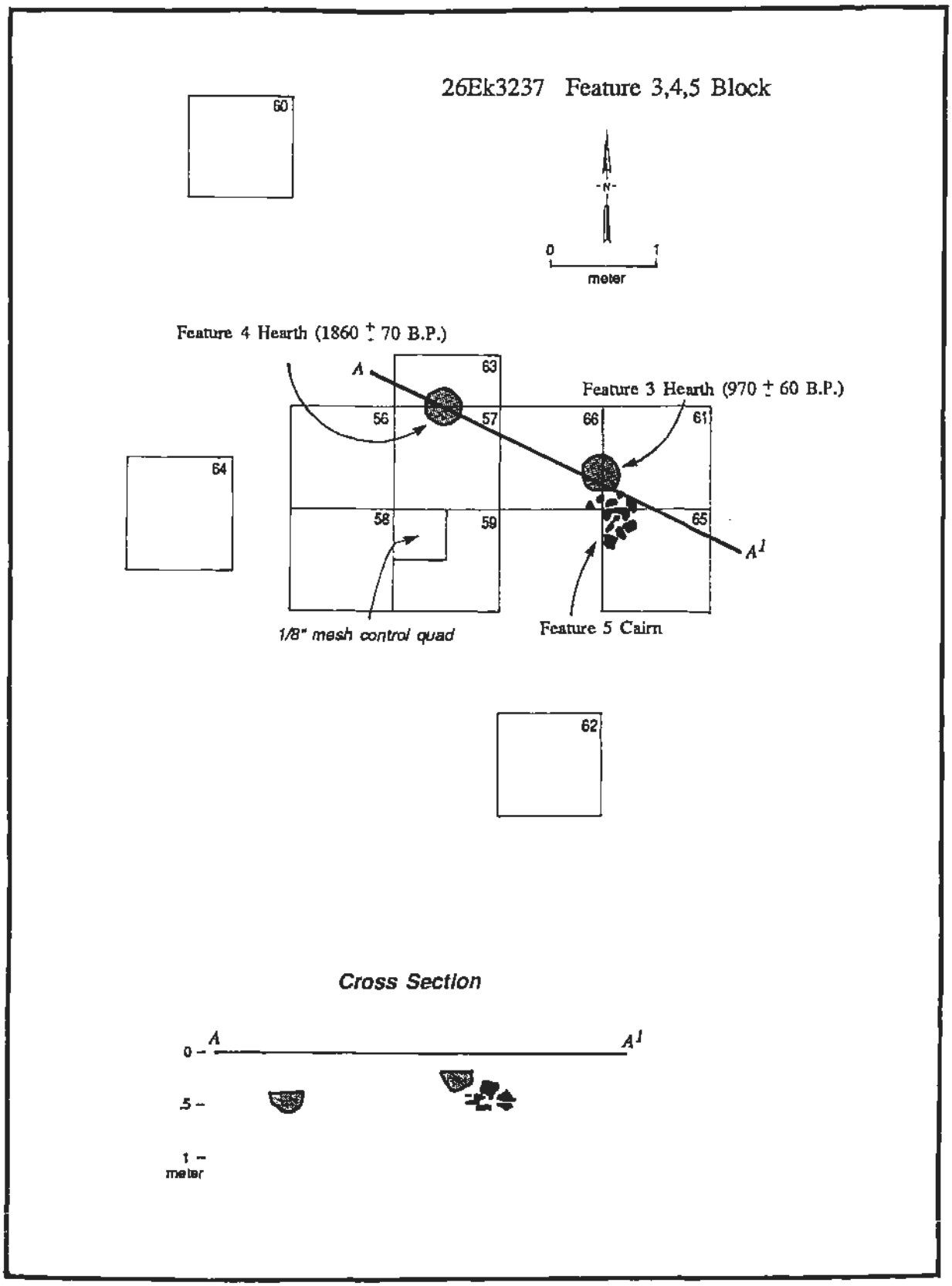


Figure 196. Feature 3, 4, and 5 block and vicinity, Locus C, 26Ek3237.

Table 192. Artifacts Recovered from the Feature 3, 4, and 5 Block and Vicinity, 26Ek3237.

Depth (cm)	Volume Excav. (m^3)	Feature(s)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Modif. Chunks	Perc./ Cobble Tools	Ground Stone	Total
0-10	1.05	-	2,829	2,580.4	9	5	13	2	-	1	1	31
10-20	1.05	3	1,140	2,040.7	4	2	9	2	1	1	-	19
20-30	1.05	3	842	934.4	1	1	7	1	-	1	-	11
30-40	1.05	4, 5	680	1,041.1	4	1	8	1	-	-	-	14
40-50	.95	4, 5	448	490.0	2	-	2	-	-	-	-	4
50-60	.45	-	352	334.7	-	-	2	-	-	-	-	2
60-70	.10	-	39	34.2	-	-	-	-	-	-	-	0
70-80	.10	-	15	9.7	-	-	-	-	-	-	-	0
Totals	5.80	-	6,345	7,465.2	20	9	41*	6	1	3	1	81

* Includes 3 "possible" bifaces

To examine the hearth's contents and assess its antiquity more fully, we extracted a soil sample for flotation and radiocarbon assay. While the former yielded no evidence of lithic heat-treatment or subsistence residues, radiocarbon analysis returned a date of 970 ± 60 years B.P. (Beta-36993), compatible with occupation of the overlying veneer during Desert times.

Approximately two meters east, a second basin-shaped, rock-lined hearth (Feature 4) was exposed between 35 and 50 cm below surface in Units 57 and 63 (Figures 196 and 197). Like Feature 3, Feature 4 is rich in ash, carbon, and oxidized soil, containing numerous fire-cracked rocks (cf. Figure 197). Radiocarbon assay and projectile point typology assign the feature a Mid-Archaic occupation; evidence includes a radiocarbon date of 1860 ± 70 years B.P. (Beta-36994) as well as two Elko Series points and a Gatecliff Split Stem. Although plant and animal macrofossils contain no unequivocal evidence of human subsistence, a few (often charred) artiodactyl bone fragments were found adjacent the hearth, *probably* representing subsistence refuse. Artifacts from these levels include 1128 flakes, 10 bifaces, and a perforator (cf. Table 192).



Figure 197. Feature 4 hearth, 26Ek3237.

An enigmatic, partially collapsed rock pile (Feature 5) was discovered in horizontal association with Feature 4 in Units 61, 65, and 66 (cf. Figure 196); it encompasses approximately 100 cobbles ranging from 10 cm to 25 cm in diameter, including a few fire-cracked specimens. Flecks of carbon occur throughout the pile, especially on the undersides of deeply buried cobbles, suggesting that the structure stood exposed for some time while precipitation leached out other carbon. The feature may consist of hearth rocks or cooking (boiling) stones deposited during use of Feature 4; too, it may have served as a "dump" for cobbles removed from task areas adjacent the hearth (e.g., sleeping areas).

The functional assessment of stacked rock features can be difficult, if not impossible. Such features are relatively common in the Great Basin, exhibiting various shapes and sizes and occurring in a variety of contexts (e.g., Budy and Elston 1986; Pendleton and Thomas 1983; Schmitt 1988c; also cf. site 26Ek3238, above). Their temporal affiliation usually must be left to speculation, but Feature 5 is an exception; its origin is associated with a dated hearth, and its apex, bracketed by another.

Excavations within the Feature 3, 4, and 5 block revealed structures and artifacts representing a palimpsest of campsite locations. Although distinct, feature-specific tool and debitage assemblages were not apparent, subjective characterization of debitage samples in the block revealed a predominance of early and late stage biface thinning flakes in the G3 size grade (cf. Chapter 10), indicating that thinning Stage 3, and possibly Stage 4 bifaces was the main lithic reduction activity performed in the vicinity, regardless of feature association. Similarly, a relatively large proportion of heat-treated bifaces and thinning flakes was recovered throughout our block excavations. Although the sporadic presence of thermally fractured opalite bifaces suggests that Features 4 and 5 may have served as heat-treatment facilities, debitage patterns (e.g., flake stages, paucity of differential luster) imply that the reduction of heat-treated bifaces occurred here after initial, post heat-treatment reduction at another location.

26Ek3251

As Willow Creek flows southeast toward its confluence with Rock Creek in the lower reaches of Squaw Valley, it passes through a wide (ca. 650 m) bottomland consisting of a complex series of stream terraces, oxbows, and ephemeral drainages. Ivanhoe Creek is a primary tributary to the system, upon the entrance to which it abruptly bends west and parallels Willow Creek for about 1 km (cf. Figure 187).

Approximately 400 m north of the bend of Ivanhoe Creek, 26Ek3251 occupies the second low stream terrace adjacent the north bank of Willow Creek (elevation 5,215 ft. [1590 m]). Present on-site vegetation is comprised exclusively of tall sagebrush with a sparse understory of cheat grass and rabbitbrush; but the host of riparian species once flourishing here has succumbed to diminished flow (owing to the construction of Willow Creek Reservoir) and to years of cattle grazing. Despite livestock trampling and the construction of Ivanhoe Creek road, most of the site remains intact, including six discrete concentrations of lithic detritus and formed tools (Figure 198).

Geomorphic Analyses

26EK3251 is situated on an oblong, northeast to southwest trending, slight topographic eminence on the alluvial plain of Willow Creek. Despite being a positive feature on the alluvial plain above the present entrenched channel of Willow Creek, this terrace has channels cut into its surface, suggesting drainage at a higher base level in the past. Seven backhoe trenches were dug at locations selected to reveal spatial differences in subsurface depositional history (cf. Figure 198); Trenches 4 and 7 were selected for detailed geomorphic description.

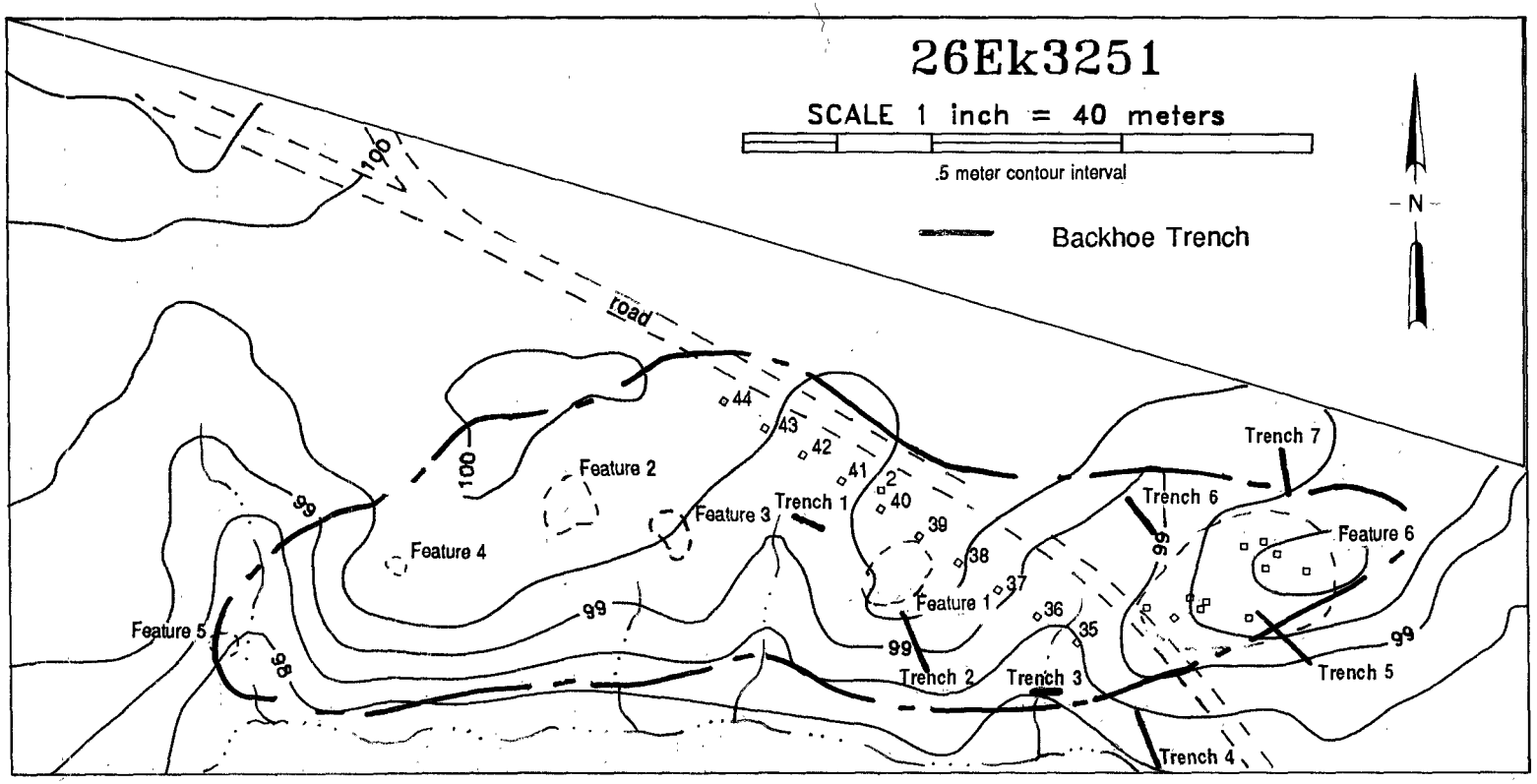


Figure 198. 26Ek3251 site map.

As displayed in the profile of Trench 4 (Figure 199), the terrace at 26EK3251 has been a fairly stable geomorphic feature during at least two past intervals separated by erosional channel cutting events. The stratigraphic sequence begins with Unit 10, a silty clay, overlain by Unit 9 and the equivalent Unit 11. At the north end of the trench, Unit 8, a silty clay loam, overlies Unit 9. These three units are well weathered and probably represent a buried soil profile; fine platy to granular soil structure in Units 8 and 9, and reddish brown root traces in Unit 10 are evidence of this. Following the soil-forming interval, the surface was eroded and much of Unit 8 was truncated where the gravel and cobbles of Unit 7 subsequently were deposited; these coarse sediments experienced channel erosion as well. Units 4, 5, and 6 (sand and gravel) later filled in part of this channel. The truncation of Units 4 through 7 indicates yet another fairly broad, later channel. Finally, sediments of Units 3, 2, and 1 progressively filled in the channel with increasingly finer materials. Unit 3 contains lenses of sand and silt representing the final alluvial stages of the terrace, whereas Units 2 and 1 are late Holocene eolian silts which typically mantle local surfaces and contain virtually all archaeological remains. Although the surface retains channel morphology, alluvial flow no longer occurs.

Molecular weathering ratios in Trench 4 (Figure 200) show a complex but systematic variation that supports the chronology presented above. For example, iron and aluminum ratios for Units 8, 9, and 10 are very low compared to overlying units. This confirms that they indeed are strongly weathered with abundant clay. Unit 9 also shows a relative increase in bases, especially carbonate, suggesting that it was the zone of carbonate accumulation in this paleosol. In the alluvial deposits of Units 4 through 7, overlying the buried soil, Unit 5 appears to be leached of silica and enriched in aluminum, iron, and bases. It is possible that this unit was modified as well during a brief period of weathering. Unusual lenticular pockets of sand found in Unit 5 may reflect either alluvial deposition or burrows filled with sediments similar to those of Unit 4. Finally, Units 1 through 3 exhibit increased weathering as a product of the accreting eolian surface.

The phosphorus plot shows enrichment at the modern soil surface in Unit 1 relative to the lower silt Unit 3. It is relatively high in Units 4, 5, 6, 7, and 10, probably reflecting changing oxidation rates in the coarser sediments or the unweathered state of the sands and gravel. Finally, in Unit 8, the high percentage of phosphorus probably results from organic enrichment when it was part of the soil surface.

In Trench 7 (Figure 201), deposition was dominated by fine sediments in Units 8, 9, and 10, similar to Units 1, 2, and 3 in Trench 4. At the bottom, the profile revealed Unit 6, a deposit of alluvial gravel and cobbles. This is immediately overlain by Unit 8, a thin, intermittent, grayish brown volcanic ash, very similar in appearance and texture to Mazama ash (6,800 years B.P.) seen in profiles along the modern Willow Creek channel (Figure 202); Unit 5 in Trench 5 probably is the same ash. This suggests that units above these ashes are younger than late middle Holocene, as supported by time sensitive artifacts recovered in excavation (cf. below).

Above the ash in Trench 7, Unit 5 is a fairly massive calcareous silt loam. It appears eolian in origin but may be fine alluvium. In the equivalent Unit 4 of Trench 5 (Figure 198), there were isolated pockets of moderately hard, white vitreous material. Although they exhibited little acid reaction for carbonate, chemical analysis revealed them to be calcium and magnesium rich; their origin remains unclear. Another notable characteristic of Unit 5 in Trench 7 and Unit 4 in Trench 5 is an extremely irregular yet distinct upper contact. Two possible origins seem likely: either it is a severely irregular erosional surface or an artifact of bioturbation and disturbance of the unit's structure. Evidence for extensive bioturbation was noted in the overlying loose silty Unit 3 where several burrows were identified. Unit 3 simply may be a bioturbated zone of the underlying unit. Some of this mixing also may owe to rooting by larger vegetation. Units 1 and 2 were typical of eolian silts mantling the surface at the site.

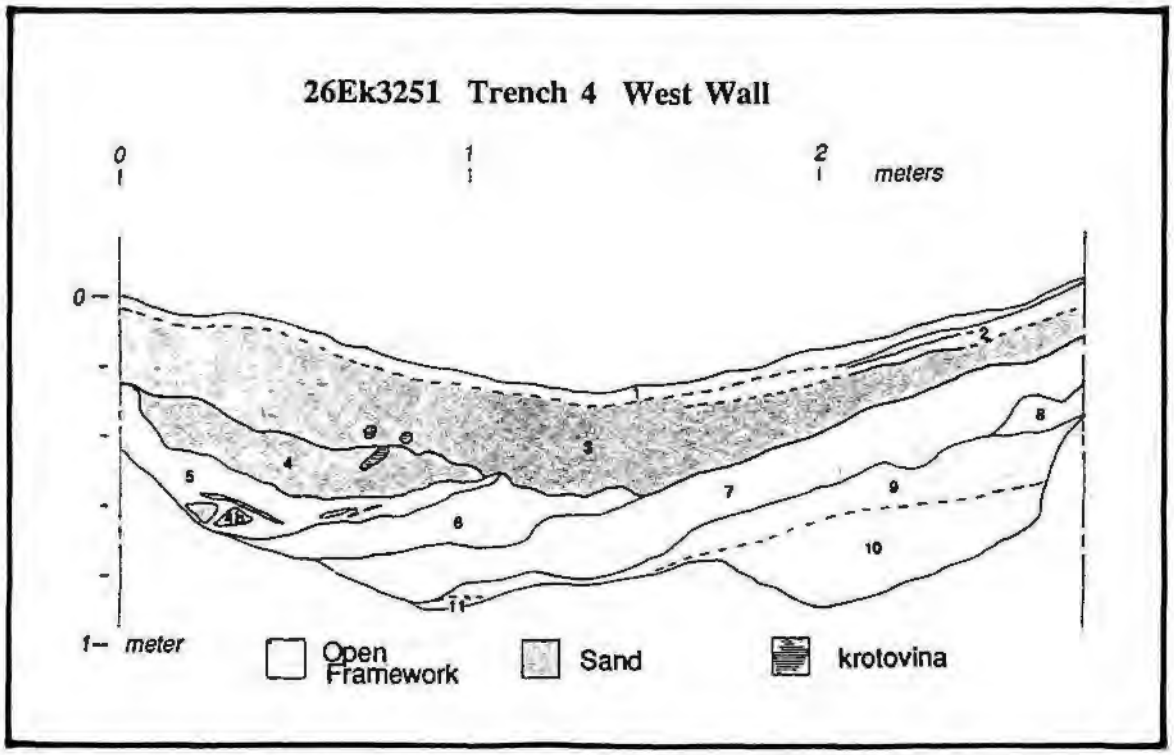
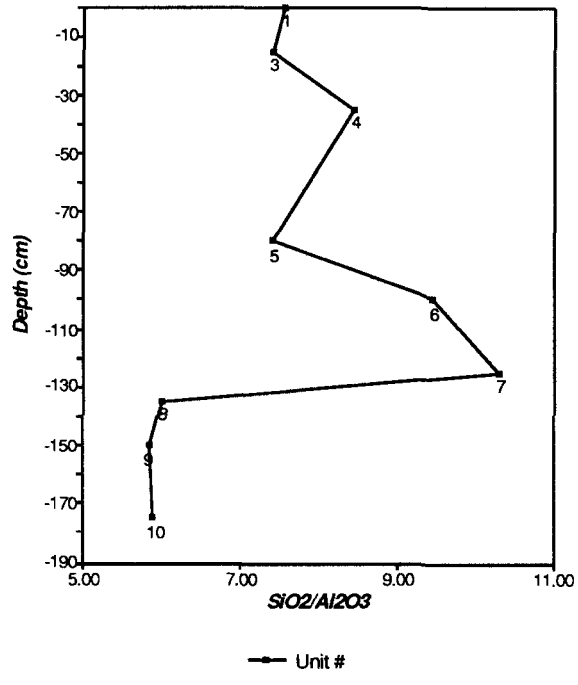
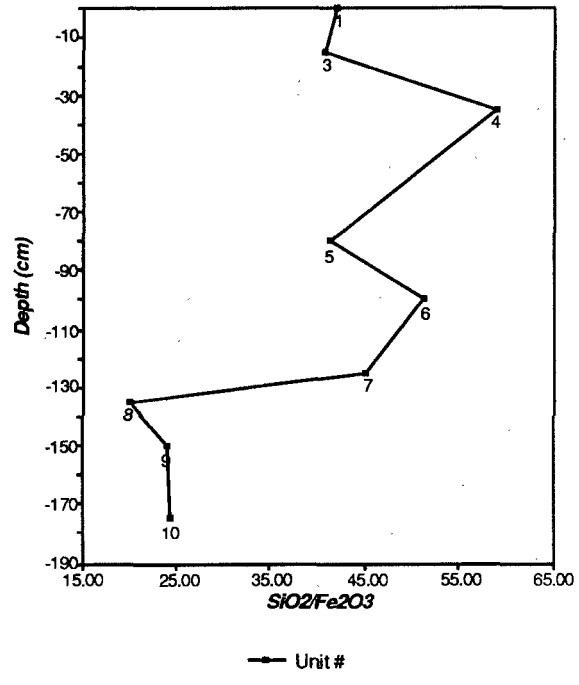


Figure 199. Stratigraphic profile of Trench 4, West wall, 26Ek3251.

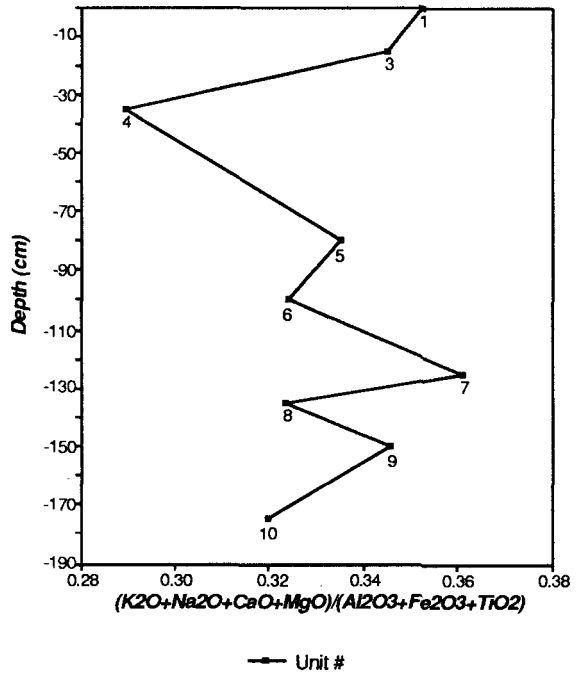
Stratum	Description
1	Dark brown (10YR 4/3) dry; silt loam; weak medium to coarse granular; rare fine to medium subangular to subrounded pebbles; abundant fine to medium roots; boundary abrupt and broken.
2	Light grayish brown (10YR 6/2) dry; silt loam; weak medium platy to moderate medium subangular blocky; rare fine to medium subangular to subrounded pebbles; abundant fine to medium roots; boundary abrupt and smooth to wavy.
3	Dark grayish brown (2.5Y 4/2) dry; loamy medium to coarse sand to loam, distributed as discontinuous lenses; weak fine platy to weak medium subangular blocky; rare subrounded to rounded fine pebbles to fine cobbles; common fine to medium roots; rare krotovina; boundary abrupt and wavy to irregular.
4	Dark grayish brown (2.5Y 4/2) dry; fine to coarse, subrounded to rounded sand, generally coarsening downward, showing cross-bedding, with intermittent silty sand lenses; rare coarse roots; boundary abrupt and wavy.
4b	See description of Unit 4, occurring as isolated pockets in Unit 5.
5	Pale brown (10YR 6/3) dry; sandy loam, with fine to medium subrounded sand lenses; rare medium roots; boundary abrupt and wavy.
6	See description of Unit 4, with the exception that sands are generally coarser with fine to medium subrounded medium to coarse gravels; boundary clear and irregular.
7	Pale brown (10YR 6/3) dry; matrix and clast supported, poorly sorted, subrounded coarse gravel to medium subrounded cobbles; gradual and irregular.
8	Dark yellowish brown (10YR 4/4) dry; silty clay loam; moderate fine platy to coarse granular; rare medium roots; boundary gradual.
9	Yellowish brown (10YR 5/6) dry; strong mottling very pale brown (10YR 8/3), yellowish red (5YR 5/6) and dark reddish brown (5YR 3/3) silt loam; moderate fine platy; rare very fine roots; boundary diffuse and slightly wavy.
10	Yellowish brown (10YR 5/8) dry; silty clay; strong mottling, possibly root traces, yellowish red (5YR 5/6) and dark reddish brown (5YR 3/3); fairly massive; boundary unexposed.
11	Brown (10YR 5/3) dry; sandy loam; no structure apparent; boundary abrupt.



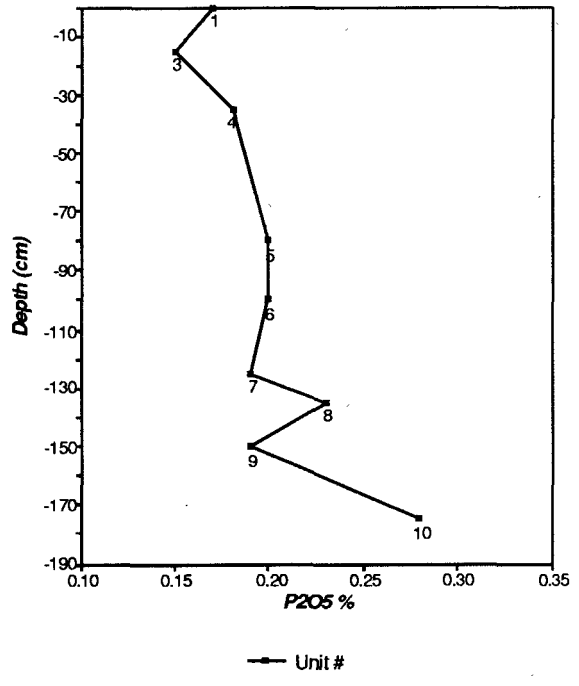
a.



b.



c.



d.

Figure 200. Molecular weathering ratios for 26Ek3251, Trench 4 profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, and (d) weight percent phosphorus.

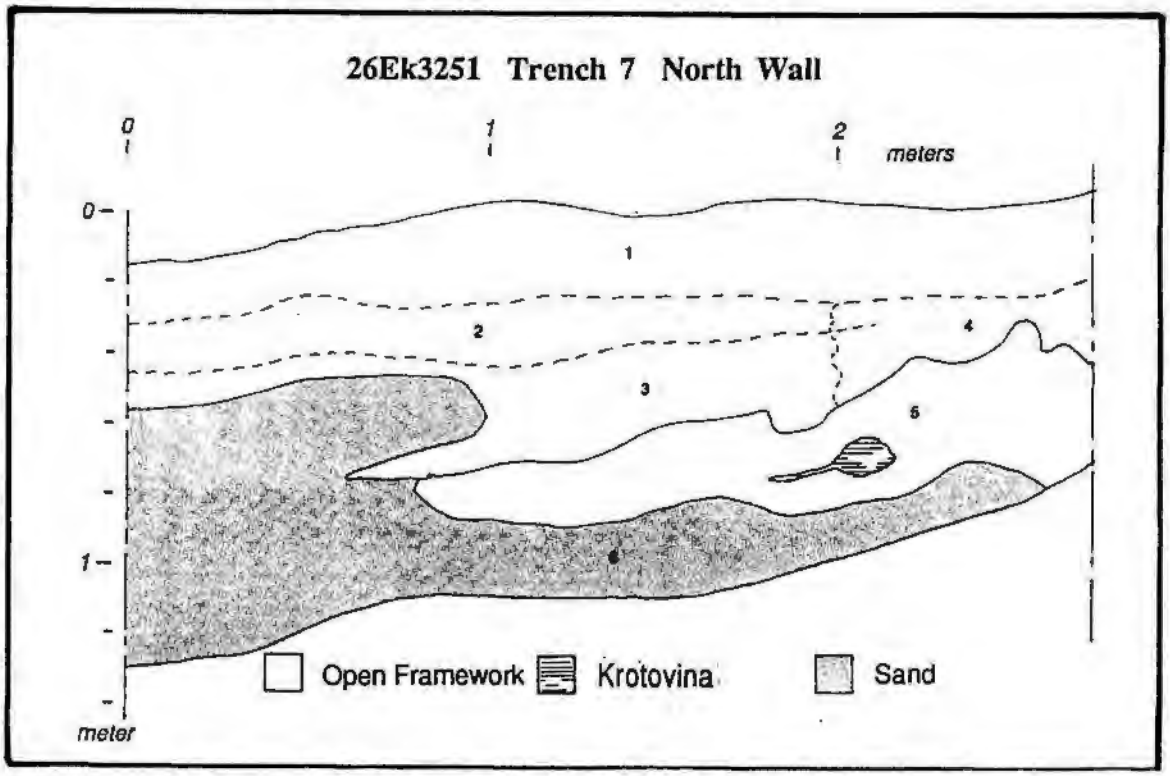


Figure 201. Stratigraphic profile of Trench 7, North wall, 26Ek3251.

Stratum	Description
1	Pale brown (10YR 6/3) dry; silt loam; weak medium to coarse granular to weak fine subangular blocky; rare fine to medium subangular pebbles; abundant fine to medium roots, rare to common fine pores; boundary clear and smooth.
2	Dark brown (10YR 4/3) moist; clay loam; weak to moderate medium angular to subangular blocky; rare fine to medium subangular pebbles; common fine to medium roots, rare fine pores; boundary clear and smooth.
3	Dark yellowish brown (10YR 4/4) moist; silt loam; weak to moderate medium angular to subangular blocky; rare fine to medium angular to subangular pebbles; common fine roots and pores; boundary abrupt and very irregular.
4	Light yellowish brown (10YR 6/4) dry; silt loam; moderate medium angular to subangular blocky; rare fine to medium angular to subangular pebbles; common roots and pores; strong acid reaction on carbonate filaments and weak nodules; boundary abrupt and irregular.
5	Brown (10YR 5/3) dry; sandy loam to silt loam; fairly massive; rare fine to medium subrounded pebbles; rare fine roots; strong reaction on carbonate filaments and mottling, very pale brown (10YR 8/3) dry; boundary abrupt and irregular.
6	Fine to medium sand matrix, dark reddish brown (5YR 3/3) supporting medium to coarse subrounded gravels, cross-bedded; grading downward to clast-supported coarse subrounded cobbles; possible iron staining in sands; strong acid reaction on carbonate lenses up to 4 cm thick; boundary unexposed.



Figure 202. Mazama ash stratum exposed in Willow Creek cutbank south of 26Ek3251 (photograph taken in November, 1988).

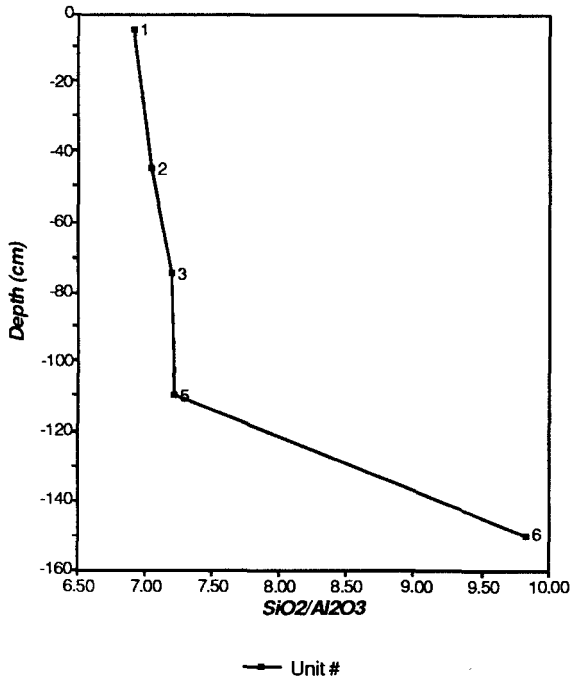
The weathering ratio plots for Trench 7 (Figure 203) show greatest weathering at the surface, decreasing downward to Unit 3. Unit 5 appears weathered in terms of relative iron accumulation, yet there is a decrease in aluminum, reflecting the clay-poor texture of the unit. A relative increase in calcium and magnesium oxide and a small increase in phosphorus suggests that this is part of a former weathered surface.

Excavation Units 28 and 34 (cf. Figure 205), which exposed profiles of the uppermost silt deposits seen in the backhoe trenches, also underwent detailed field description and chemical analysis. These excavations had simple profiles which showed the strongest leaching of sediments at about 30-40 cm depth. This suggests that silts shallower than 30 cm have not experienced as much weathering and therefore may be relatively new eolian deposits accreted onto former stable surfaces.

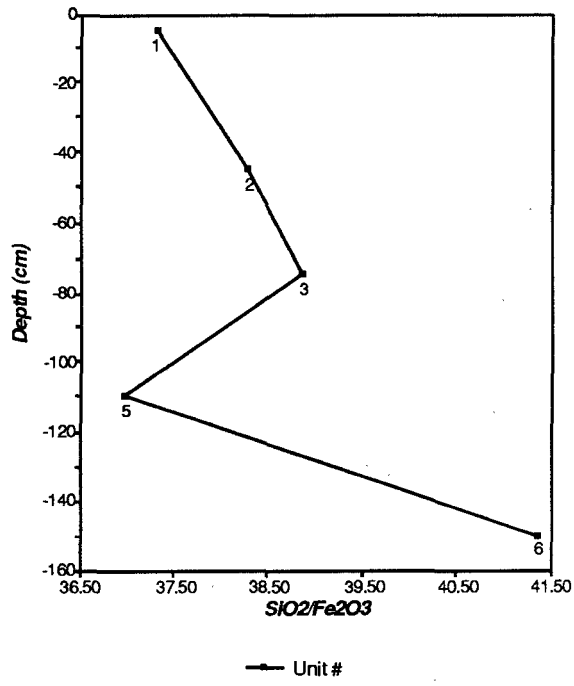
In conclusion, geomorphic evidence from surface morphology and the stratigraphy in a series of backhoe trenches disclose the following general structure and history of the alluvial terrace at 26EK3251. First, a core of older land surface, best represented by the buried paleosol in Trench 4, was apparently developed in older alluvial sediments. Following this interval, there was a period of channel migration, erosion, and deposition on the terrace surface. This produced the alluvial Units 7, 6, 5, and 4 of Trench 4, and Units 6 and 5 of Trench 7. Finally, after a major, possible mid-Holocene channel cutting event that truncated sediment units from the previous depositional interval and which may account for some of the irregular erosional relief, fine channel filling and eolian mantling occurred during the latter half of the Holocene. Some stratigraphic breaks suggesting stable surfaces may also be present in the upper silts (e.g., increased leaching of the silts around 30-40 cm depth). As we observe below, evidence of human occupation has accumulated only on the surface and in the upper few centimeters of this stack of sediments.

Nonfeature Contexts

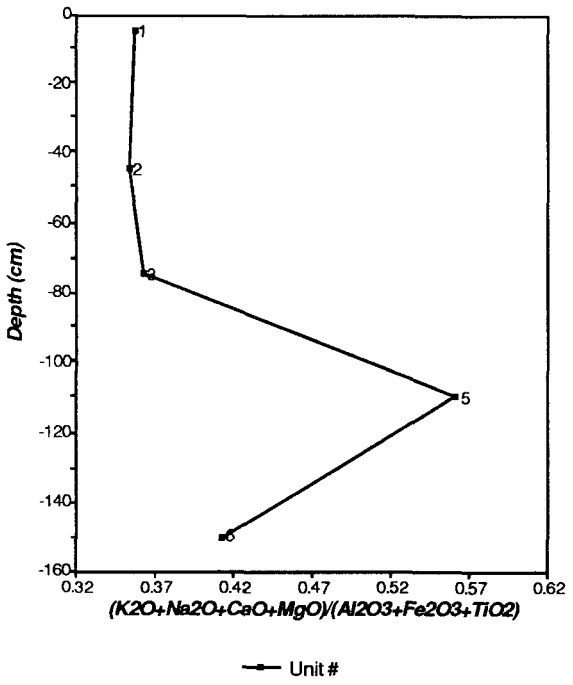
Nonfeature investigations at 26Ek3251 involved the collection of surface artifacts and subsurface excavation of 1 m x 1 m units. Surface collections retrieved preforms, bifaces, flake tools



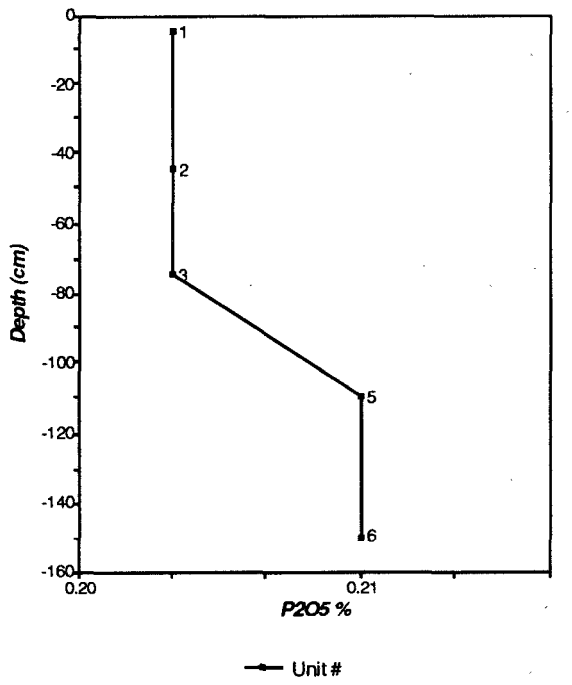
a.



b.



c.



d.

Figure 203. Molecular weathering ratios for 26Ek3251, Trench 7 profile displaying relative oxide enrichment of (a) alumina, (b) iron, (c) bases, and (d) weight percent phosphorus.

(including highly modified end scrapers and a drill/perforator), metates, a single mano, and abundant debitage (Table 193). Seven projectile points were recovered as well, including Humboldt, Rosegate, and Desert Side-notched specimens.

Table 193. Artifacts Recovered from Nonfeature Contexts, 26Ek3251.

		DEBITAGE		FORMED ARTIFACTS Perc./						
Unit No.	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Cobble Tools	Ground Stone	Total
(2)	0.10	13	4.0	-	-	-	-	-	-	0
35	0.20	16	11.3	-	1	-	-	-	-	1
36	0.20	35	21.8	-	-	-	-	-	-	0
37	0.30	108	108.0	-	-	3	-	-	-	3
38	0.30	57	34.9	-	-	5	-	-	-	5
39	0.20	28	17.6	-	-	-	-	-	-	0
40	0.20	31	20.1	-	-	-	1	-	-	1
41	0.20	13	11.1	-	-	-	-	-	-	0
42	0.20	7	9.4	-	-	-	-	-	-	0
43	0.20	14	14.4	-	-	-	-	-	-	0
44	0.20	8	3.7	-	1	-	-	-	-	1
Surface	N/A	-	-	7	6	17	4	1	7	42
Totals	2.30	330	256.3	7	8	25*	5	1	7	53

( ) = Test Excavation Unit

* Includes 1 "possible" biface

During testing, a 1 m x 1 m unit was excavated adjacent Ivanhoe Creek Road (Unit 2; cf. Figure 198) in an area of sparse surface lithics. Although subsurface materials were scant (cf. Table 193), our revisit deployed 10 additional 1 m x 1 m units along a baseline in similar, nonfeature contexts; our intent was twofold: to examine the various, subtle topographic features and to examine loess deposits systematically for buried features. These excavations disclosed a small concentration of flakes and bifaces in Units 37 and 38 (cf. Figure 198; Table 193), but exposed no features and, overall, found very little buried lithic debris.

Feature 1

Located on an elevated flat near the center of the site, Feature 1 is a dense scatter (11 m x 7.5 m) of heat-treated opalite debitage containing several flake tools, ground stone fragments, and fire-cracked rocks. Testing involved scraping a 2 m x 6 m block of 1 m x 1 m units (Units 1-12) and limited subsurface excavation (Figure 204). Numerous bifaces, projectile points, and preforms recovered from these initial investigations (Table 194) prompted our return to expand surface and subsurface investigations with the hope of identifying heat-treatment facilities or structural remains (Intermountain Research 1988d).

Supplementary data recovery employed 10 1 m x 1 m surface scrapes adjacent the existing block (Units 13-22), and judgmental placement of 10 excavation units subsequent to scraping (cf. Figure 204). As presented in Table 194, these investigations recovered thousands of pieces of debitage (dominated by small, heat-treated opalite flakes, but also including obsidian, jasper, and basalt), ground stone, flake and cobble tools, projectile points, preforms, and bifaces; artifacts were especially abundant in the southern and eastern excavations (e.g., Units 14, 15, and 18; cf. Figure 204 and Table 194).

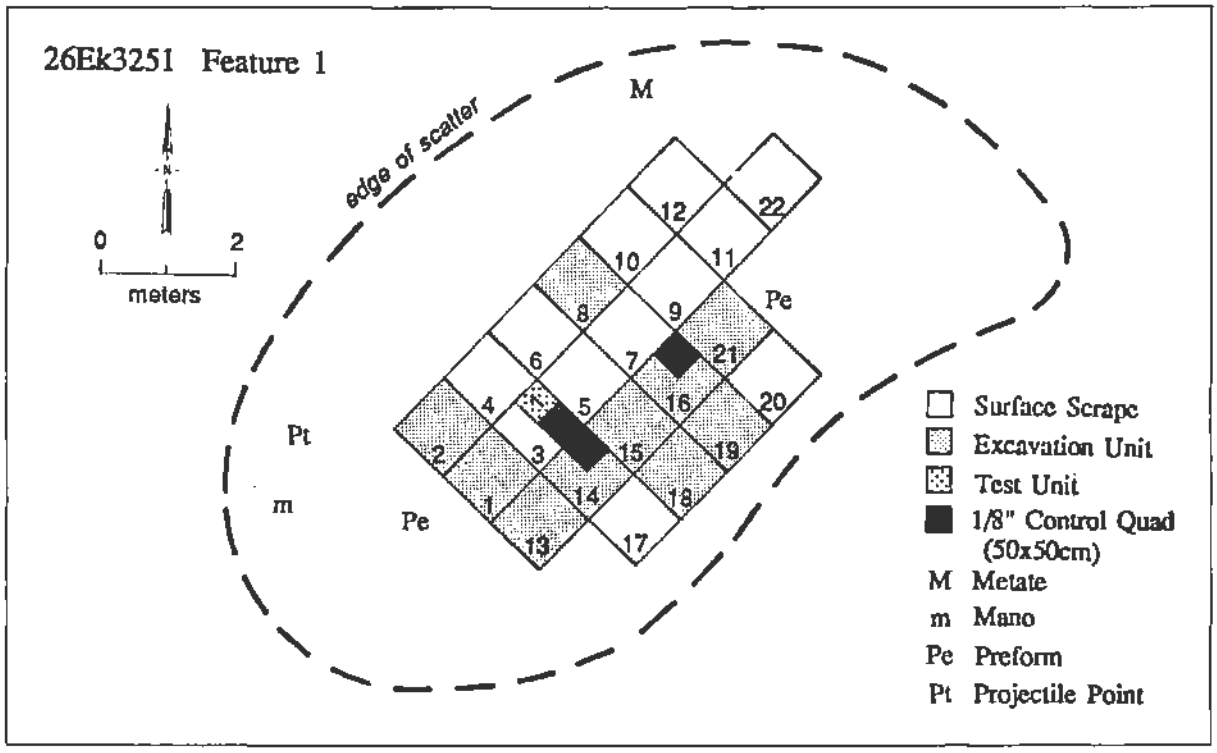


Figure 204. Plan view of Feature 1, 26Ek3251.

Table 194. Artifacts Recovered from Feature 1, 26Ek3251.

Unit No. (Type)	Volume Excav. (m^3)	DEBITAGE n	DEBITAGE wt. (gm)	FORMED ARTIFACTS Proj. Points	Preforms	Bifaces	Flake Tools	Perc./ Cobble Tools	Ground Stone	Total
1 (TS)[a]	0.125	1,566	393.0	1	1	9	1	-	-	12
1 (EU)	0.40	484	193.9	-	1	3	3	-	-	7
2 (EU)	0.30	489	236.8	-	2	2	-	-	-	4
3 (SF)	0.01	262	121.4	1	-	6	-	-	-	7
4 (SF)	0.02	124	50.0	2	1	3	1	-	-	7
5 (SF)	0.02	336	119.4	-	2	1	-	-	-	3
6 (SF)	0.02	165	68.0	-	1	3	-	-	1	5
7 (SF)	0.02	177	67.8	-	1	1	-	-	-	2
8 (EU)	0.30	222	98.6	-	-	2	2	-	-	4
9 (SF)	0.02	80	34.6	-	1	3	-	1	-	5
10 (SF)	0.02	50	28.8	1	-	1	-	-	-	2
11 (SF)	0.02	63	22.9	-	-	-	-	-	-	0
12 (SF)	0.02	43	18.5	-	-	-	-	-	-	0
13 (EU)	0.30	599	316.0	1	4	6	1	-	-	12
14 (EU)[a]	0.30	2,015	757.0	3	4	7	6	-	-	20
15 (EU)	0.30	1,043	391.9	2	3	12	1	-	1	19
16 (EU)[a]	0.30	748	263.2	1	-	6	-	-	2	9
17 (SF)	0.02	239	152.0	1	2	3	2	-	-	8
18 (EU)	0.30	543	257.1	2	3	4	1	-	-	10
19 (EU)	0.30	282	140.4	-	2	1	-	-	-	3
20 (SF)	0.02	191	109.5	1	-	2	2	-	-	5
21 (EU)	0.30	541	292.7	1	1	8	2	-	-	12
22 (SF)	0.02	39	26.0	-	-	1	-	-	-	1
Surface	N/A	-	-	1	2	-	-	-	2	5
Totals	3.455	10,301	4,159.5	18	31	84*	22	1	6	162

The wealth and variety of artifacts retrieved from Feature 1 suggest that the area served as a campsite. While neither hearths nor structural remains were identified, fire-altered rocks and charcoal flecks were encountered throughout our excavations; a hearth subsequently eroded and dispersed, may have once been present. Debitage and heat-treated bifaces (n=73, commonly middle-to-late stage) indicate frequent biface reduction, but the abundance of flake tools (scrapers, drills, knives, and retouched flakes) and the presence of grinding stones suggest an array of subsistence and fabrication tasks as well.

The most salient aspect of the assemblage is the abundance of small, heat-treated preforms and projectile points reflecting manufacture and maintenance of hunting equipment. Projectile points were encountered throughout excavation, represented largely by fragments, chiefly tangs, margins, and midsections; three of four classifiable points (three Rosegate Series and a Cottonwood Triangular) are fragmentary, including two specimens displaying impact fractures. Preforms, both complete and fragmented during manufacture, also were recovered (cf. Table 194), and represent the largest aggregate of this artifact class recovered from the Tosawihi vicinity. Clearly, Feature 1 commonly was used by hunters to "gear-up" for hunting forays around Willow Creek, and points were manufactured there to replace specimens broken in previous ventures; three identified Rosegate Series points suggest these episodes occurred most frequently between A.D. 700 and A.D. 1300.

Feature 2

Feature 2 (cf. Figure 198) is a 11 m x 7 m ovate lithic scatter encompassing four debitage concentrations. We scraped a 2 m x 6 m contiguous block of 1 m x 1 m units in the westernmost concentration; 7,174 flakes and 30 formed artifacts were recovered. The observed toolkit includes 20 bifaces, four preforms, and six projectile points, including an identified Rosegate specimen. Additionally, we excavated a 1 m x 1 m unit within the scrape; a biface fragment, and 1,015 flakes were recovered, most of which (89%) were retrieved from the uppermost 20 cm of excavations (Schmitt 1989b).

Most of the debitage consists of heat-treated opalite flakes produced during mid-to-late biface reduction. The bifaces, exhibiting manufacture failures, reflect similar stage reduction (most are mid-to-late stage 3 heat-treated fragments), suggesting that the feature served chiefly for biface reduction and manufacture.

Features 3, 4, and 5

Three lithic reduction features (Features 3, 4, and 5; cf. Figure 198) were recorded in the field, but were not subjected to further scrutiny; characterization involved recordation of debitage types and abundances, and the collection of formed artifacts. Each assemblage is dominated by biface reduction debris, but a projectile point fragment, a preform, and a scraper at Feature 3 signal more diverse tasks. Surface collections at Feature 4 returned a single heat-treated opalite biface fragment, and at Feature 5, a biface and a Humboldt point.

Feature 6

Feature 6, the largest feature in the corridor, consists of a lithic scatter ca. 35 m x 15 m adjacent the eastern site boundary (cf. Figure 198); initial surface reconnaissance

identified two metate fragments, two bifaces, and a preform. Generally, light debitage density appeared higher in deflated and eroded areas, suggesting that subsurface deposits might be present (Schmitt 1989b:145); accordingly, to explore subsurface deposits, we placed a 1 m x 1 m test unit central to a small debitage concentration. Excavation (to 50 cm) returned four formed artifacts (Table 195), 907 flakes (including obsidian tertiary flakes from our 1/8 in. mesh control quadrant), and fragmentary faunal remains.

Table 195. Artifacts Recovered from Feature 6, 26Ek3251.

		DEBITAGE		FORMED ARTIFACTS								
Unit No.	Volume Excav. (m^3)	n	wt. (gm)	Proj. Points	Preforms	Bifaces	Flake Tools	Perc./ Cobble Tools	Ground Stone	Ceramics	Other/ Exotic	Total
(3)[a]	0.50	907	376.3	1	-	2	1	-	-	-	-	4
25	0.40	254	124.3	1	1	2	-	-	-	-	-	4
26	0.30	146	89.3	1	-	-	-	-	-	-	-	1
27	0.40	381	240.9	1	3	2	1	-	-	-	-	7
28[a]	0.60	922	304.7	-	3	7	-	1	-	-	-	11
29	0.30	229	134.5	1	-	3	-	-	-	-	-	4
30	0.40	448	244.4	-	-	2	2	-	-	-	-	4
31	0.50	522	293.3	3	8	9	3	-	-	-	1	24
32	0.40	503	362.8	1	-	1	1	-	-	-	-	3
33	0.30	189	101.8	-	-	1	-	-	-	-	-	1
34	0.60	163	92.6	-	1	3	1	-	-	-	-	5
Surface	N/A	-	-	3	3	5	1	-	5	2	-	19
Totals	4.70	4,664	2,364.9	12	19	37*	10	1	5	2	1	87

( ) = Test Excavation Unit
[a] Includes a 25 x 25 cm 1/8 inch mesh control quadrant

* Includes 1 "possible" biface

We returned to Feature 6 the following season to collect additional artifacts from the surface and to examine its subsurface contents through further excavation of 10 randomly placed 1 m x 1 m units (Figure 205; cf. Intermountain Research 1988d). Although we found flakes and artifacts restricted largely to the uppermost 30 cm of the deposits, artifacts are abundant across the feature, and include various material types and functional classes (cf. Table 195). Supplementary surface collections inflated artifact diversity with an edge faceted cobble and two Brownware sherds; the surface also yielded the only two diagnostic projectile points at Feature 6 (Desert Side-notched and a Gatecliff Split Stem specimens).

Level 3 (20-30 cm B.S.) of Units 28 and 32 disclosed scatters of fire-cracked rock and charcoal flecks probably reflecting dispersed hearths. Flotation of a sediment sample from Unit 32 returned very little carbon, but plant macrofossil analysis identified charred seeds, strengthening our initial assumption. Not surprisingly, all identified specimens are riparian species native to regional wetland environments (see Chapter 15).

An increase in tool and debitage counts was noted in associated (contiguous) unit/levels, including the *in situ* recovery of a number of flake tools and bifaces. Artifacts were especially abundant in Unit 28 (although partially enhanced by a 1/8 in. mesh control quadrant; cf. Table 195), but relatively sparse in Unit 32. Neighboring Unit 31 (cf. Figure 205), however, *may* represent an activity area associated with an inferred hearth; excavations yielded an unprecedented 24 artifacts (including flake tools and a bone awl fragment) associated with fragmentary large mammal remains.

In sum, Feature 6 yielded an abundant and functionally diverse artifact assemblage. Like Feature 1, it served periodically as a campsite where resource acquisition and processing as well as artifact fabrication and maintenance were performed. The presence of Brownware pottery and a Desert Series point signal occupation after A.D. 1300, and a Gatecliff Split Stem point suggests a much earlier visit sometime during the mid-Archaic.

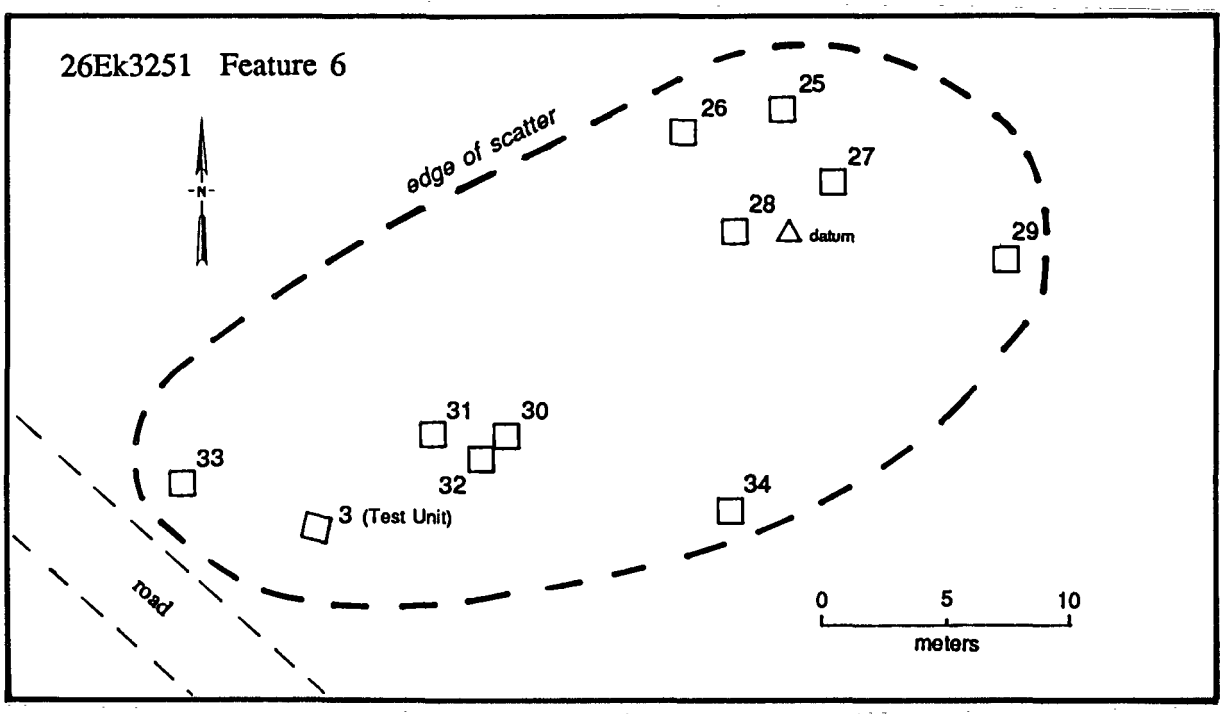


Figure 205. Unit location map, Feature 6, 26Ek3251.

Chronology

Relative and absolute time markers were recovered from five of eight sites investigated in the Northern Corridor (Figure 206). A single Gatecliff Split Stem point and two Humboldt points from 26Ek3251 indicate occupation perhaps as early as 3000 B.C., but the remaining specimens (six Rosegate Series and three Desert Series), as well as Shoshone Brownware sherds, suggest more frequent occupations during Late Archaic times; a single Rosegate point from 26Ek3231 also indicates Late Archaic use of Perron Canyon.

Several time sensitive artifacts were recovered from Ivanhoe Creek Valley; they reflect thousands of years of visits (also cf. Chapters 8 and 19). Testing at 26Ek3238 returned Large Side-notched and Gatecliff types, as well as a Stemmed point indicating occupation between ca. 8000 and 6000 B.C. (Figure 206). At 26Ek3239, an Elko Corner-notched point and a Rosegate Series specimen denote occupation between 850 B.C. and A.D. 1300. Two small, non-diagnostic ceramic sherds recovered from the site also have chronological significance; regardless of typological identification, they signal occupation sometime between A.D. 500 and historic contact (cf. Chapter 13).

Surface collections and excavations at 26Ek3237 returned both temporally diagnostic artifacts and radiocarbon dates (cf. Figure 206); of particular interest, the site yielded the entire Great Basin projectile point sequence, spanning some 10 millennia (i.e., Clovis to Desert Series). Although our single Clovis point doubtless was scavenged and redeposited by later peoples, the presence of the entire Desert West projectile point sequence has few precedents in the Great Basin.

Locus C of 26Ek3237 also returned several chronological markers, including three hearth features which fix separate occupations between 1860 years B.P. and the mid-Nineteenth Century. While Loci A and B probably experienced multiple occupations as well, associated projectile points

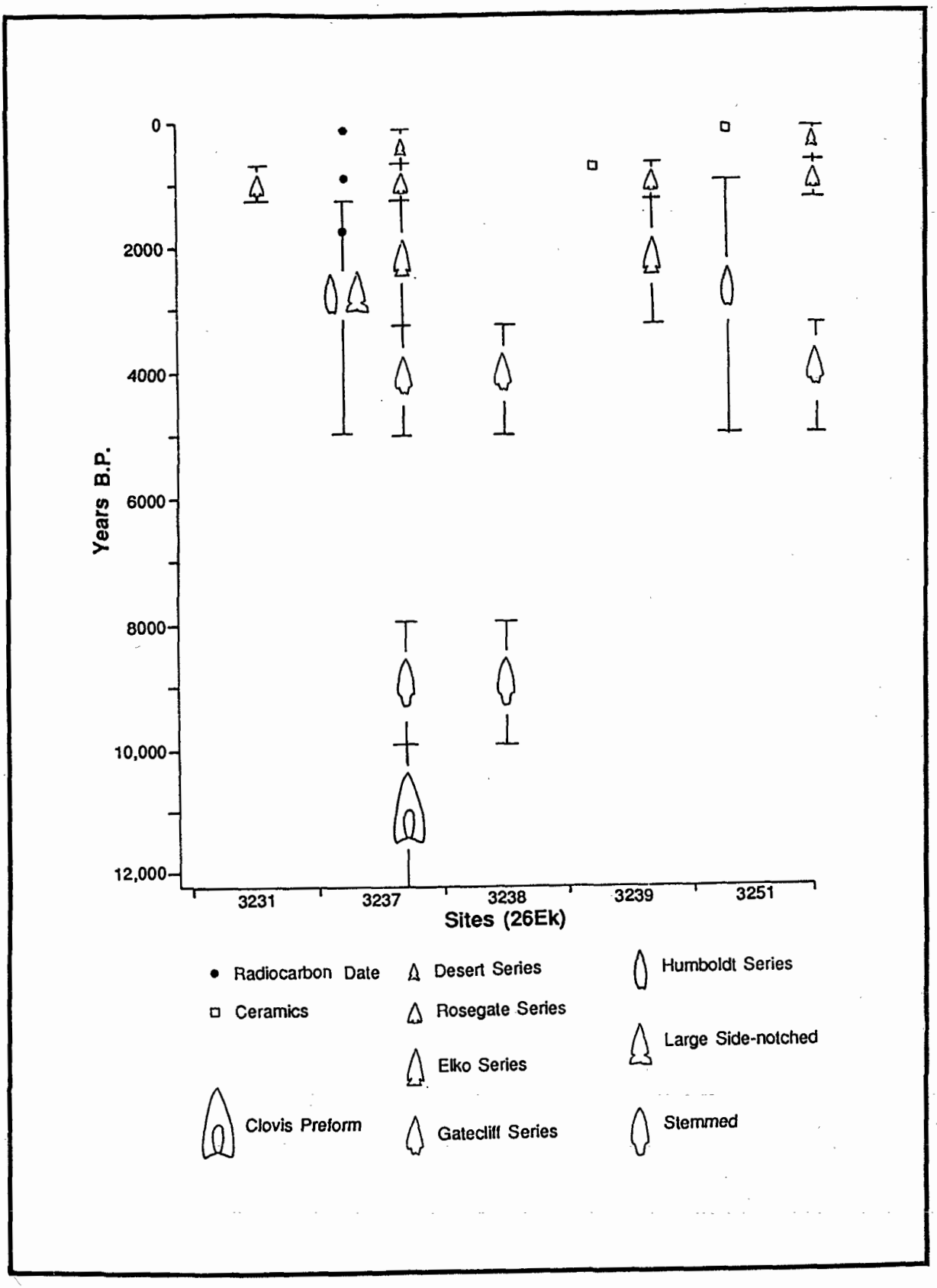


Figure 206. Chronological indicators, Northern Corridor.

reflect more temporally restricted use; two Rosegate Series points reflect visits to Locus B only during the Late Archaic, and two Gatecliff Spilt Stem points and an Elko Eared specimen bracket occupations of Locus A between 3000 B.C. and A.D. 700.

All excavations in the Northern Corridor found cultural remains restricted to the veneer of Middle to Late Holocene eolian silts that blanket the region. While most time sensitive artifacts and all of the radiocarbon dates clearly concur, a Clovis preform and numerous Great Basin Stemmed points also occupy these later deposits, suggesting that cultural remains predating known sites by as many as 6,000 years *may* exist in the Tosawihi vicinity; they may lie beyond our present realm of inquiry.

Summary

With the exception of a small, inferior quality opalitic cobble field at 26Ek3239, archaeological sites in the Northern Corridor are dominated by non-quarry attributes. Nearby opalite sources (e.g., isolated outcrops, stream cobbles) peripheral to the Tosawihi Quarries may have been exploited, but the archaeological paucity of early stage reduction (i.e., cores and Stage 1-2 bifaces), the low frequency of cortex and angular shatter, and the high frequency of heat-treated tools and detritus suggest that most toolstone in these sites was acquired at and transported from the heart of the quarries. However, based on their contents and proximity to the quarries, some "reduction" sites in the corridor (e.g., 26Ek3238 and 26Ek3228) may represent diurnal task sites where toolstone was further reduced, probably to facilitate transport.

Although data recovered from the Northern Corridor reveal little about how toolstone was *procured*, they offer a unique laboratory for exploring the economics of toolstone *transport*. Because stone is dense and heavy, transportable quantities are defined by human limits of effort that doubtless inspired much of the extensive initial processing and caching of products (e.g., bifaces) at or near the quarries (cf. Chapter 4). To examine overall fall-off rates in toolstone packages along the corridor as a function of distance from source, mean weight per debitage item was calculated for each site assemblage containing more than 200 flakes. Figure 207 plots the results, revealing the expected, gradual inverse relationship; flake sizes diminish with increased distance from the quarries.

In sum, the Northern Corridor is dominated by biface reduction debris, but tool fabrication and subsistence tasks were pursued there as well. Toolkits and subsistence residues from 26Ek3237, 26Ek3251, and, to a lesser extent, 26Ek3239, reflect streamside campsites offering access to a broader suite of biotic resources than available in the quarries; riparian plants and permanent water must have drawn attention, as did the mammalian resources they attract.

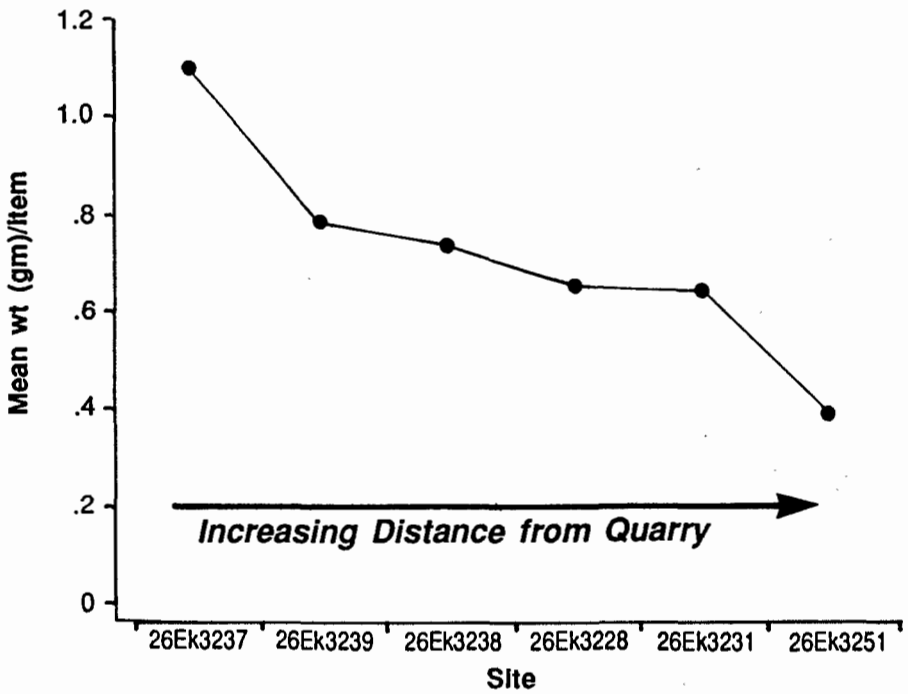


Figure 207. Mean debitage weight/item at selected Northern Corridor sites.

PART IV. DISCUSSIONS

Chapter 19

CULTURAL CHRONOLOGY

Robert G. Elston and Michael P. Drews

Cultural chronologies describe the dates and sequence of phases in the culture history of a locality or region, providing frameworks for the study of change through time. Data used to construct them include relative stratigraphic positions, dates derived from radiocarbon and obsidian hydration, and distributions of time-diagnostic artifacts such as projectile points and pottery. Patterning in these data may themselves suggest cultural change. Cultural phase boundaries mark changes in sets of cultural attributes sufficient to discriminate archaeological units (Willey and Phillips 1958:22). The prehistoric past can be divided at several different levels of generality; in the western Great Basin, the inclusiveness of phase discrimination ranges from shifts in adaptive strategy (Elston 1986a) to changes in projectile point styles (Thomas and Bettinger 1976; Thomas 1981). Chronological data for the Middle and Upper Humboldt regions are summarized in Figure 208 and compared to the Monitor Valley sequence (Thomas 1981, 1983b) and Elston's (1982, 1986a) adaptive chronology for the western Great Basin.

Adaptive Strategies in the Western Great Basin

As a means of organizing discussion of temporal variability in the western Great Basin, Elston (1982; 1986a) partitioned the prehistory of the region on the basis of broad changes in adaptive strategy (Figure 208). The resulting intervals are relatively long, with indistinct temporal boundaries, and local and regional variations in the ways different adaptive strategies were played out.

The earliest period of human occupation is poorly known (Willig and Aikens 1988). The terminal Pleistocene, or Twocreekan interval (10,500 to 9,050 B.C.; J.O. Davis 1978b, 1982:63), was a time of deglaciation and erosion during which the Humboldt River discharged about ten times its current flow. Archaeological remains radiocarbon dated between 10,000 - 9,000 B.C. have been recovered from a few, widely scattered caves, including Cougar Mountain Cave 2 and Connley Cave 4B, Oregon; Danger Cave, Utah, and Fishbone Cave, Nevada (Bedwell 1973; Jennings 1957; Orr 1956, 1974; Thompson et al. 1987). Clovis points in the far West are associated with radiocarbon dates between 10,000 and 9,250 B.C. (Willig and Aikens 1988:Table 2a).

In the Great Basin, the only fluted point from a dated context (9,503-8320 B.C.) lay in the lowest levels of Danger Cave (Jennings 1957; Holmer 1986), but the specimen is morphologically atypical as Clovis. Surface finds of Clovis points are more common (Basgall 1988; Campbell and Campbell 1940; E.L. Davis 1978a; Kelly 1978; Tadlock 1966; Tuohy 1968, 1969; Warren and Phagan 1988). A cache of Clovis points was discovered recently in East Wenatchee, Washington (Mehringer 1988), and dated geochemically to slightly later than 9,300 B.C. (the fall of Glacier Peak tephra; Mehringer and Foit 1990). As described in Chapter 8, the Clovis preform recovered from site 26Ek3237 on Ivanhoe Creek during the present project is very similar in size, morphology, and technology to points in the Wenatchee cache.

Other basally thinned, concave based points occasionally occur in early assemblages associated with ancient lake shores. Pendleton (1979) includes them in the Great Basin Concave Base Series, which includes *Tonopah* and *Triple-T* variants. Thomas (1981) placed the basal date of the Triple T variant at about 3,500 B.C. The Tonopah variant, so far lacking stratigraphic context, may be much earlier.

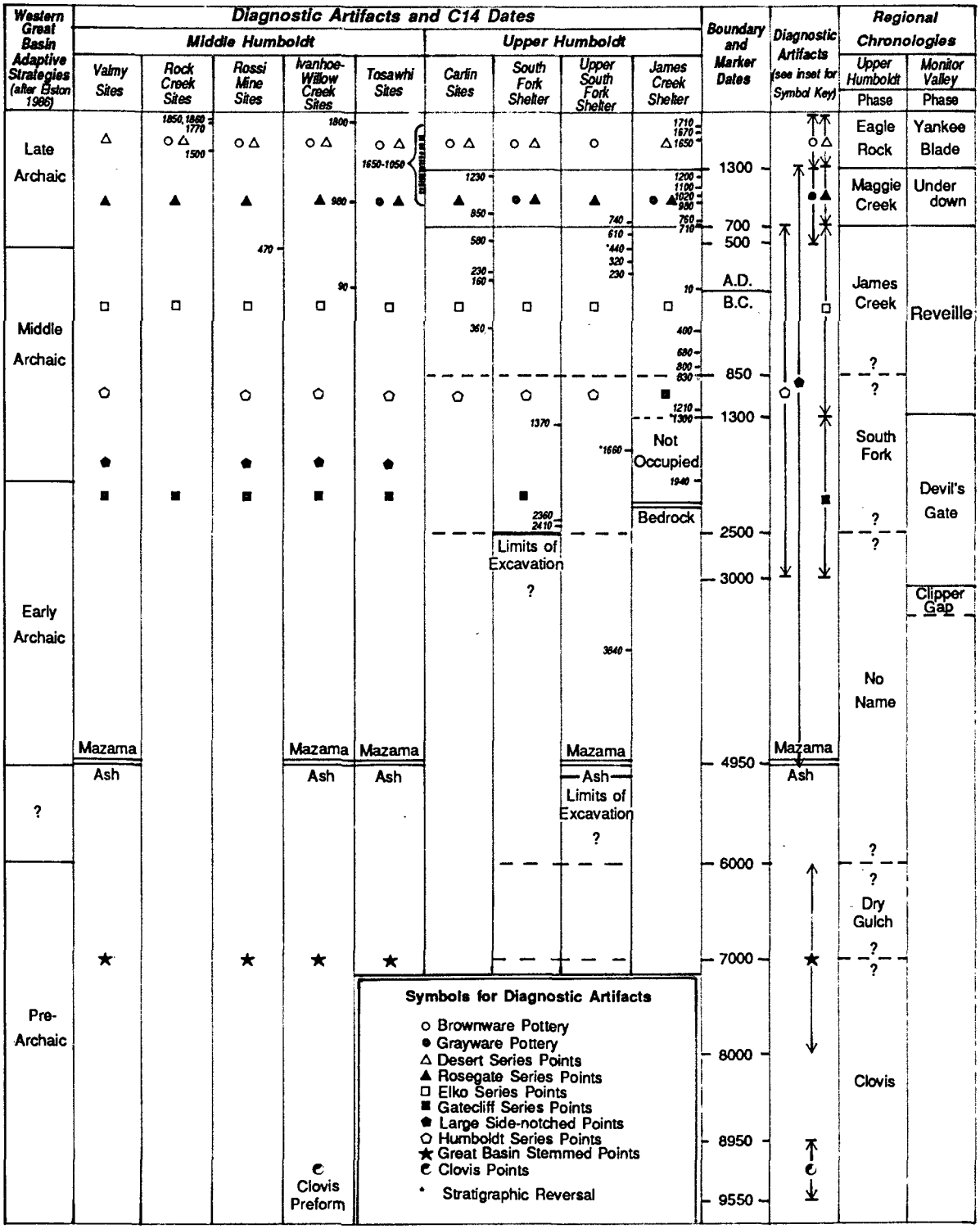


Figure 208. Middle and Upper Humboldt regional chronology.

The Early Holocene, between 9,050 and 4950 B.C., saw the final transition to a fully interglacial climate and ecology (Davis 1982:63-65). Early in the period, the Great Basin was occupied by people who used Great Basin Stemmed Series (GBSS) projectile points (Tuohy and Layton 1977). Surface finds of GBSS points are much more common than finds of Clovis points; they occur both in isolation and in large assemblages (cf. Willig and Aikens 1988). Too, they are found more frequently in buried contexts with associated radiocarbon dates. The extreme range of radiocarbon dates for GBSS points in the Great Basin (Willig, Aikens, and Fagan 1988:Table 3) is 8650 B.C. (Connley Cave 5B; Bedwell 1973) to 5480 B.C. (Hogup Cave; Aikens 1970), but most dates fall between 8,000 B.C. and 6,000 B.C.

The cultural manifestations discussed above are usefully referred to as Western Clovis and Western Stemmed complexes (Willig and Aikens 1988:1). In Elston's (1982, 1986a) scheme of Great Basin adaptive strategies, both are lumped as *Pre-Archaic*, temporarily deferring the question, until more evidence accrues, of whether either or both represent variants of Paleoindian adaptation, early Archaic adaptations, or something else entirely. They seem sufficiently different, however, to be distinguished from variants of the better-known Archaic adaptive strategy. While the pre-Archaic strategy probably involved sparse populations, high residential mobility, and non-intensive plant food processing and storage (reflecting a relatively narrow diet breadth), the Archaic strategy entailed a decrease in overall mobility, increased land-use diversity, broadened diet breadth, and intensified resource procurement.

Shifting strategies and broad-based foraging are characteristic of the Archaic. Basic technologies change very little, but, on a large scale, there seem to be long term, additive trends in strategies forming the basis for a tripart division. Characteristics include introduction of intensive seed processing technology (mano and metate) in the Early Archaic (ca. 5000-2000 B.C.), lowered mobility and increased reoccupation of residential and cache sites in the Middle Archaic (ca. 2000 B.C.-A.D. 500), and introduction of bow and arrow and additional plant processing equipment (suggesting further increase in diet breadth and resource intensification) in the Late Archaic (ca. A.D. 500-Present). Temporal ranges of projectile point styles associated with these strategies are summarized in Figure 208.

Regional Chronologies

Cultural chronologies have been synthesized for most of central and eastern Nevada (Thomas 1983b, 1988; James 1981; Rusco 1982; Smith et al. 1983; Elston and Budy 1990), with regional cultural sequences divided into phases developed only for Monitor Valley (Thomas 1983b) and the Upper Humboldt region (Elston and Budy 1990). However, phase boundaries in the two regions do not necessarily match owing to differences in phase definition (Figure 208).

Monitor Valley and Upper Humboldt Regions Compared

Thomas (1981, 1983b) defined the phases of the Monitor Valley sequence as purely temporal units bounded by changes in projectile point style manifest in the well stratified, radiocarbon-dated deposits of Gatecliff Shelter. He then used the phase units to monitor archaeological variability and change in mostly surface assemblages throughout the Monitor Valley region (Thomas 1983b, 1988). In contrast, the Upper Humboldt sequence is pieced together from several excavated rockshelters and open sites the archaeological records of which vary in stratigraphic resolution and completeness (Elston and Budy 1990). Since the number of archaeological observations is limited, phase content and boundaries are provisional. Prior to about 1300 B.C., Upper Humboldt radiocarbon dates are scarce, and phase boundaries are distinguished by little more than changes in projectile point style; later phases are thought to mark shifts in settlement patterns and variable intensity of site use.

Cultural Chronology of the Upper Humboldt Region

The Upper Humboldt River extends from Beowawe east to the headwaters; the Upper Humboldt Region is comprised of the country tributary to the Upper Humboldt River east of the Tuscarora Mountains. The Middle Humboldt River is the reach between Golconda and Beowawe; the Middle Humboldt Region includes the tributary area between the Osgood and the Tuscarora Mountains. By this definition, the Tosawihi Quarries lie in the Middle Humboldt, although, as discussed in earlier chapters, there is much to suggest that they served as a major lithic resource to both the Middle and Upper Humboldt regions. The degree to which the Upper Humboldt cultural sequence is applicable to the prehistory of the Middle Humboldt region is a question explored in this report.

The archaeological record of the Upper Humboldt region, while not wholly invisible, is difficult to see before 2500 B.C. The South Fork shelters (Heizer et al. 1968; Spencer et al. 1987) and James Creek Shelter (Elston and Budy 1990) provide the only long stratigraphic records in the region. Variability in proportions of local toolstone and Tosawihi chert in James Creek Shelter reflects toolstone economics at the site during periods of greater or less intense occupation. The only radiocarbon date older than 2500 B.C. in the Upper Humboldt (3840 B.C.) comes from Upper South Fork Shelter, where sparse debitage was found below Mazama Ash dating to 4950 B.C. (Spencer et al. 1987). No Clovis sites are known in the Upper Humboldt. Diagnostic GBSS points of the earliest Upper Humboldt phase (Dry Gulch: 7,000-6000 B.C.) occur as isolated artifacts or in small assemblages of lithic tools and debitage; these frequently occur with flaked stone crescents in other regions, but, not so far, in the Upper Humboldt. GBSS points also are found in palimpsest surface assemblages with later components which, in some cases, may be products of scavenging. There are no reliable dates for terminal use of GBSS points. The temporal boundaries and content of the Dry Gulch Phase thus remain unclear.

The No Name Phase (5000-2500 B.C) *should* represent the first local expression of the Early Archaic as characterized above, but it is an interval less well-known archaeologically than the preceding period. A major environmental change during this interval was the invasion of single-leaf pinyon (*Pinus monophylla*) into the western and central Great Basin between 4000 and 2000 B.C. (Thompson 1984a), reaching its northern limit just south of the Humboldt River by about 1500 B.C. (Thompson 1984b). Few archaeological sites referable to the No Name Phase have been observed on the Upper Humboldt (Elston and Budy 1990), although it is possible that the right places have not yet been searched. The 3040 B.C. radiocarbon date from Upper South Fork Shelter relates to a hearth, but associated cultural materials are sparse, suggesting use of the shelter as a short-term field camp (Spencer et al. 1987). If the lack of sites of this age throughout the Upper Humboldt region is not due simply to sampling error, the data suggest that population levels were relatively low.

The last 500 years of the No Name Phase coincide with part of the temporal range of Gatecliff Series projectile points (3000-1300 B.C.: Thomas 1981, 1983b), but there are no reliable diagnostic artifacts for the interval between about 6,000 and 3,000 B.C. (Figure 208). At one time, Humboldt points were thought to date between 4000 and 1000 B.C. (Heizer and Hester 1973). Thomas (1981) later suggested that Humboldt points occur throughout the Archaic and thus are not good time markers; certainly their stratigraphic position in Gatecliff Shelter is ambiguous (Thomas 1983b). Large Side-Notched points apparently were used as early as 5,000 B.C., but their chronological range is great and they, too, are poor time markers (Figure 208).

The South Fork Phase (2500-850 B.C.) spans the boundary between the Early Archaic (2500-1500 B.C.) and the Middle Archaic (1500 B.C.-A.D. 500), but the archaeological visibility of its early portion is slight in the Upper Humboldt Region. Moreover, both upper and lower boundaries of the South Fork Phase differ from the otherwise congruent Devil's Gate Phase (3000-1300 B.C) of central Nevada, for which Gatecliff points are diagnostic (Figure 208). The

earliest radiocarbon date from South Fork Shelter (Heizer et al. 1968) is 2410 B.C.; a Gatecliff point and two Humboldt points were produced from deposits dated between 2410 B.C. and 1370 B.C. Occupation began in James Creek Shelter sometime before 1250 B.C., and a Gatecliff point was recovered from deposits there dating between 1250 B.C. and 850 B.C. (Drews 1990). The terminal date of 850 B.C. for the South Fork Phase, based on the end date for the South Fork component of James Creek Shelter, is about 400 years later than the end of the Devil's Gate Phase in Monitor Valley (Thomas 1983b).

Relatively little is known of prehistoric lifeways on the Upper Humboldt during the South Fork Phase. Although in central and western Nevada, more intensive use of upland areas and particular sites after about 1500 B.C. is thought to signal increased population (Elston 1982; Thomas 1982). Remains from James Creek Shelter (Elston and Budy 1990) and the South Fork Shelters (Heizer et al. 1968; Spencer et al. 1987) suggest occasional use by individuals or small groups, probably during hunting forays. Various toolstones were exploited at James Creek Shelter during the South Fork Phase; 66% of the debitage consists of locally available Maggie Creek chert, 22%, of Tosawihi chert, 4%, of obsidian, and 13%, of other toolstone. Although the sample is small, Paradise Valley obsidian is more abundant than Brown's Bench obsidian at James Creek Shelter (Hughes 1990).

The temporal boundaries of the James Creek Phase (850 B.C.-A.D. 700) are defined on the basis of radiocarbon dated stratigraphy from James Creek Shelter (Elston and Budy 1990). The lower boundary date of 850 B.C. falls 450 years later than the Reveille-Devil's-Gate boundary in Monitor Valley (Figure 208). During the first part of the phase, occupation of James Creek Shelter and the South Fork Shelters intensified, although all these sites continued to be used as overnight stops or short term logistical bases for individuals or small groups of hunters (Spencer et al. 1987; Elston and Budy 1990). After about A.D. 1, use of James Creek Shelter intensified further, with the occasional construction of shallow, saucer-shaped, grass lined features which probably served as beds. The proportion of Tosawihi chert declined to 11% and obsidian to 1%, while local Maggie Creek chert increased to 82%. Similar features and increased activity also occurred at Upper South Fork Shelter, but possibly somewhat later. Elko Series projectile points are diagnostic of the James Creek Phase, and their wide distribution across the landscape indicates the exploitation of an broader range of settings and a more eclectic use of the environment than previously obtained (Rusco, Davis, and Jensen 1979; Armentrout and Hanes 1987). This trend mirrors more intensive use of uplands and particular sites after about 1,500 B.C. in western and central Nevada; it may reflect increased population (Elston 1982; Thomas 1982).

The Maggie Creek Phase (A.D. 700-1300) was accompanied by a vast increase in the intensity and frequency of occupation at James Creek Shelter, including the construction of residential structures such as pits with brush wind breaks and level floors with multiple hearths (Elston and Budy 1990). Absolute numbers of artifacts increased at the site. Local Maggie Creek chert comprised 89% of the debitage, while Tosawihi chert declined to 7% and obsidian nearly disappeared. Large amounts of bison bone occur in Maggie Creek deposits at James Creek Shelter, as does a wide variety of plant remains; these suggest use of the site during several seasons, and the procurement of several different resource sets. Level floors perhaps represent summer foraging base camps, while pits with brush structures may have been used in late fall or winter by hunters. However, construction within the shelter declines in late Maggie Creek times between A.D. 1200 and A.D. 1300. A similar intensification in use of Upper South Fork Shelter occurred during the same time (Spencer et al. 1987); the record there (Heizer et al. 1968) is less clear, however, possibly reflecting a change in target resources rather than a change in intensity of use. Rosegate Series projectile points and Salt Lake Grayware ceramics (Madsen 1986) are diagnostic.

The Eagle Rock Phase (A.D. 1300 through protohistoric times) apparently represents the archaeological record of the Numic speaking Shoshoni peoples who occupied the region at historic contact. Along the Upper Humboldt, the phase is marked by Desert Series projectile points (Desert Side-notched and Cottonwood), and by Shoshone Brownware ceramics (Elston

and Budy 1990). In James Creek Shelter, occupational intensity sufficient to create discrete use areas did not resume until about A.D. 1600. The proportion of local Maggie Creek chert in the debitage falls to its lowest value (61%), while that of Tosawihi chert is highest (32%); obsidian accounts for less than 1%, suggesting a return of toolstone economy similar to that prevailing during the James Creek Phase. A comparable hiatus is suggested at South Fork Shelter by a layer of decomposed pack rat nesting material 18 in. below the surface; all the Desert Series points and Brownware pottery lay either in this layer or above it. Only James Creek Shelter has produced radiocarbon dates in the range of the Eagle Rock Phase; judging by projectile point frequency, the intensity of occupation diminishes throughout the Upper Humboldt during the Eagle Rock Phase.

Cultural Chronology of the Middle Humboldt Region

The cultural chronology of the Middle Humboldt Region is known only from archaeological work at Valmy (Treaty Hill) on the plain of the Humboldt River in Pumpernickel Valley (Davis et al. 1976; Elston et al. 1981; Rusco and Davis 1979), Rossi Mine in the Tuscarora Mountains (Rusco et al. 1982), and the Rock Creek sites in the Sheep Creek Range (Clay and Hemphill 1986). In all these areas, the proportion of Tosawihi chert or opalite in debitage ranges between 70% and 100%. The record of the Middle Humboldt is slender, however, with only four radiocarbon dates; few other data suggest cultural variation over time.

Rusco et al. (1982) investigated five archaeological sites in the Rossi Mine area about 15 km from the Tosawihi Quarries, two of which (26Ek2304 and 26Ek2305) contained temporally diagnostic artifacts. The full range of Archaic point types, Brownware pottery, and pre-Archaic Great Basin Stemmed Series points were recovered from 26Ek2304; a hearth at this site yielded a radiocarbon date of A.D. 1480. In contrast, 26Ek2305 produced only Late Archaic Rosegate and Desert Series points. Assemblages from all the Rossi Mine sites are *similar (considering sample size), including bifaces, cores, flaked stone, and ground stone tools;* the faunal assemblage from 26Ek2304 includes antelope and bison.

Archaeological study of the Rock Creek sites, located between 50 and 30 km from the Tosawihi Quarries, involved limited surface collections and testing (Clay and Hemphill 1986). The Rock Creek sites produced the full range of Archaic projectile points with the exception of the poorly diagnostic Large Side-Notched type; in addition, Brownware pottery was recovered from 26La1950. The projectile point sample at each site, however, consists of fewer than ten items. Three radiocarbon dates were obtained from Rock Creek; the earliest (from 26La1902) is A.D. 1770 (Figure 208).

Studies conducted during evaluation of power plant siting at Valmy (Davis et al. 1976; Elston et al. 1981; Rusco and Davis 1979) involved survey of over two sq mi. and the recording of 79 archaeological sites, ranging from isolated finds to large scatters of artifacts. These were interpreted variously as Archaic long term (winter) residential base camps, short term seed gathering and processing camps as well as ambush and processing sites for large game, and short term hunting and game processing locations. In addition, several sites contain isolated artifacts or small assemblages of Pre-Archaic Great Basin Stemmed points (and in one case, a crescent), as well as a couple of Great Basin Concave Base points. No radiocarbon dates were recovered from any sites in the Valmy area.

The question of the age of the Humboldt Series is of importance at Valmy; they account for 61% of the total Valmy projectile point assemblage (Table 196). On the basis of the chronological range for Humboldt points given by Heizer and Hester (1973), and in the absence of radiocarbon dates, there seems to be evidence for a mid-Holocene intensification in use of the Valmy area between 4000 B.C. and 1000 B.C. (Davis et al. 1976; Rusco and Davis 1979; Elston et. al 1981). If Thomas (1981) is correct in his assessment of the performance of the

Humboldt Series as time markers, their presence at Valmy is just noise. If, on the other hand, Humboldt points in this context are coeval with Gatecliff points (as they are in Hidden Cave) and in upland intercept hunting sites in Monitor Valley (cf. Thomas 1985, 1988), their abundance in the Valmy area suggests greatly intensified use of the marshy Humboldt River flood plain in the Early Archaic, coincident with the late No Name Phase and South Fork phases of the Upper Humboldt. Calculating the average loss rate for Humboldt points (series duration divided by number of points) further elucidates the Early Archaic intensification in the Middle Humboldt region; assuming that the 3700 year range for the Humboldt Series is correct (Thomas 1981), the points were dropped at an average rate of one every 77.08 years, while loss rates for pre-Archaic and later Archaic types range from one/285 years (Stemmed Series) to one/200 years (Desert Series). However, since this plethora of Humboldt points is unparalleled elsewhere, and is unsupported by radiocarbon dates, interpretation is difficult.

Even if Humboldt points are removed from consideration, Table 196 still suggests anomalous (compared to the Upper Humboldt) variation in the intensity of use of the Valmy area throughout prehistory. For one thing, there are as many Great Basin Stemmed points as there are Gatecliff points. For another, post-Elko (James Creek Phase) projectile point frequencies decrease. We must conclude with the old saw that additional work is needed in Pumpernickel Valley and elsewhere on the Middle Humboldt in order to clarify chronological ambiguities.

Table 196. Frequencies of Projectile Points by Series at Valmy

Series	N	%
Desert	3	4
Rosegate	2	3
Elko	9	11
Gatecliff/Pinto	7	9
Humboldt	48	61
Large Side-notched	3	4
Stemmed	7	9
Total	79	

Cultural Chronology at Tosawihi Quarries and Vicinity

Chronological data from the Tosawihi Quarries and sites on Ivanhoe Creek and Willow Creek is provided by radiocarbon dates, time-diagnostic artifacts, and, in some places, the presence of Mazama tephra (Figure 208). Obsidian hydration measurements provide independent dating.

Radiocarbon Dates

Radiocarbon dates were presented by site in Chapters 16-18; here (Table 197) they are grouped by project area. While such dates are relatively abundant at Tosawihi compared to other archaeological study areas in the region; they were obtained from relatively few sites, most of them from quarry pit features with complex stratigraphy where inverted dates are common. Plotted in chronological (not stratigraphic) order by area in Figure 209, these dates form convincing patterns that should be viewed with a certain caution. Nevertheless, the reality of these patterns, as we shall see, is supported by other, independent chronological indicators.

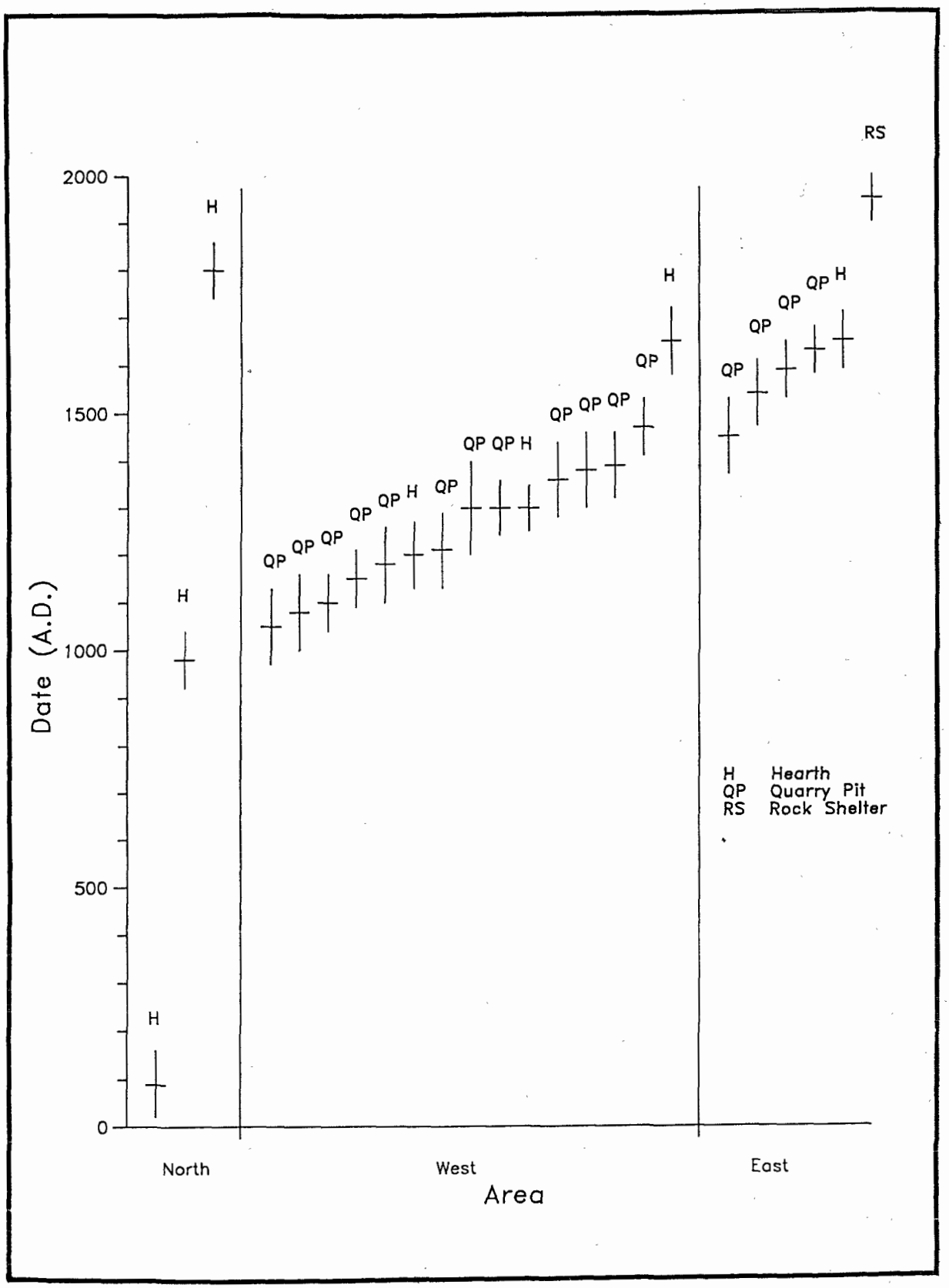


Figure 209. Radiocarbon dates for Tosawihi and vicinity.

Three dates from the Northern Corridor (all from 26Ek3237) are spread evenly over the past 2,000 years or so, as are the dates from open sites at Carlin depicted in Figure 208. Dates from the Western Periphery, however, cluster around a mean of A.D. 1275±162. There are only six radiocarbon dates from the Eastern Periphery and, with the exception of the anomalous date of A.D. 1950 from rockshelter 26Ek3204, these dates also cluster, with a mean of A.D. 1553±78. These data suggest intensive quarrying at Western Periphery site 26Ek3208, and associated hearth building at near-by residential and processing sites, over the period A.D.1050-1650. In contrast, radiocarbon dates associated with quarrying and hearth building in the Eastern Periphery fall within a 200 year period between A.D. 1450 and 1650.

Table 197. Radiocarbon Dates From Tosawihi Quarries and Vicinity

Study Area	Site Number	Reference Number	Laboratory Number	Feature Type	Date (Radiocarbon Years B.P.)	Date
Northern Corridor	26Ek3237	2141	Beta-28314	Hearth	150±60	A.D. 1800
	26Ek3237	8802-4	Beta-36993	Hearth	970±60	A.D. 980
	26Ek3237	8845-1	Beta-36994	Hearth	1860±70	A.D. 90
Western Periphery	26Ek3092	8584-5	Beta-36976	Hearth	750±70	A.D. 1200
	26Ek3092	8645-1	Beta-36977	Hearth	650±50	A.D. 1300
	26Ek3106	2021-1	Beta-26827	Hearth	300±70	A.D. 1650
	26Ek3208	2500-2	Beta-26754	Quarry Pit	800±60	A.D. 1150
	26Ek3208	2500-4	Beta-26755	Quarry Pit	650±60	A.D. 1300
	26Ek3208	2599-15	Beta-36383	Quarry Pit	900±80	A.D. 1050
	26Ek3208	2599-21	Beta-36984	Quarry Pit	870±80	A.D. 1080
	26Ek3208	2599-22	Beta-36985	Quarry Pit	650±100	A.D. 1300
	26Ek3208	2599-23	Beta-36986	Quarry Pit	570±80	A.D. 1380
	26Ek3208	2599-24	Beta-36987	Quarry Pit	480±60	A.D. 1470
	26Ek3208	2599-25	Beta-36988	Quarry Pit	840±60	A.D. 1100
	26Ek3208	2599-28	Beta-36989	Quarry Pit	560±70	A.D. 1390
	26Ek3208	2599-31	Beta-36990	Quarry Pit	770±80	A.D. 1180
	26Ek3208	2599-33	Beta-36991	Quarry Pit	740±80	A.D. 1210
	26Ek3208	2599-36	Beta-36992	Quarry Pit	590±80	A.D. 1360
Eastern Periphery	26Ek3171	2599-5	Beta-36978	Quarry Pit	410±70	A.D. 1540
	26Ek3195	2599-129	Beta-36979	Quarry Pit	320±50	A.D. 1630
	26Ek3195	2599-130	Beta-36980	Quarry Pit	500±80	A.D. 1450
	26Ek3195	2599-131	Beta-36981	Quarry Pit	360±60	A.D. 1590
	26Ek3204	2003-13	Beta-26828	Rockshelter	40±50	A.D. 1950
	26Ek3198	8462-6	Beta-36982	Hearth	300±60	A.D. 1650

Ceramics

Pottery was found at nine sites. All Grayware discovered so far is Salt Lake Gray, thought to date between A.D. 700 and A.D. 1300; Shoshone Brownware is dated less securely, but probably ranges between A.D. 1300 and about A.D. 1850 (Madsen 1986). Unclassifiable sherds are assumed to range somewhere between A.D. 500 to historic times. The time ranges represented by ceramics at Tosawihi are graphed in Figure 210. The number of sites with pottery in each study area is small, but more sites in the Eastern Periphery contain pottery than in the north or west, and a higher proportion of eastern sites contain only the relatively late Brownware.

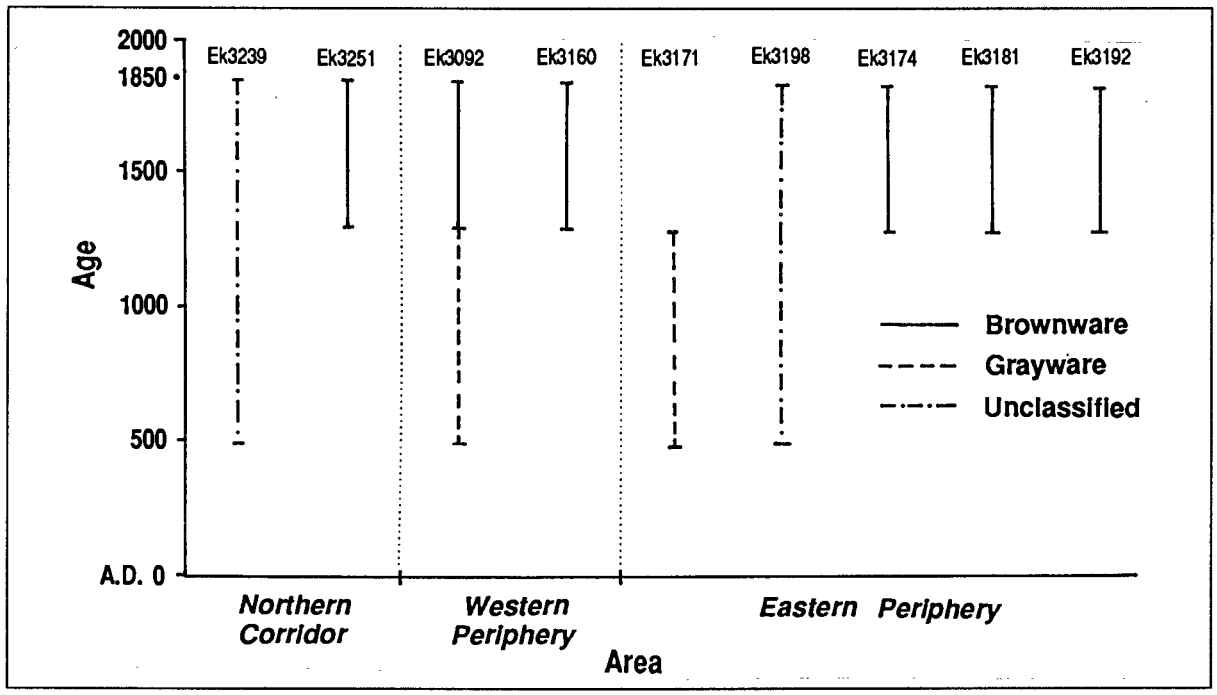


Figure 210. Chronological ranges of ceramics at Tosawihi and vicinity.

Projectile Points

The full chronological range of Great Basin projectile points has been observed in sites at Tosawihi and vicinity. The occurrence of a Clovis point preform fragment at 26Ek3237 suggests that people were in the Tosawihi uplands during the Pleistocene-Holocene transition as early as 10,000 B.C.; Great Basin Stemmed Series, Gatecliff Series, Elko Series, Rosegate Series, and Desert Series points document the presence of prehistoric hunters and gatherers at Tosawihi throughout the Holocene, including the Pre-Archaic - Archaic transition, and all the stages of the Archaic (cf. Figure 208).

Projectile points are numerous and their distribution reveals several patterns suggesting changing use of the Tosawihi landscape through time. Arranged in chronological order and plotted by cumulative frequencies, each assemblage exhibits a characteristic "temporal curve" (Thomas 1983b; 1988). Projectile point loss-discard rates may be influenced by variation in technology, lithic terrane, site function, frequency of occupation, and other factors; heuristically, the curves allow the graphic observation and comparison of this variability. Differing rates among areas or time periods in the same site may signal functional, technological, and spatial variability that can be investigated further.

Figure 211 shows the cumulative frequency curve of projectile points in the Tosawihi assemblage compared with similar ogives from various other upland assemblages in central and northeastern Nevada. In the Tosawihi curve, frequencies of points increase steadily through time, but the rate of increase is greater for Elko Series points with the greatest gain exhibited by Desert Series types. This produces a J-shaped curve, concave to the left. In contrast, point frequency curves for upland sites suggest the greatest increase in frequencies for the Elko Series, and lower frequencies among Late Archaic point series (Rosegate and Desert); thus, the non-Tosawihi curves are all S-shaped.

Thomas (1988) has observed that cumulative ogives sometimes suggest statistically insignificant similarities or differences among frequency distributions. These differences may be

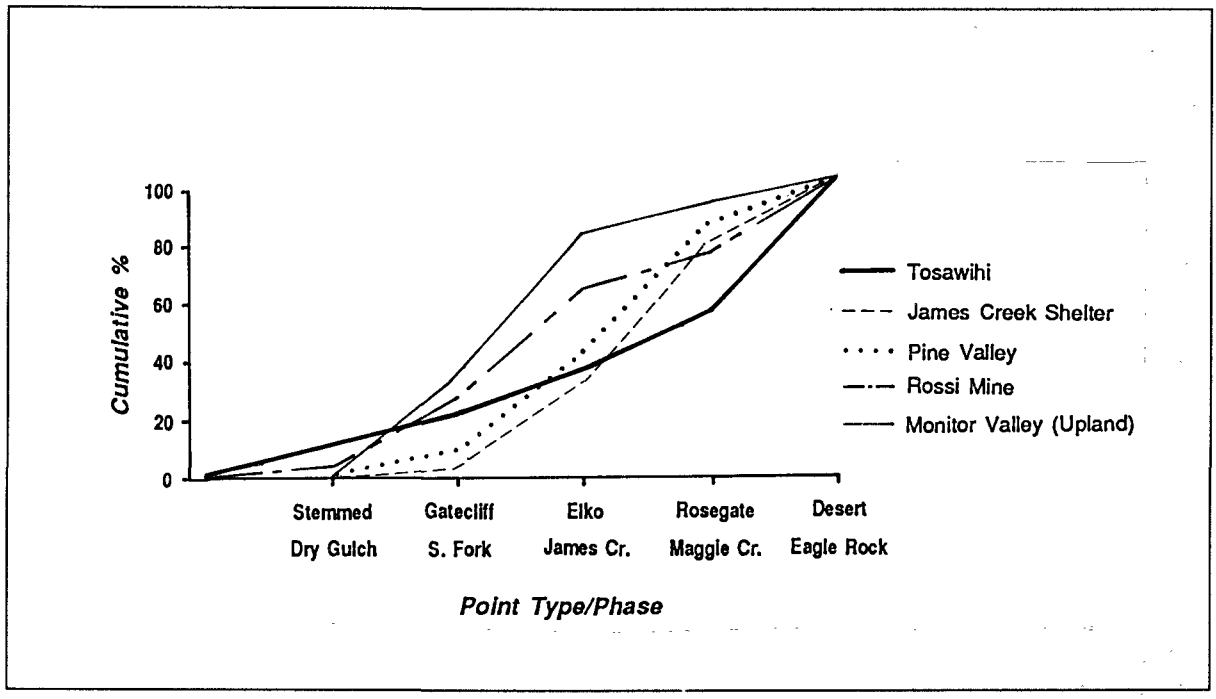


Figure 211. Cumulative frequency curve of Tosawihi assemblage and other upland assemblages.

assessed more adequately by employing the Kolmogorov-Smirnov (KS) two-sample test (Blalock 1979), wherein frequency distributions are considered significantly different only if observed differences in cumulative frequencies exceed a predetermined critical value at the 0.05 level. Table 198 shows that the critical values are exceeded in all cases; thus, we conclude that the Tosawihi distribution is distinctly different from other upland distributions.

Table 198. Maximum Observed and Critical Values Between Tosawihi and Upland Profiles.

	Sample Size n1	n1	Critical Value (0.05)	Max. Observed Value
Tosawihi/Rossi Mine	191	41	.230	.263
Tosawihi/Pine Valley	191	80	.181	.299
Tosawihi/James Creek	191	80	.181	.238
Tosawihi/Monitor Upland	191	62	.199	.451

The temporal curves for each Tosawihi geographic study area are plotted in Figure 212. The curve for the Tosawihi Quarries is most unique. The Northern Corridor and Western Periphery appear similar, while curves for the quarries and the Eastern Periphery contrast the most. Point frequencies in the Northern Corridor and Western Periphery uniformly increase through time, describing a nearly flat line in the case of the North and a slightly J-shaped line for the West. Frequencies in the Eastern Periphery are relatively low through the Rosegate Series, and increase sharply for Desert Series points, producing an even more strongly J-shaped curve. Conversely, the profile for the Tosawihi Quarries exhibits a high frequency of early Great Basin Stemmed Series points, with decreasing trends thereafter, producing a C-shaped curve. A KS test of frequency distributions (Table 199) confirms the statistical significance of the graphic differences among these curves at the 0.05 level. Only the Western Periphery and Northern Corridor distributions and the curves they describe could have been drawn from the same population.

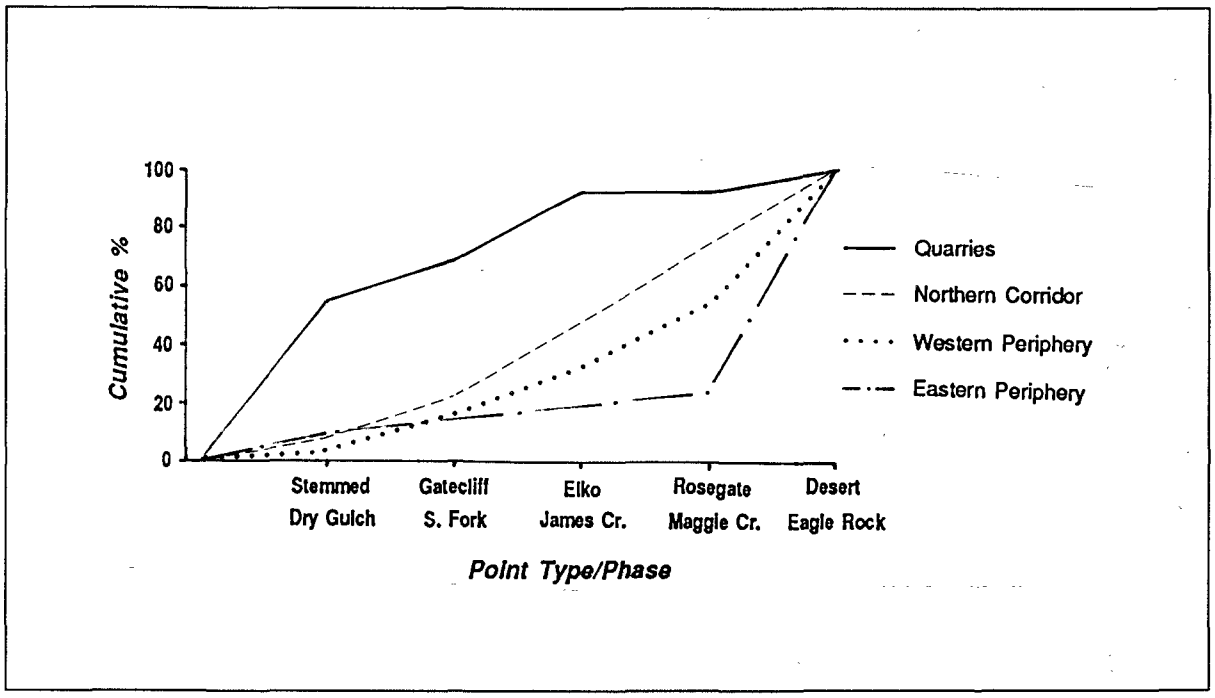


Figure 212. Cumulative frequencies of Tosawihi point assemblage by study area.

Table 199. Maximum Observed and Critical Values Between Tosawihi Geographic Area Profiles.

	Sample Size n1	n1	Critical Value (0.05)	Max. Observed Value
East/West	40	95	.256	.290
East/North	40	43	.299	.500
East/Quarry	40	13	.434	.720
West/North	95	43	.250	.210
West/Quarry	95	13	.402	.600
Quarry/North	13	43	.430	.460

Since the Northern Corridor sites are most distant from the quarry proper, we might expect projectile point frequencies to be somewhat similar to non-Tosawihi upland assemblages, and, in fact, Northern Corridor frequencies are not significantly different from the frequency curves of the pooled upland point assemblage. This probably is due to the relative flatness of both the upland and Northern Corridor curves. The more variable frequency distributions of the three project areas are significantly different, however, from the pooled upland assemblages.

Details of the differences between projectile point curves for different project areas at Tosawihi are illuminated by plots of projectile points across the landscape and by frequency seriation. Figure 213 plots total projectile point frequency by site. It is apparent that many sites are limited to the occurrence of a single point, and that certain sites contain more points than others. Frequency seriation by site presented in Figure 214 reveals that the sites in which projectile points are most abundant have sustained recurring occupation from the Early Archaic (and in the case of 26Ek3237, from the Pre-Archaic). Such sites all lie in the Western Periphery and Northern Corridor. Although some sites in the Eastern Periphery have small accumulations of projectile points, they never are as large as those in the West; moreover, 60% of all points in the Eastern Periphery assemblage are of the Late Archaic Desert Series. The

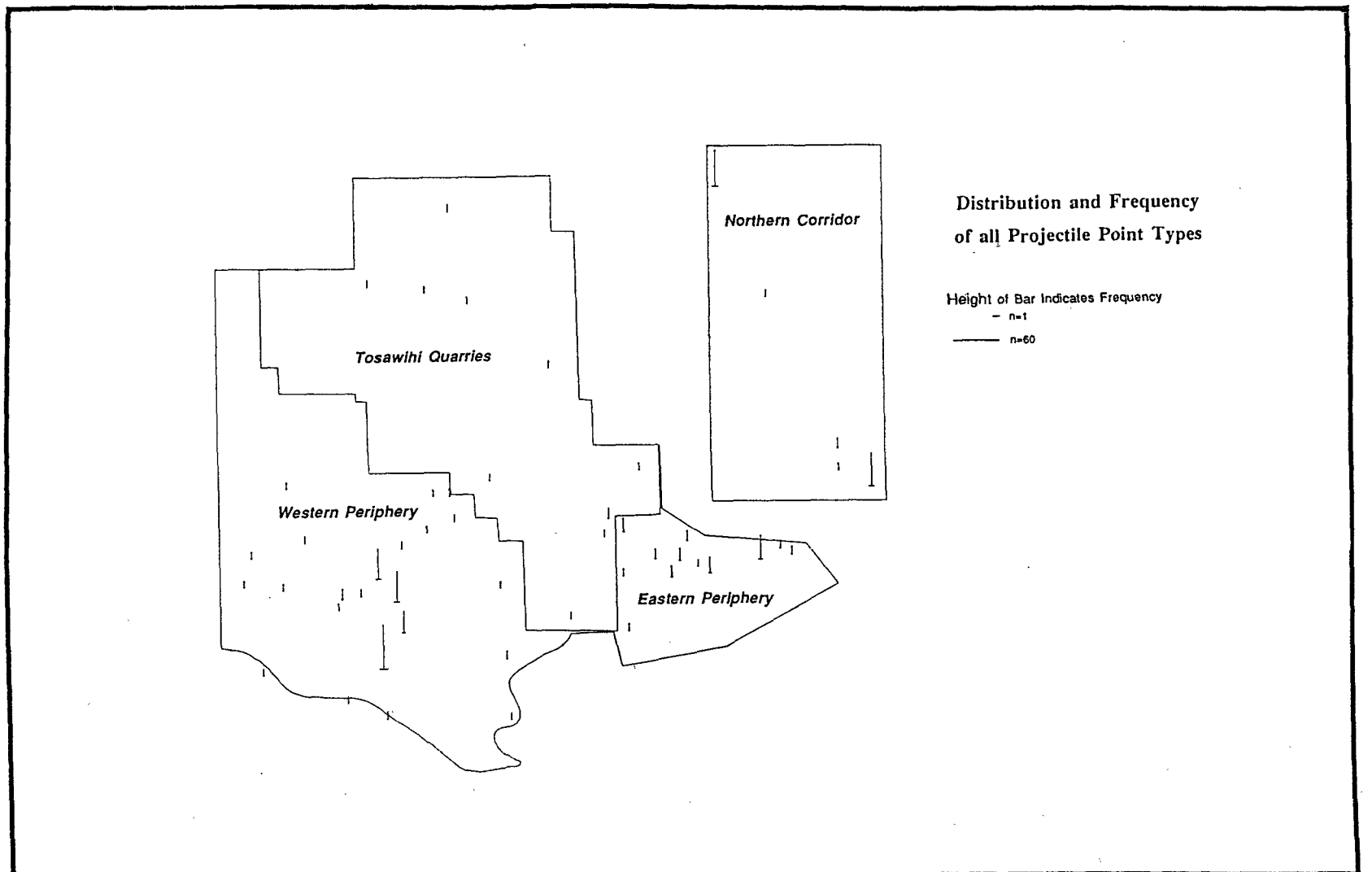


Figure 213. Distribution and frequency of all projectile point types.

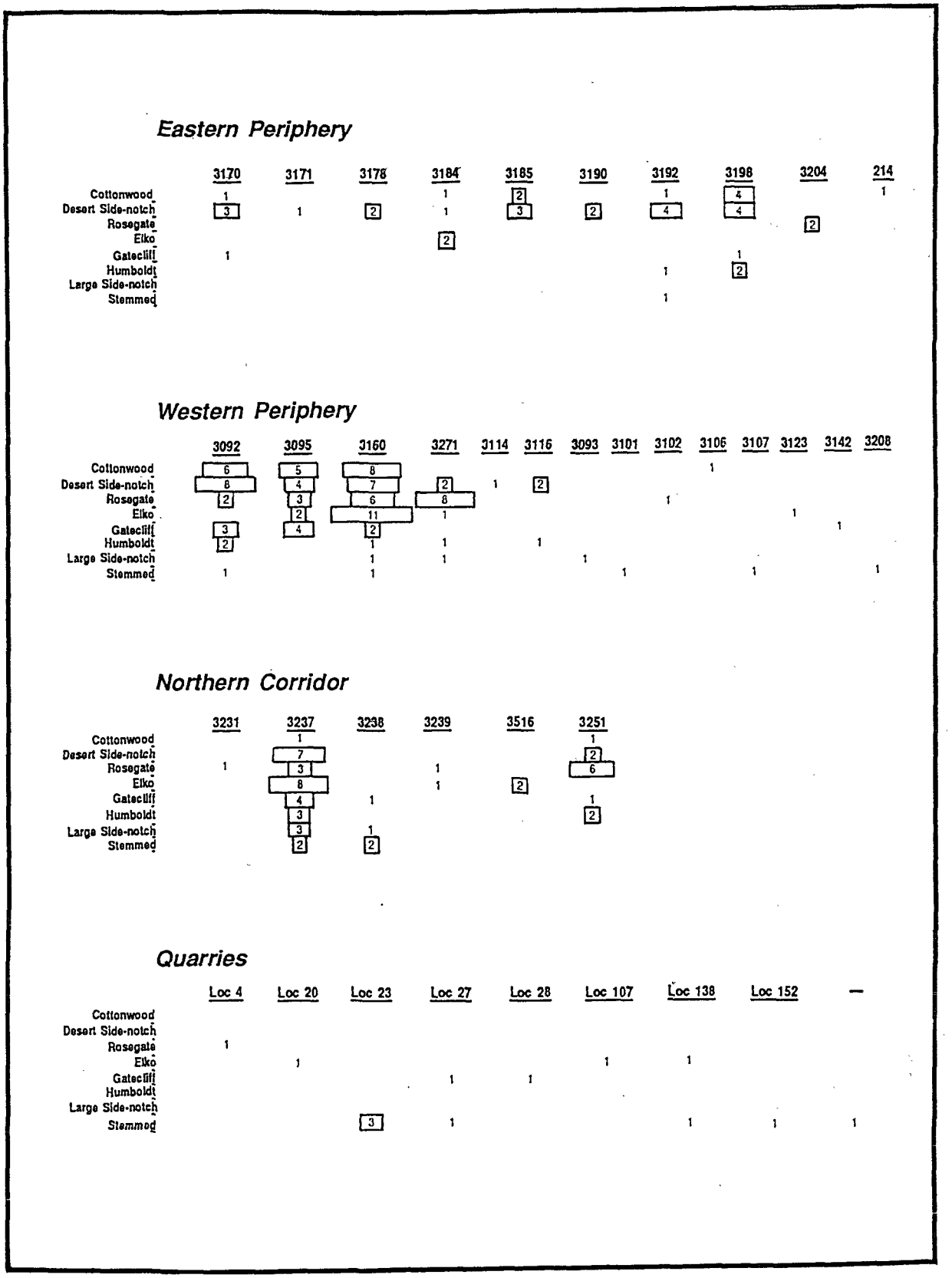


Figure 214. Frequency seriation of Tosawihi projectile points.

Tosawihi Quarries (26Ek3032) exhibit yet a different pattern, with one small accumulation at Locality 23 and only isolated points elsewhere. In the Quarries, only one projectile point is Late Archaic; all others are Middle Archaic to Pre-Archaic.

As shown in the rose diagram of Figure 215, the contrast is striking between the distribution of Pre-Archaic and Early Archaic points on the one hand, and Middle to Late Archaic points on the other. The former are scattered across the landscape as if particular location were unimportant. By the middle Archaic, however, certain places begin to be favored for occupation and are used over and over again. In the very Late Archaic, the same sites are used as in the Middle Archaic, but projectile points begin to accumulate at new places in the Eastern Periphery, an area heretofore visited infrequently.

Average loss rates reiterate the Late Archaic intensification at Tosawihi (Table 200); they are consistently higher in the Western Periphery than in other areas, a pattern most likely linked to continued reoccupation and subsequent retooling at a few favored "residential" localities in that area. While raw frequencies suggest that the Eastern Periphery was the focus of activity during the final phase of the Late Archaic, loss rates suggest concurrent intensification of activity in the West. For Tosawihi as whole, Late Archaic types are deposited at rates nearly three times higher than their Middle and Early Archaic counterparts.

Table 200. Average Loss Rates for the Tosawihi Projectile Point Assemblage.

	Duration	North		West		East		Quarry	
	years	n	rate	n	rate	n	rate	n	rate
Desert	600	11	54.55	44	13.63	30	20.00	1	600.00
Rosegate	600	11	54.55	20	30.00	2	300.00	-	
Elko	2000	11	181.82	15	133.33	2	1000.00	3	1000.00
Gatecliff	1700	6	283.33	10	170.00	2	850.00	2	850.00
Humboldt	3700	5	740.00	5	740.00	3	1233.00	-	
LSN	6300	6	1050.00	3	2100.00	-	-		
Stemmed	2000	4	500.00	5	400.00	4	400.00	7	285.71

It is this Late Archaic increase in projectile point frequencies that gives Tosawihi its unique temporal signature; it may imply changes in mobility and procurement strategies, and probably reflects an intensification of quarrying activity. Something of this sort is suggested by the distribution of projectile point series in feature and non-feature contexts (Table 201). The tendency for Desert Series points to be located within discrete features appears to be directly related to the tendency for Middle Archaic, Early Archaic, and Pre-Archaic points (Elko, Gatecliff, and GBSS) to be found in non-feature contexts. This suggests several possibilities. One is that the creation of discrete features was less frequent in earlier times than later. In turn, fewer features might indicate fewer visits, shorter time of residence, or less intensive processing of toolstone (most discrete features are concentrations of debitage), or a combination of all three. On the other hand, geological and taphonomic processes may have biased the archaeological record in favor of late features by progressive deterioration. These possibilities are examined further in Chapter 22.

Table 201. Proportions of Projectile Points by Series in Feature and Non-Feature Contexts.

	FEATURE			NON-FEATURE		
Series	N	Col %	Row %	N	Col %	Row %
Desert	55	64.0	64.0	31	29.5	36.1
Rosegate	15	17.4	44.1	19	18.1	55.9
Elko	7	8.1	22.6	24	22.9	77.4
Gatecliff	4	4.7	20.0	16	15.2	80.0
Stemmed	5	5.8	25.0	15	14.3	75.0
Total	86			105		

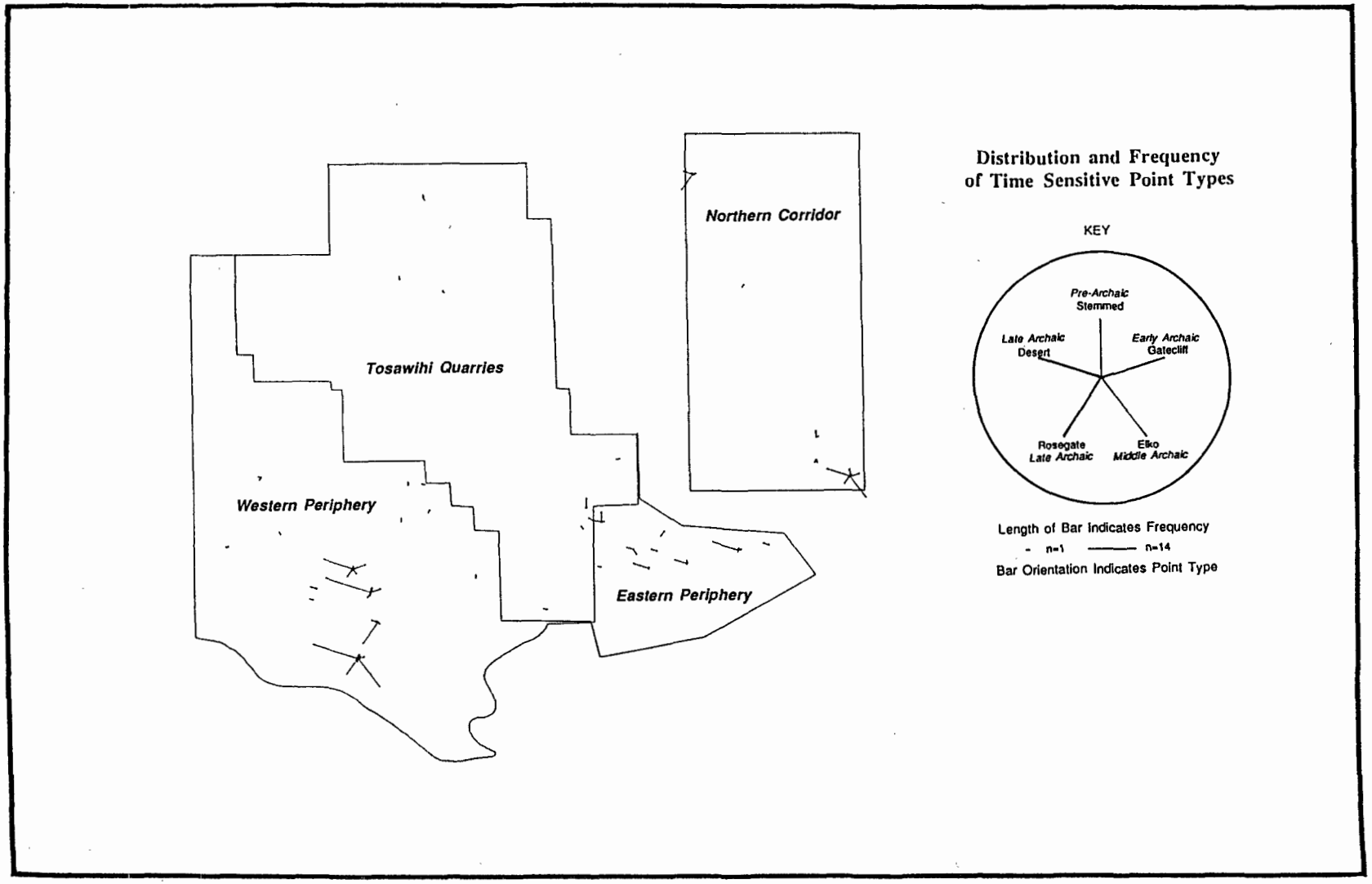


Figure 215. Distribution and frequency of time sensitive point types.

Obsidian Sourcing and Hydration

Chemical composition and source identification is a necessary precursor to obsidian hydration analysis because glass chemistry varies from source to source, and hydration rates vary with glass chemistry. In addition, the distance and direction to source informs on such problems as overall mobility and trade. One hundred forty-seven obsidian artifacts from Tosawihi and vicinity were subjected to nondestructive energy dispersive X-Ray florescence analysis (Appendix N) in order to determine their chemical composition. The composition of specimens then was matched to reference specimens from known sources.

Each of the 147 specimens sourced by X-ray florescence subsequently was subjected to hydration analysis (Appendix M). Most specimens were cut only once, but six sustained additional cuts in order to check for multiple or variable hydration rinds that might suggest scavenging and reuse. Hydration rims were absent from eight artifacts, however, so the total number of hydration values (153) differs from the total number of obsidian artifacts observed.

X-Ray florescence studies reveal 14 to 16 sources of obsidian used at Tosawihi Quarries (Table 202 and Appendix N). The identification of the Fox Mountain source is less than certain and four specimens may have come from either Double H Mountains or Pinto Peak. Several sources of unknown location have been identified in previous studies (Unknown A-F), and nine specimens derived from a previously unrecognized source of unknown location. Six of the known sources (Bordwell Spring, Fox Mountain, Double H Mountains, Majuba Mountain, Pinto Peak, and Paradise Valley) lie to the west (Figure 216). Three others (Brown's Bench, Malad, and Timber Butte) lie to the north. The Paradise Valley source, located some 90 km northwest, provided nearly half of all sourced obsidian from Tosawihi.

Box plots of hydration values by source are given in Figure 217; Table 202 presents hydration value statistics. Obsidian from the Brown's Bench source exhibits the widest range of values, followed by Paradise Valley, the unrecognized source, Pinto Peak, and Unknown D.

Table 202. Mean Obsidian Hydration Values by Source.

Source	n	%	No. of Readings	Missing Rinds	Mean Hydration Thickness	Standard Deviation
Browns Bench	37	25.34	38	4	3.338	2.431
Bordwell Spring	1	.68	1	-	4.200	-
Fox Mountain	1	.68	1	-	2.600	-
Double H Mountain	1	.68	1	-	3.500	-
Malad, Idaho	3	2.05	3	-	1.733	.155
Majuba Mountain	1	.68	1	1	-	-
Pinto Peak/Double H Mtn.	4	2.74	4	-	3.000	2.166
Paradise Valley	71	48.63	74	1	3.403	2.056
Timber Butte, Idaho	1	.68	1	-	1.500	-
Unrecognized Source	9	6.16	12	-	3.317	2.091
Unknown A	4	2.74	4	-	1.325	.0287
Unknown B	2	1.37	1	1	4.800	-
Unknown C	2	1.37	2	1	1.100	-
Unknown D	6	4.11	6	-	1.450	-
Unknown E	1	.68	1	-	7.500	-
Unknown F	2	1.37	2	-	1.700	-
	146	100.00	152	8		

Arranging hydration values of Paradise Valley obsidian (for which sample size is sufficient) by projectile point series in chronological order shows values to vary systematically

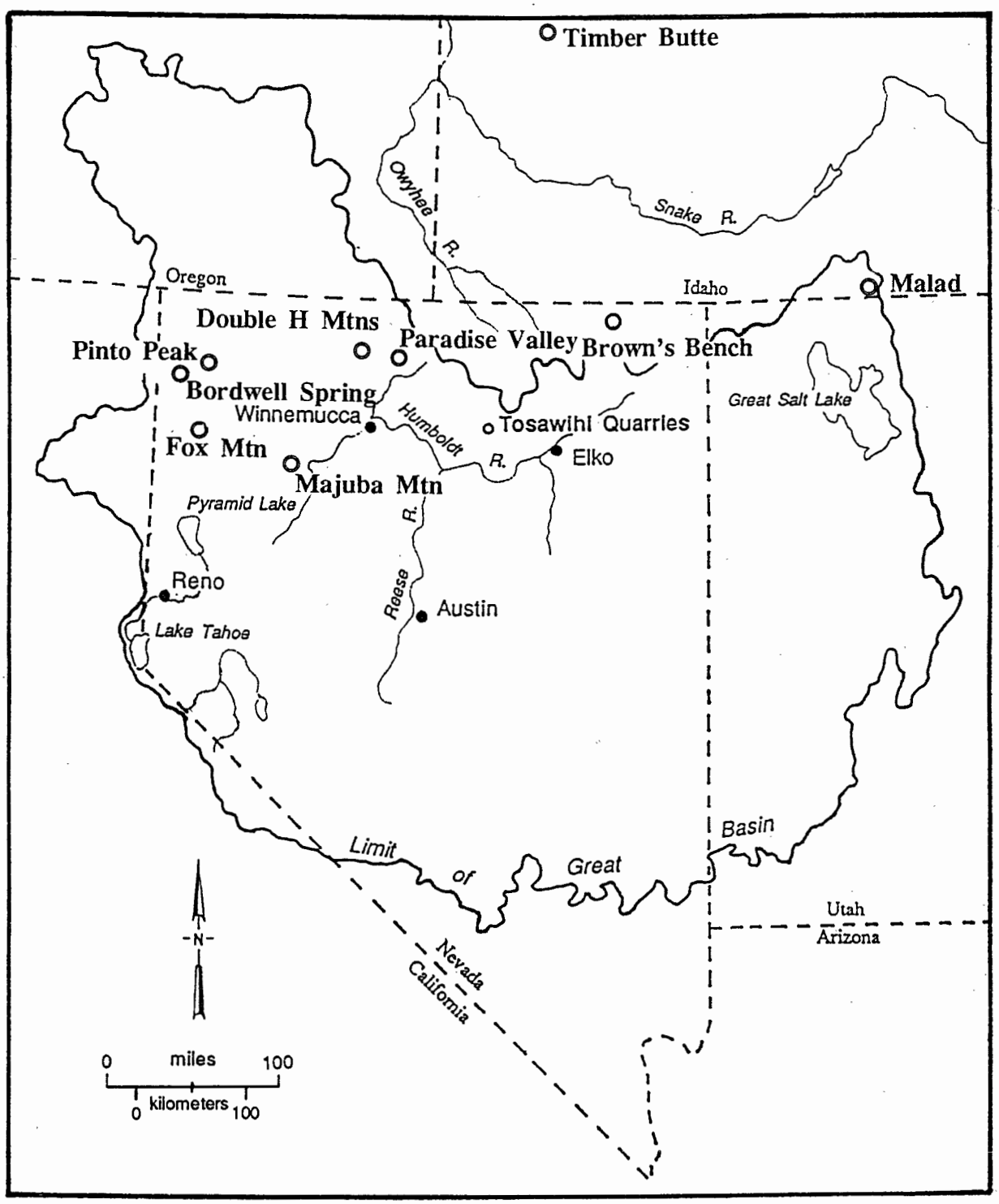


Figure 216. Obsidian source locations.

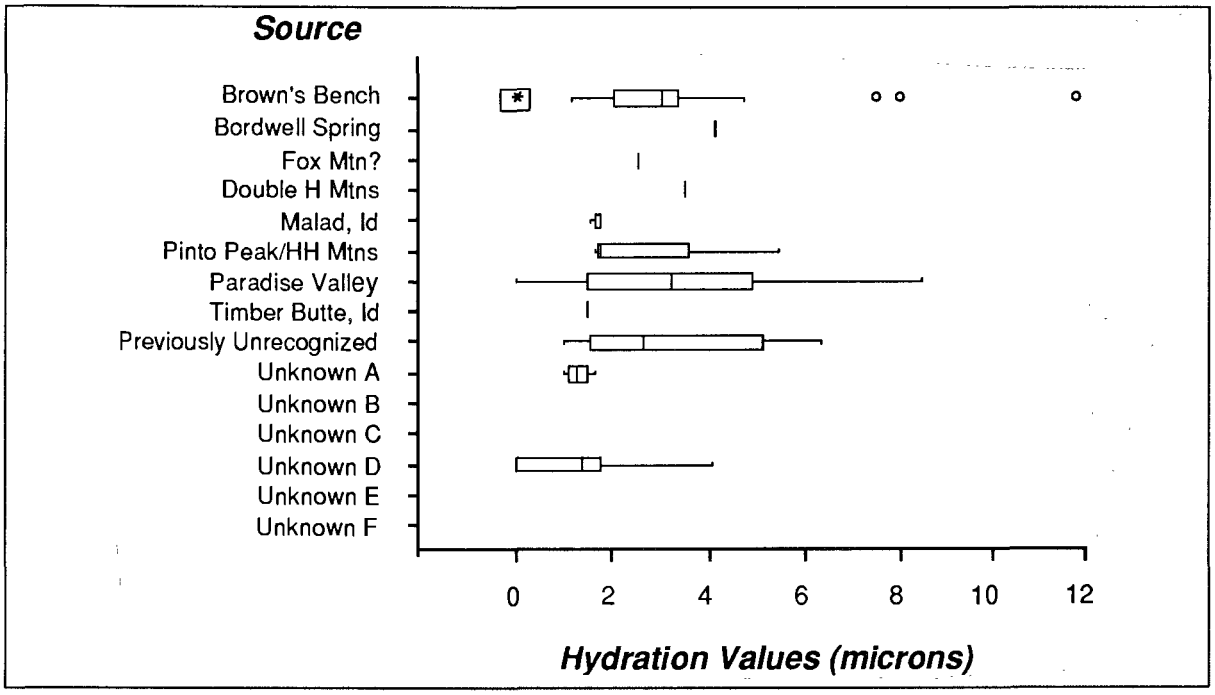


Figure 217. Mean hydration values by source.

as expected (Figure 218a), although there is considerable overlap between series. The very large spread for Large Side Notched, although only based on three values, is as expected for this poorly time sensitive series. The very large value for the single Humboldt Series point is greater than expected but not interpretable with only a single datum. The larger than expected outliers for Cottonwood points in the Desert Series, as well as Rosegate, Elko, and Gatecliff Series suggest the possibility that some points were misclassified. For example, a few specimens keyed as Cottonwood points may actually be Rosegate preforms. Similarly, some of the Rosegate points may have been reworked from older points, and extreme measurement from an Elko point was taken from a re-worked margin.

The box plots in Figure 218a-b show these relationships in a different way. The much greater range of hydration values for artifacts classified as Cottonwood points is clear for the Paradise Valley and Brown's Bench sources. The box plots and the simple plot of values from various other sources (Figure 218c) suggest a generally late range for artifacts morphologically outside the parameters of the Thomas (1981) key, and a large range of values for points unclassifiable due to fragmentation. Together, these suggest that the Paradise Valley source was used more or less throughout prehistory, while use of the remaining sources was restricted to the Late Archaic and Pre-Archaic. Figure 218b does not reflect two Great Basin Stemmed points made of Brown's Bench obsidian on which hydration rinds could not be observed; the distribution of Brown's Bench obsidian thus appears to be part of a larger pattern in which there is greater variability in obsidian sources during Pre-Archaic and Late Archaic times. It is interesting to note that Brown's Bench obsidian was present throughout the record at James Creek Shelter (Hughes 1990), although Paradise Valley obsidian always was more abundant.

As touched on previously, there are two common explanations for increased variability in toolstone sources. One involves greater mobility which makes more sources accessible to individuals; the larger number of Pre-Archaic sources thus fits well with our interpretation of a highly mobile Pre-Archaic subsistence and settlement strategy. The other explanation involves trade and redistribution in a less mobile settlement pattern, such as we have proposed for the Late Archaic; this fits with the Middle Archaic collector - Late Archaic traveller pattern proposed by Bettinger and Baumhoff (1982). Of course, confirmation of this will require additional sourcing and hydration data from sites outside Tosawihi.

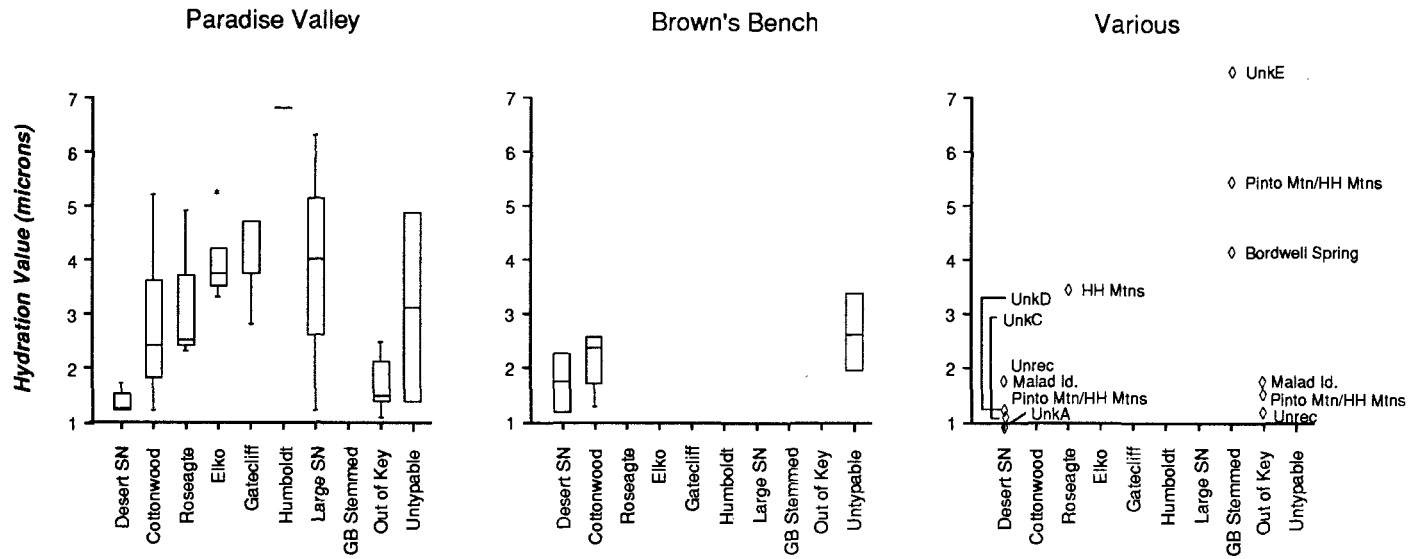


Figure 218. Mean hydration values by source and projectile point type.

Although the distribution of projectile points suggests a strong temporal contrast between feature and non-feature contexts, the relationship is expressed less robustly by the obsidian hydration data. The mean hydration values for all obsidian artifacts are given by source in Table 203. Although the mean hydration values for non-feature obsidian are greater in each case, the t-test shows no significant differences at the 0.05 level.

Table 203. Mean Obsidian Hydration Values by Source, Feature and Non-Feature Contexts.

	FEATURE			NON-FEATURE		
Source	n	Mean	SD	n	Mean	SD
Brown's Bench	20	3.29	1.76	6	3.50	4.21
Paradise Valley	30	3.20	2.10	38	3.55	2.04
All	73	2.90	1.95	62	3.50	2.24

Box plots of obsidian hydration values for major tool categories by source are presented in Figure 219. These plots show that the range of values for small bifaces and debitage is similar to the range for projectile points. This suggests that some small obsidian bifaces have considerable antiquity, and, in fact, may be fragments of preforms for GBSS points. In addition, obsidian debitage has been produced over a long period. Were subsequent research to establish absolute hydration rates for different sources, obsidian debitage could become a useful temporal marker for the region.

Tephrochronology

Mazama ash is present in deposits exposed in Willow Creek at 26Ek3251, and on Ivanhoe Creek just upstream of 26Ek3237 (Elston, ed. 1989), but not in any sites in the Eastern and Western Peripheries. The chances are, therefore, that all sites described in this report are younger than 7,000 B.P., since Mazama ash is either far below cultural deposits, if present, or is absent altogether. For a while, we thought that Mazama ash was absent from the vicinity of the Quarries, perhaps scoured away during the mid-Holocene. In the summer of 1989, however, we observed the ash in colluvium cut by an ephemeral stream at the southern base of Big Butte and in colluvial deposits at the north end of Velvet Canyon. Artifacts are present below Mazama ash in alluvial and colluvial sediments recently exposed during testing of Localities 26 and 27 in 26Ek3032 (Leach and Botkin 1991). The presence of Mazama ash in the Tosawihi uplands will allow correlations with other Mazama localities in the Upper Humboldt region, including Valmy on the Humboldt River (Elston et al. 1981), in the James Creek drainage (Elston and Budy 1990), at Upper South Fork Shelter (Spencer et al. 1987) and on Mahala Creek in North Fork Valley (Madsen 1985).

Summary and Conclusions

Compared to adjacent regions, the temporal record for Tosawihi is complete, but it suffers similar chronological ambiguities for the Pre-Archaic and Early Archaic, lacking reliably dated, buried cultural deposits or absolute hydration rates for the major obsidian sources that could be applied to surface materials. The number of radiocarbon dates is relatively large, but they are concentrated in the Late Archaic and subject to the caveats discussed above.

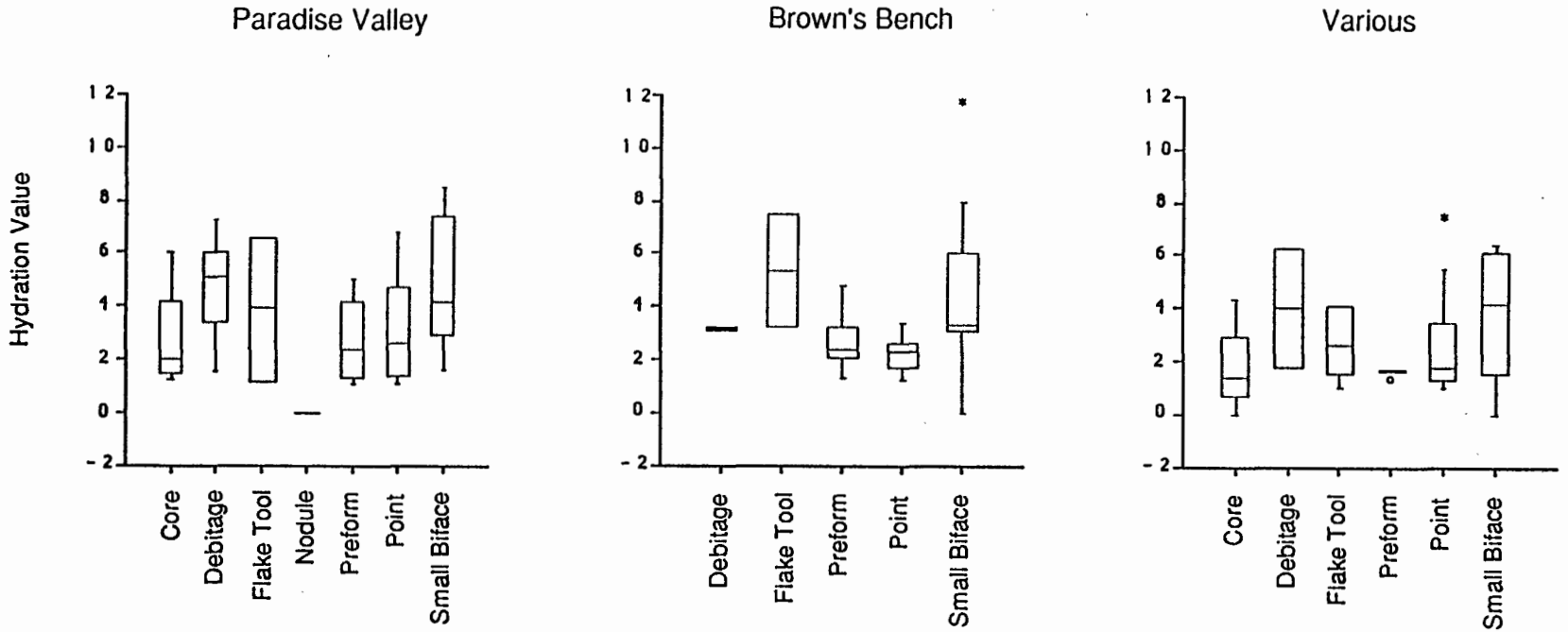


Figure 219. Mean hydration values and sources for major tool categories.

The Middle Humboldt chronology remains too ambiguous for meaningful comparisons with Tosawihi, but matching Tosawihi and the Upper Humboldt provides some interesting contrasts. In the Upper Humboldt, sites are occupied intermittently and for short periods, from earliest times through most of the Middle Archaic James Creek Phase. At James Creek Shelter and the South Fork shelters, intensity of occupation began to increase during the late James Creek Phase, accelerated in the Late Archaic Maggie Creek Phase, then abruptly fell off in the Eagle Rock Phase. Similar trends are observed elsewhere in the region. An analogous pattern of short term, intermittent use, not tied to a particular place, is seen at Tosawihi through the Pre-Archaic, although the "sweet spot" of 26Ek3237 was used regularly from earliest times. The relatively large number of obsidian sources suggests high mobility and large annual range. In the Early Archaic, a few sites in the Western Periphery (26EK3092, 26Ek3095, and 26Ek3160) were visited frequently enough for artifacts to accumulate, a trend that increased throughout the remainder of the sequence. At the same time, the number of obsidian sources shrinks to one, at Paradise Valley, 90 km west. This could have resulted from lower mobility and contraction of annual range. In the latter part of the Late Archaic, congruent with the Eagle Rock Phase of the Upper Humboldt, favored sites at Tosawihi continued to be occupied together with new sites in the Eastern Periphery, while quarrying appears to have intensified. These trends were accompanied by an increase in the number of obsidian sources to nine. One possible explanation is that further increases in population, still lower mobility, and yet smaller annual range made trade in lithics increasingly important, along with use of smaller, perhaps lower-quality sources that previously were ignored.

While it looks as if something very different is going on at the Tosawihi Quarries during the Late Archaic compared to other areas in the Middle and Upper Humboldt regions, events in both areas are likely connected, parts of system-wide changes that we presently do not see clearly. It is safe to say that people have visited Tosawihi Quarries from the earliest prehistoric times, and that the archaeological record there probably spans 10,000 years. The distributions of time sensitive artifacts, obsidian hydration values, and radiocarbon dates suggest differences in the way people used Tosawihi through time.

Chapter 20

SUBSISTENCE

Dave N. Schmitt, Eric Ingbar, and Christopher Raven

We proposed in Chapter 2 that the Tosawihi countryside was neither homogenous nor very generous in the resources it offered prehistoric foragers. Toolstone was its chief immutable attraction over most of the millennia it was visited, and to get that and bring it home in usable packages, aboriginal groups had to calculate with fairly nice precision how to feed themselves during quarrying ventures. In the present chapter we look at some of the exigencies of making a living at Tosawihi, paying particular attention to the roster of locally available foodstuffs, the energetic implications of exploiting them, and the slender archaeological evidence for any of them ever actually having come into play. Our intent is to synthesize current understanding of basic subsistence strategies at the quarries, in the interest of informing later discussions (Chapter 28) about the role they may have played in economic decision-making.

First, we identify categorically what we believe to have been the principal subsistence opportunities available to prehistoric visitors to the quarries, addressing, where we control the necessary data, both spatial and seasonal incongruities in the distribution of resources. Next, we attempt to relate the resource landscape to the specific foraging values of individual classes of species within it, relying on empirical generalizations and a few assumptions drawn from optimal foraging theory; our intent here is to sketch the determinants of a feasible diet breadth for Tosawihi foragers, to evaluate local foodstuffs in light of some of the forfeitures of other opportunities that visits to the uplands must have entailed, and to anticipate what the archaeological record should look like if our assumptions are correct. Too, we confront some of the ways in which critical elements of the effective foraging environment may have changed over the hundred centuries of the Holocene.

Subsequent discussions relate how the things we have collected from the archaeological record bear directly on these issues—how organic residues and subsistence-related artifacts testify to the content of prehistoric meals and past strategies of food-getting —and we explore the limited degree to which the distributions of these data classes in time and space inform us about the gastric organization of work at Tosawihi. In later chapters, we consider how our best current understanding of the material, spatial, temporal, and energetic aspects of reconstructible Tosawihi subsistence strategies sheds light on prehistoric strategies of lithic procurement.

Subsistence Opportunities and Constraints

Even under the most provident past ecological regime, the resource landscape of the Tosawihi uplands is likely to have differed significantly from that of the surrounding low country; the bottomlands of Willow Creek, Rock Creek, Boulder Creek, and the Humboldt River almost certainly always were lusher than the craggy, poorly watered, thinly mantled knolls and slopes of the quarry and its hinterlands. In most seasons, and under most imaginable regimes, the high country simply was less hospitable than the valley floors, owing to a chain of three ecological contingencies.

In the first place, Tosawihi lies very near the crest of the local watershed, with the result that perennial groundwaters are limited to the eruptions of a few shallow aquifers; only half a dozen springs and seeps rise early in the year, and only two of them are reliable past August under the current regime. Streams are even more fugitive; only Willow Creek and,

less exuberantly, Ivanhoe Creek, flow past June. This means that the availability of water must have constrained freedom of movement in and around the quarries whenever climate approximated the present circumstance, and that the activities of prehistoric foragers must have been tethered in time and space to a relatively small number of water sources. In contrast, we have observed fairly abundant, reliable waters in nearby, comparably upland settings (e.g., the Snowstorm Mountains, the Tuscarora Range, and the Owyhee Bluffs), suggesting that the relative dryness of the Tosawihi landscape is a local phenomenon, necessarily typical of neither the latitude nor the elevation at which it rests.

In the second place, absent many spring plots and riparian corridors, vegetation seldom flourishes with the moisture-loving communities that elsewhere comprise the Great Basin's richest foraging patches. The shallow, quickly-drained soils of most of the landscape, in fact, are dominated today by inedible or non-nutritious shrubs (big sage, low sage, rabbitbrush, and phlox), interspersed with a mundane assortment of perennial grasses. The deep gorges of a few now-seasonal drainages retain small pockets of more complex (and, from a foraging perspective, more favorable) associations, and we must assume that prior to the inception of domestic livestock grazing the grasslands were more productive than they are today. Neither setting, however, offers much browse or cover for herbivorous animals, and neither offers many plants of economic interest to human foragers. Without a significant modification of the effective moisture regime, (e.g., as a product of increased precipitation, the onset of cooler conditions, or a shift in the seasonal dominance of rainfall), no forager *ever* should have left the lowlands to go to Tosawihi solely to collect plant foods.

And in the third place, the poverty of water and plants impoverishes the abundance and distribution of wildlife. Lacking diverse or particularly favorable habitats, few native animals larger than Size Class IV (cf. Chapter 13) dwell in the countryside. In this respect, too, Tosawihi differs from surrounding upland settings; absent the extensive riparian zones or well-developed mountain shrub communities (bitterbrush, serviceberry, mountain mahogany) that characterize many mid-elevation patches within 20 km of the quarries, deer and mountain sheep are likely to have visited only seasonally. Except for brief (but sometimes tightly clustered) congregations in the spring, few deer and antelope were observed over our four seasons of fieldwork; we suspect that, even before the attrition of habitat induced by livestock grazing, mining, and fire-suppression, there would have been few resources to attract large herds. Too, while smaller mammals (especially rodents and lagomorphs) thrive in several microhabitats, and in peak seasons (chiefly, spring) doubtless compose a rich and unignorable biomass, we doubt that the populations of their largely insular colonies bulk large enough to sustain prolonged or intensive human predation.

This reading suggests, of course, that the Tosawihi environment as it presently is composed could offer foragers few opportunities to hunt and fewer to gather in most seasons of most years; even a drink of water can be hard to get away from a few scattered points on the map. Consequently, we can posit few reasons why, outside a probably narrow window in late spring or early summer, foragers should have abandoned the well-watered, fish-rich, grassy, herd-strewn valley bottoms lying on every side to come up to this unforgiving landscape (as it presently is composed) unless they were motivated by reasons *other* than feeding themselves well. Almost every upland in every direction is likely to have offered better foraging opportunities and is more likely to have been included in an annual foraging range. But the archaeological record discloses that people came to Tosawihi time and again, in great numbers or over a long span of time, to get toolstone. We are interested, then, in understanding *how* quarriers may have compromised their opportunities for better or easier meals in the interest of acquiring stone, and in measuring the degree to which the quest for toolstone may have supplanted the quest for cheap food. Some observations on the probable balance of costs and benefits follow.

Credits and Debits of Foraging at Tosawihi

None of the resources presently available at Tosawihi rewards its capture very favorably; measured calorically, the best foraging returns should come from hunting deer and antelope (mammals of Size Class V), while other classes of quarry generally should return fewer calories for greater expenditures of effort (Table 204).

Table 204. Caloric Returns from Hunting Various Size Classes of Mammal (after Simms 1987:47; cf. Thomas 1969)

Size Class		Return Rate (Cal/hr)
I	Mice, Voles	2,837 - 3,593
II	Ground Squirrels, Wood Rats	5,390 - 10,780
III	Rabbits, Hares, Marmot	8,983 - 15,400
IV	Coyote, Badger	(12,354 - 23,425)*
V	Deer, Pronghorn, Sheep	15,725 - 31,450
VI	Bison, Wapiti, Cow	Untested

*Interpolated estimate; caloric returns from hunting Class IV mammals were not tested in Simms' foraging experiments.

These experimentally-derived return rates suggest that efficient Tosawihi foragers always should have pursued animals of higher size class, since the reward of the larger meat "packages" gained far outweighs the greater costs of search, pursuit, and handling entailed in their capture and processing as food. Such a strategy could be invoked, however, only when and where the target prey was available, and we have little reason to believe that Tosawihi often hosted deer and antelope in abundance. Only along the courses of Willow Creek and Ivanhoe Creek (the Northern Corridor), along Undine Gorge (the Eastern Periphery), and perhaps in Basalt Canyon and on the slopes of Rodent Valley (the Western Periphery), do circumstances of water, vegetation, and landform conspire to invite big herbivores. Elsewhere, although they may have passed by occasionally (and on which occasions they *always* should have been taken by prudent foragers), deer and antelope, as well as their meatier precursors (elk and bison), seldom are likely to have congregated in the area and only in spring are likely to have contributed to the composition of reliable foraging patches.

Smaller animals are another matter; we saw them abound at the margins of almost every site we visited, and we found lots of them comfortably at home along Ivanhoe Creek, in Rodent Valley, and along the southern flank of Undine Gorge. Their cumulative biomass doubtless is relatively high, although it is prone to fluctuate dramatically from year to year (Janetski 1979). Efficient capture techniques (such as snare-trapping) can enhance the foraging value of Class II and III animals as game (Janetski 1979; Simms 1987:70-71), and at Tosawihi such animals are likely to have comprised the upper end of the diet breadth whenever larger game was unavailable or inconvenient to pursue (cf. below). Consequently, we should expect to see them represented more frequently in the archaeological record than the bony parts of bigger game. Because, however, irrespective of capture techniques, rabbits, rats, and mice are costlier to exploit, they make up a more expensive diet than big game hunters customarily enjoy, and other enterprises (such as toolstone acquisition) that rely on such a diet necessarily must have adopted a posture of temporary impoverishment.

Of plant foods at Tosawihi we almost cannot say too little; they are scattered, sparse, and they offer meager benefits. The richest foraging returns from species we have observed in the field should come from bitterroot (Simms 1987:181), presently confined to a relatively small zone in the Western Periphery (i.e., Bitterroot Ridge, subsuming 26Ek3095, 26Ek3160, and 26Ek3165). Elsewhere, save a few ragged patches where roses and currants struggle at the bottoms of deep gorges, there are no plants better to eat than grass. Grasses, however, are among the costliest foods Great Basin peoples are known to have pursued, and their caloric returns reflect how hard it is likely to have been for foragers to rely on plant foods at the quarries (Table 205).

Table 205. Caloric Returns from Collecting Various Plant Species (after Simms 1987:47)

Species	Return Rate (Cal/hr)
Bitterroot	921 - 1,238
Bluegrass	266 - 473
Great Basin Wildrye	301 - 392
Bluebunch Wheatgrass	ca. 250*
Sedge	202
Squirreltail	91

*Interpolated estimate; caloric returns from bluebunch wheatgrass were not tested in Simms' foraging experiments.

So, when foragers went to Tosawihi (for whatever reason), planning to live off the land, they had to plan also to eat lean, and to burn a lot of energy assembling, for the most part, scrappy meals. Only in late spring or early summer could the hunter reliably expect to bring home an antelope or a deer; more often, he or his party could count at best only on returning marmots, rabbits, and rodents. Gathering, inevitably, was even less rewarding; aside from bitterroot (the richest locally available food plant, but less than half as productive as the poorest animal quarry), only wretchedly costly grasses were at hand. For human groups living at other times of the year lower on the landscape, where resources were richer and their capture more assured, trips to Tosawihi must have comprised a considerable forfeiture of other, less risk-prone opportunities, a tacit willingness to embrace a broader diet breadth, and a measured assessment of resource costs and values that judged toolstone acquisition an affordable (that is, profitable) pursuit.

We have few bases from which to speculate about *how* profitable such ventures ultimately may have been, but we can begin to understand something of the economic decision-making they entailed by measuring the subsistence costs they are likely to have exacted. If we assume, for instance, that a young adult male will burn on the order of 600 Cal/hr while quarrying in pits (a very rough approximation based on our own actualistic quarrying experiments [cf. Chapter 4] as well as on interpolations from estimates for various athletic activities demanding comparable levels of effort; cf. World Almanac 1991:205), we observe that subsistence reliance on most locally available plant foods would require preposterous outlays of time to fuel the work. A quarrier *could* live on a diet of squirreltail grass, but only if he or his cohort were willing to invest about seven hours in seed collection and processing for every hour spent quarrying. Even bitterroot, the most favorable plant resource available in the local biotic assemblage, should require about .5 person-hours of post-encounter handling time to support every person-hour of quarrying. Hunting, on the other hand, could support quarrying more easily, the expected ratio of subsistence time to quarrying time ranging from about 5:1 to more than 50:1. Clearly, quarriers at Tosawihi always should have relied chiefly on a diet of meat, supplemented by high ranked plant foods only where an otherwise unoccupied, non-hunting labor force was available to carry out the necessary collection and processing.

These considerations contribute to modeling some of the scenarios under which subsistence may have been pursued at Tosawihi, and to sketching some of the ways in which other work there may have been organized to accommodate the need to eat. If we assume, for instance, that quarrying ventures most likely were staged in late spring or early summer in the interest of capitalizing reduced opportunity costs, then pursuit of big game must have been part of the enabling strategy. Regardless of group composition, however, this means that the efforts of at least some potential quarriers necessarily were deflected sometimes to get food. If quarrying parties were composed of small groups of males, this could have been accomplished either through task specialization or rotation of tasks; in either case, both hunting *and* quarrying must have required forfeiture of time spent in the other pursuit, and each, in consequence, must have been rendered more costly. Alternately, if mixed gender parties visited the uplands during the same season, women (and perhaps children) could have foraged for lower-ranked but still energetically enabling resources (small mammals, bitterroot) while men quarried. It even is conceivable that, in the interest of maximizing efficiency, women may have relieved men from certain quarrying tasks to support occasional hunting forays. Implicit in this, of course, and untestable archaeologically, is the assumption of a sexual division of labor in which men usually pursue more mobile subsistence resources (i.e., big game) while women usually collect more static ones (which happen, incidentally, to fall lower along the optimal diet curve; cf. Figure 220). Too, we assume that women did not constitute the primary quarrying work force, although this might be challenged by the proposition that, physical strength allowing, the most profitable blend of effort should assign big game hunting as men's first priority in support of the quarrying party, however composed.

Past early summer, with the retreat of deer and antelope from the area, foragers would have to shift their attention to lower-ranked resources, and time spent at the quarries should grow progressively more expensive. We have observed, for instance, that small mammal colonies

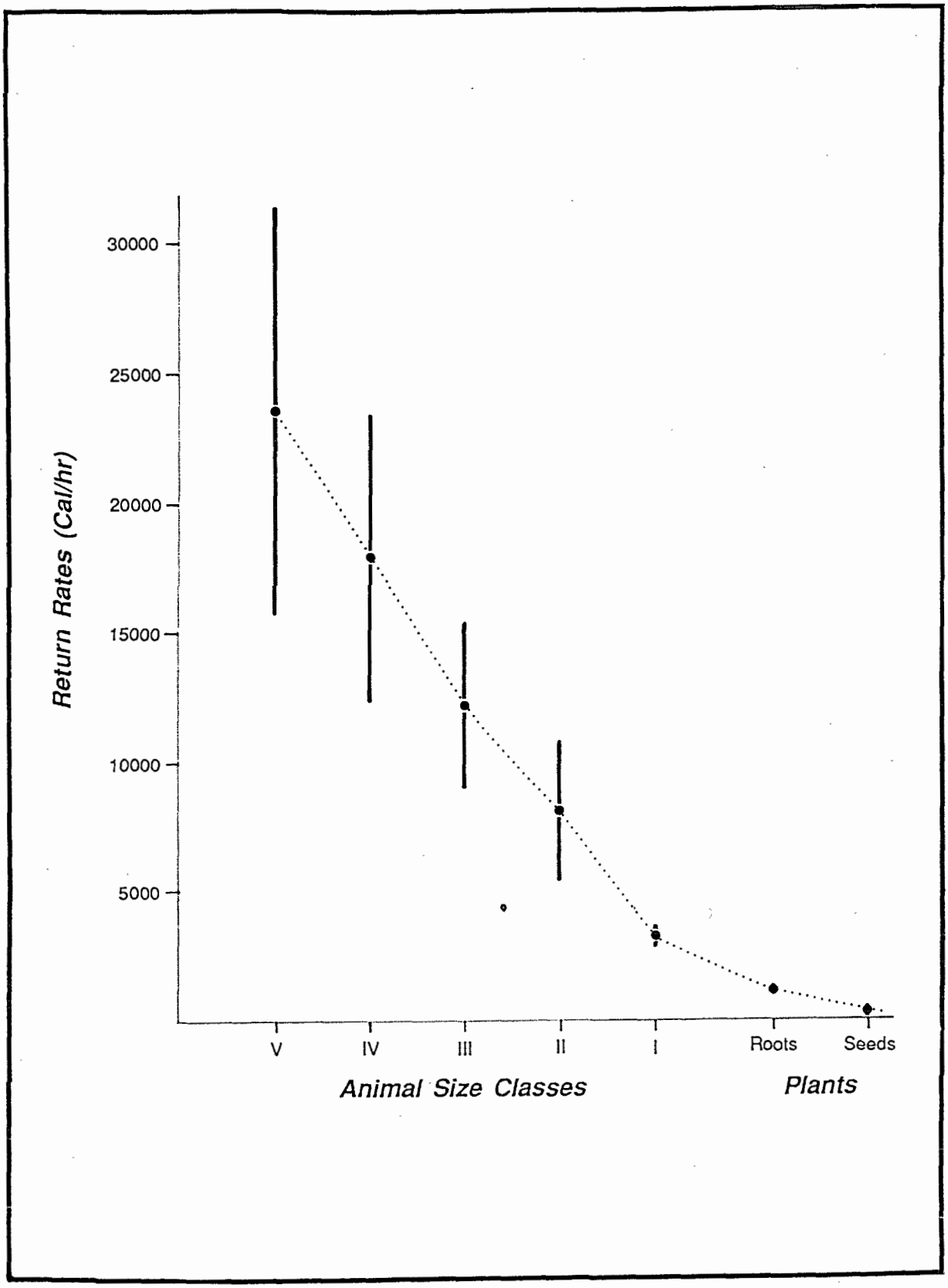


Figure 220. Categorical Optimal Diet curve for presently available Tosawihi resources (return rates after Simms 1987).

constitute probably favorable (but finite) foraging patches throughout the summer of most years, but that other resources decline, sometimes critically. By the end of summer there remain few plant foods to bolster the diet; grasses have dropped their seeds, and the starch reserves of roots have been depleted to foster new growth. We suspect that even the most robust colonies of small mammals at Tosawihi could tolerate to only a limited degree the intensification of predation that a late summer foraging focus would impose, since at that time they would constitute virtually the whole of the diet; if not depleted utterly, their populations easily could be stressed, with severe consequences for out-year foraging in the same patches.

Too, of course, water sources outside the Northern Corridor are unreliable late in the warm season, with the result that in many years (under the current regime) quarrying forays would be taxed by the additional costs of travel or water transport. The unreliability of local water prevails throughout the fall of most years, posing a formidable limiting factor on human presence in the quarries, and is relieved only with the onset of winter snowfall, itself a major constraint inflating the costs of both foraging and quarrying.

We suspect, then, that amelioration of the opportunity costs of quarrying (cf. Chapter 3) could be achieved effectively only in late spring or early summer, when big game, rodents, roots, and water all were available, relatively plentiful and predictable, and cheaper to exploit than in any other season. The possibility remains, however, that quarrying ventures sometimes (i.e., in unfavorable seasons or years) were provisioned from resource patches lying outside the immediate Tosawihi vicinity; since better habitats for upland game lie only moderate distances north and east of the quarries, better lowland habitats to the west and south, and even a salmon fishery is (was) within reach (cf. Chapter 2), it might have repaid quarriers to bring food with them. Unless the remains of species exotic to the quarries (e.g., salmon) were detected, we do not expect to be able to discern such practice in the archaeological record. We observe, however, that such a strategy necessarily would entail added transport costs diminishing, by variable degrees, the value of the support resources (Madsen and Jones 1987) and inflating the cost of off-season quarrying.

If our various assumptions about the value and distribution of resources at Tosawihi are correct, what should we expect to see in the archaeological record by way of subsistence-related artifacts and residues? In the first place, hunting implements (particularly, projectile points) should be more abundant and more broadly distributed than plant processing equipment, but we should not expect their absolute frequency to approach that of neighboring upland regions in which hunting is likely to have been a more central enterprise. Moreover, they should not be distributed homogenously across the landscape, but rather should tend to cluster in vicinities likely to have attracted larger (and hence more valuable) game; the immediate margins of Ivanhoe Creek, Willow Creek, Little Antelope Creek, and the seeps of Basalt Canyon are the most probable arenas for the aggregation of high-ranked game, and it is in those locations (together with Tosawihi Spring in Big Butte Valley, outside our present theater of interest) that we should expect to find the most abundant incidence of projectile points.

Milling stones, on the other hand, reflect the expenditure of much harder work for lower returns, and we should expect to find them only coincident with patches of relatively high-ranked plant resources (such as Bitterroot Ridge) or at locations that, owing to other attributes (e.g., the availability of water), invited residential stays; stream banks and spring meadows should encompass nearly the entire assemblage of plant-processing equipment. *All* classes of subsistence-related artifact, of course, should occur in habitation sites, with which the occurrence of permanent or semi-permanent sources of water should be the most overt environmental correlate.

We expect organic subsistence residues to be bound almost exclusively to habitation sites (cf. Chapter 26), because it is only in those settings that we anticipate *virtually* all butchering of animals and *all* processing of plants to have been carried out. Since few of the reconstructibly available food species save deer and antelope demand remarkable transport costs, we should expect small game and plant residues to be found only in hearthside contexts. Large game residues (reflecting occasional field butchering) may be distributed more widely, but their spatial patterning (particularly, their coincidence with probable foraging patches) is likely to be undetectable without massive areal sampling.

Finally, we control very few data on how the Tosawihi environment is likely to have changed over the course of the Holocene, but most changes, irrespective of their nature, probably influenced the timing, geography, and energetics of foraging opportunities. A slightly moister regime than prevails at present, for instance, predictably would support the proliferation of grasses and forbs, while a cooler one could have invited the colonization of more robust tap-rooted species (inducing a semi-woodland setting?) than occur today. In the former instance, we should expect small mammals to flourish; in either, large herbivores are likely to have benefitted. Were we to model *conceptually* (absent empirical evidence that they ever actually occurred) the effects of some categorical changes in the local environment – if, for instance, we were to subscribe to Antevs' (1948) "neothermal" model of climatic change throughout the Great Basin, and were to assume that a post-Pleistocene "anathermal" episode, roughly coincident with the Late Pre-Archaic archaeological period (Elston 1986a), wrapped most of the countryside in a cooler, moister regime than we currently enjoy—then we should expect that during that episode Tosawihi and similar settings were better places for foragers to visit than they are now. In fact, the Tosawihi uplands should not under those circumstances have constituted an *un*favorable foraging patch, but should have rewarded foragers with big packages of meat (e.g., bison and elk, neither of which reside in the vicinity today) and plant resources vastly easier (and more profitable) to collect. And given such an assumption, how should the archaeological record of such different, early times look? Probably, we should find in the Early Archaic (or *whenever* climate supported richer habitats) that people may have been attracted to the uplands for reasons additional to or *besides* the acquisition of toolstone, that the distribution of their activities over the landscape should be less dependent on the distribution of outcrops and deposits of opalite, and that subsistence residues and subsistence-related artifacts should be more plentiful.

In the following pages we discuss how the observed archaeological record comments on these assumptions. We focus particularly on organic residues and various artifact classes believed to have functioned in the procurement or processing of food, giving special attention to the areal and temporal distributions of the subject data classes.

Archaeological Data

Most artifact classes used by foragers contribute to subsistence; even cores yield flakes that may be used to produce projectile points and meat cutting implements, and in this way assume at least indirectly a subsistence relationship. The following discussions, however, consider only artifact classes which, based on morphology, use traces, or strong warranting arguments from ethnographic observations, were used in the food quest and food processing; we are concerned with projectile points, ground stone, ceramics, and cutting tools, and archaeologically recovered floral and faunal remains. Our focus here is on data offering direct evidence of subsistence related tasks, and on how the distribution of these tools and residues reflect prehistoric subsistence patterns at Tosawihi.

Organic Evidence: Faunal Remains

Faunal remains are scarce at Tosawihi, and, when they are present, they are represented largely by small mammals. Above, we outline our expectation that faunal evidence should occur preferentially in areas most attractive as habitation sites. Although rodents probably were exploited as food (at least on an encounter basis), the small mammal assemblage offers little indication of such activities; most elements are complete, or they evidence partial digestion by non-human predators. Consequently, our discussions here address only the fragmentary, burned, and/or butchered remains of larger mammals (i.e., jack rabbit-sized and larger; cf. Table 206, Figure 221). Clearly, the scant occurrence and wide distribution of bones with cut marks offers few insights into subsistence practices (e.g., carcass transport and butchery; cf. Binford 1981a; Lupo 1990; Lyman 1985; O'Connell, Hawkes, and Jones 1990), but rather afford only brief glimpses of where subsistence activities occurred in the Tosawihi Quarries vicinity.

Table 206. Summary of Organic and Artifactual Subsistence Evidence by Site.

Site	Faunal Remains[1]	Plant Macrofossils[1]	Ground Stone (n)	Pottery[2] (n)	Projectile Points[3] (n)	Edged Tools[4] (n)	Total # of Classes Present
26Ek3032,L.4	-	-	0	0	1	0	1
26Ek3032,L.19	-	-	1	0	0	1	2
26Ek3032,L.20	-	-	0	0	1	1	2
26Ek3032,L.23	-	-	0	0	6	0	1
26Ek3032,L.28	-	-	0	0	1	0	1
26Ek3032,L.40	-	-	0	0	1	0	1
26Ek3032,L.72	-	-	0	0	1	0	1
26Ek3032,L.93	-	-	1	0	0	0	1
26Ek3032,L.107	-	-	0	0	1	0	1
26Ek3032,l.138	-	-	0	0	2	0	1
26Ek3032,L.152	-	-	0	0	1	0	1
26Ek3032,L.158	-	-	0	0	1	0	1
26Ek3075	-	-	0	0	1	0	1
26Ek3092	+	+	8	4	37	9	6
26Ek3093	-	-	0	0	2	1	2
26Ek3095	+	-	13	0	36	15	4
26Ek3096	-	-	1	0	0	0	1
26Ek3099	-	-	0	0	1	0	1
26Ek3101	-	-	0	0	1	0	1
26Ek3102	-	-	0	0	1	1	2
26Ek3106	-	-	1	0	2	1	3
26Ek3107	-	-	0	0	1	0	1
26Ek3110	-	-	0	0	0	1	1
26Ek3114	-	-	0	0	1	1	2
26Ek3116	-	-	0	0	6	0	1
26Ek3123	-	-	0	0	1	0	1
26Ek3125	-	-	0	0	1	0	1
26Ek3142	-	-	0	0	1	0	1
26Ek3144	-	-	0	0	1	0	1
26Ek3148	-	-	0	0	1	0	1
26Ek3149	-	-	2	0	3	0	2
26Ek3154	-	-	0	0	1	0	1
26Ek3160	-	-	18	1	57	16	4
26Ek3162	-	-	0	0	1	0	1
26Ek3165	-	-	4	0	3	5	3
26Ek3170	-	-	2	0	11	4	3
26Ek3171	-	-	1	1	2	0	3
26Ek3173	-	-	0	0	2	0	1
26Ek3174	-	-	0	1	0	0	1
26Ek3177	-	-	0	0	2	0	1
26Ek3178	-	-	0	0	3	0	1
26Ek3179	-	-	0	0	0	1	1
26Ek3181	-	-	1	1	0	2	3
26Ek3184	+	-	1	0	6	2	4
26Ek3185	-	-	1	0	8	1	3
26Ek3190	-	-	1	0	9	2	3
26Ek3191	-	-	0	0	1	0	1
26Ek3192	+	-	7	1	15	5	5
26Ek3196	-	-	1	0	0	0	1
26Ek3198	-	+	0	1	27	4	4
26Ek3201	-	-	2	0	0	0	1
26Ek3202	-	-	0	0	0	1	1
26Ek3204	-	-	1	0	6	2	3
26Ek3208	-	-	0	0	1	0	1
26Ek3228	-	-	1	0	0	1	2
26Ek3231	-	-	0	0	1	0	1
26Ek3237	+	+	8	0	40	6	5
26Ek3238	-	-	1	0	5	1	3
26Ek3239	-	-	0	1	2	1	3
26Ek3251	+	+	17	1	45	4	6
26Ek3271	-	-	6	0	23	5	3

Notes: [1]Denoted here as present/absent (±).
[2]Estimated number of vessels (cf. Chapter 12).
[3]Includes non-classifiable fragments and specimens. Excludes points broken in manufacture.
[4]Includes pressure retouched Stage 4 and Stage 5 bifaces, and flake tools with soft to medium edge damage and polish traces.

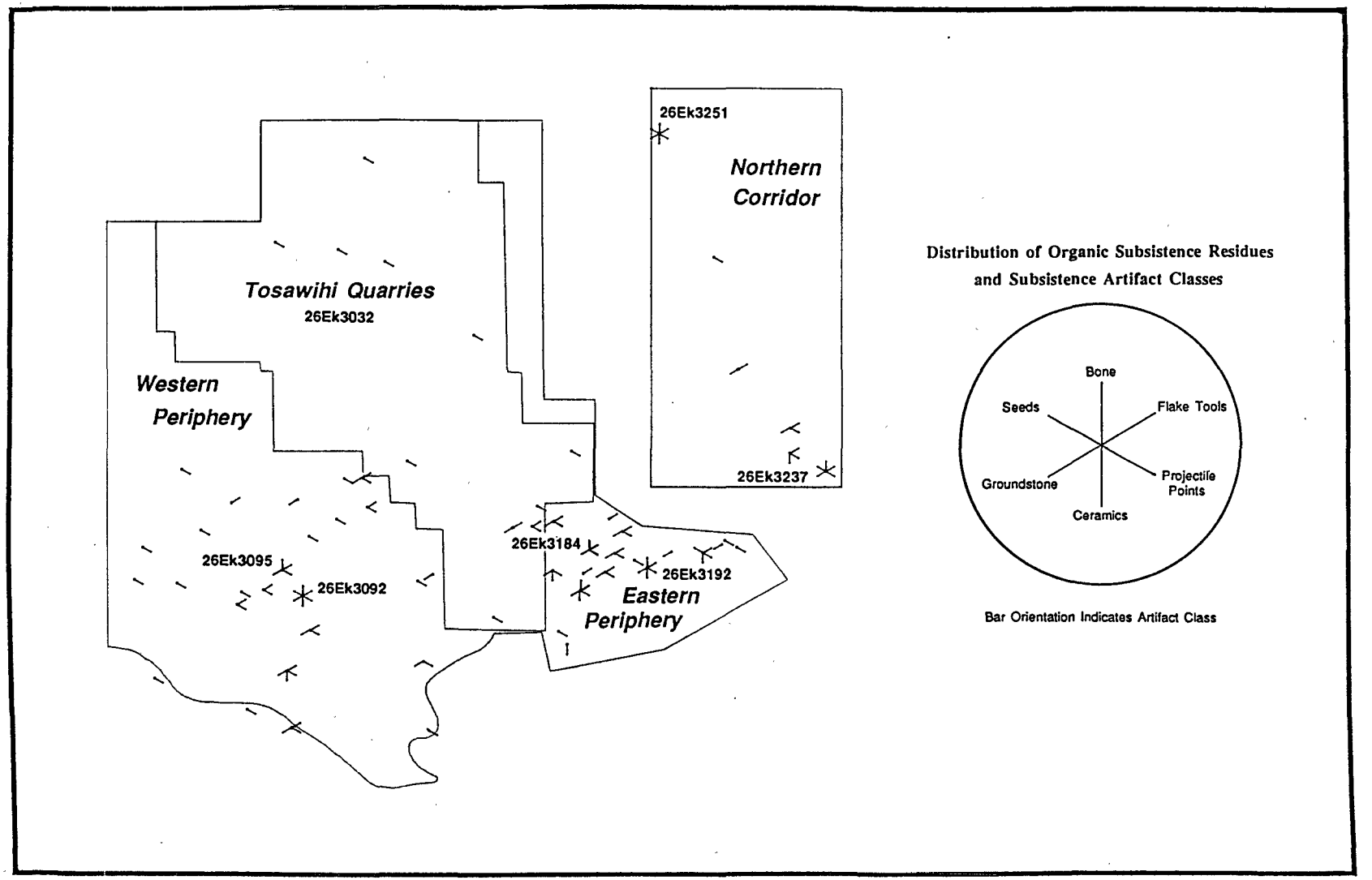


Figure 221. Presence/absence distribution of organic subsistence residues and subsistence artifact classes.

Two sites adjacent Ivanhoe and Willow Creeks in the Northern Corridor returned fragmentary (often burned) large mammal bones, most of them adjacent hearths (i.e., Features 3 and 4 at 26Ek3237) or dispersed hearth-like features (Feature 6 at 26Ek3251), in association with ground stone and flake and cobble tools. 26Ek3092 and 26Ek3095 in the Western Periphery also yielded subsistence-related faunal remains, including five specimens from 26Ek3092 which display butchering marks characteristic of dismemberment, marrow extraction, and possibly filleting (cf. Table 107).

Aside from elements displaying cut marks or flake scars, the least equivocal evidence of cultural bone refuse at Tosawihi is a cluster of fragmented and burned marmot remains recovered from Feature 1 at 26Ek3192; all came from a single unit/level aggregate in association with ground stone, flake tools, projectile points, and a fragmentary ceramic vessel (cf. Chapter 15). Only a few isolated faunal items were retrieved elsewhere in the site.

Not surprisingly, cut, fragmented, and/or burned large mammal remains were found almost exclusively in areas utilized as campsites, signaled by the presence of hearths and the recovery of multifunctional toolkits. Conversely, two quarry pits yielded bison and elk remains used as quarrying implements (cf. Chapter 13). These artifacts most likely were brought to the quarries as tools, rather than as food elements, and probably are not (Tosawihi) subsistence indicators. Although the occurrence of "food bone" attests to subsistence activities performed at these sites, the overall rarity of faunal remains must be attributed to post-depositional attrition, as most Tosawihi sites occupy the shallow, commonly bioturbated aeolian silts blanketing the region; the recovered faunas probably are only a small portion of what was deposited originally.

Organic Evidence: Plant Macrofossils

Like archaeofaunal remains, we expected plant macrofossils to be present chiefly in places used for human habitation, but they, too, are scarce. This is attributable in part to sampling techniques, but the overall scarcity of plant macrofossils seems also a product of post-depositional organic degradation; our samples were taken from areas where floral subsistence debris should be anticipated in the archaeological record (e.g., in and adjacent hearths), but analysis found many sediment samples virtually devoid of such remains (cf. Chapter 14). The dearth of plant macrofossils may be a product of poor preservation, infrequent use, or both.

Of the 37 sediment samples from four sites (26Ek3092, 26Ek3198, 26Ek3237, and 26Ek3251; cf. Table 206; Figure 221), charred seeds are most abundant (but still relatively few) in a "dispersed hearth" adjacent Willow Creek at 26Ek3251; the association includes riparian plant species presently absent from the Willow Creek bottomlands (cf. Chapters 14 and 17). Charred seeds in hearth features at the remaining sites probably represent subsistence refuse, but they are sparse and they reflect only meager caloric returns.

Artifacts: Ground Stone

The use of manos, metates, mortars, and pestles in the processing of plant and animal resources is well documented in Great Basin ethnographies (e.g., Downs 1966; Steward 1941; also cf. Fowler 1986). Macroscopic observations of morphology and surface use wear commonly segregate these artifacts as food processing tools. As discussed above, we expect ground stone to be present in habitation sites and in association with patches of relatively high-ranked plant resources.

Ground stone artifacts occur at numerous Tosawihi sites, and are particularly abundant in the Western Periphery (cf. Table 206; Figure 221). In the Bitterroot Ridge vicinity, milling

equipment (especially metates) abounds at 26Ek3095 and 26Ek3160 (cf. Chapter 11), both of which occupy areas within or adjacent patches of bitterroot, grasses, and onion. Similarly, 26Ek3251, situated in the riparian bottomlands of Willow Creek, yielded a large assemblage of milling stones, including fragments of at least nine individual metates.

Ground stone was collected from several sites in the Eastern Periphery, but, with the exception of two manos and five metates recovered from 26Ek3192, most assemblages consist of single specimens (cf. Chapter 11). Compared with ground stone frequencies in the Western Periphery, milling equipment in the Eastern Periphery suggests that certain subsistence tasks were undertaken less frequently there. This may be the case, but chronological markers recovered from the Western Periphery indicate occupation over a much longer span of time, and the higher frequency of ground stone may be simply a product of longer use. Further, the abundance of milling equipment in the Western Periphery could owe to patterns of expedient use and discard; most metates are manufactured on the tabular basalt (cf. Chapter 11) occurring throughout the area in exfoliated outcrops, colluvial flows, and stream cobbles, and, being close at hand, required little investment of search time.

Artifacts: Ceramics

Ceramic vessels can serve as food storage containers and cooking pots, and probably usually reflect subsistence activities; they are expected to occur most frequently in places used for habitation. Ceramic analyses found some interior surfaces to exhibit noncarbonaceous blackened residues (cf. Chapter 12), suggesting that many vessels were employed in the preparation and storage of food (cf. Steward 1941:232). These artifacts signal subsistence tasks performed after A.D. 500.

Excavations and surface collections yielded fragments of 12 vessels from nine sites; 26Ek3092 returned pieces of 4 pots (including Fremont Grayware) in association with hearths, ground stone, and faunal remains; the remaining eight sites contained one each (cf. Chapter 12). Interestingly, fragments of five vessels were recovered from sites in the Eastern Periphery, lending support to our model of Late Archaic intensification of use of this area (cf. projectile point discussions, below).

Artifacts: Projectile Points

In the ensuing discussion, we consider the general distribution of projectile points across the Tosawihi landscape as indirect evidence of subsistence practices, recognizing that their presence can owe to multiple factors; those specimens lost in hunting or left with untransported animal parts should reflect areas exploited for game, while those broken during maintenance or transported in prey away from kill locations will not necessarily reflect the same geography. Unfortunately, we cannot distinguish these various contexts. Instead, we are interested in the spatial and temporal distribution of points, since patterns of discard or loss reflect how landscape use was organized. Projectile points do not necessarily mark hunting areas, but they can indicate group organization; insofar as different organizational patterns correspond to different subsistence practices, projectile point distributions are indirect subsistence indicators.

The distribution of projectile points of all types, including unclassifiable fragments and specimens (cf. Chapter 8) is summarized in Figure 213 (cf. Chapter 19). We exclude from consideration the nine points broken in manufacture, since these never became part of a subsistence tool kit. Far more projectile points were recovered from the Western and Northern areas than from the Eastern Periphery and localities within 26Ek3032. The Bitterroot Ridge

area of the Western periphery exhibits a particularly high frequency of points, as do sites 26Ek3237 and 26Ek3251 in the Northern Corridor. Topographically, locations with high point frequencies tend to lie within one to two hundred meters of larger drainages. Since larger drainages support richer forage and more diverse resources, they undoubtedly were more attractive as habitation locales, and attracted more abundant wildlife.

Time-sensitive projectile point series further elucidate the pattern observed in the overall distribution of projectile points (cf. Figure 215). The Bitterroot Ridge sites (26Ek3092, 26Ek3095, 26Ek3160, 26Ek3271) together with two Northern Corridor sites (26Ek3237 and 26Ek3251), have the widest temporal spreads. These locations were used over the longest periods and perhaps, in consequence, they accumulated the largest projectile point assemblages.

The distribution of time sensitive point series reflect changes perhaps related to general changes in subsistence strategies through time. Great Basin Stemmed points often occur as isolates. Gatecliff points are infrequent, but when present they tend to occur with other, later point types. Elko and Rosegate Series points are relatively frequent (cf. Chapter 9), but the majority of them come from the Bitterroot Ridge sites listed above. Desert series points (Cottonwood and Desert Side-notched) also are common there, but they also frequently occur in the Northern Corridor and in the Eastern Periphery, where they are the most common projectile point series.

Three distributions of time-sensitive projectile points are apparent. The oldest series (Great Basin Stemmed) shows no obvious clustering; this may indicate dispersed use, with little revisitation of particular locales. Tentatively, hunting at Tosawihi during this time period may not have been organized from particular places on the landscape, being staged rather on a sporadic, *ad hoc* basis. Elko and Rosegate Series points clearly cluster in space, suggesting repetitive use of certain places, particularly those in the Bitterroot Ridge area and in the Northern Corridor; within this time period, hunting may have been organized from a few recurrently used places, often within a short distance of drainages. A marked change in distribution is evident among Desert Series points; they occur in many new locations, including the Eastern Periphery and several smaller sites in the Northern Corridor. The tendency of Desert Series points to cluster, rather than to occur as isolates, again suggests organized hunting from a few repetitively used places, but with many "new" places being visited.

Artifacts: Edged Tools

Morphological attributes of bifaces and flake tools are discussed in Chapters 7 and 8; the classes are considered together here because both provide edges useful for subsistence tasks, irrespective of morphological class. Only flake tools with edge damage or wear polish consistent with the cutting of soft to medium texture materials are considered to be subsistence tools (cf. Chapter 8). Similarly, pressure-retouched Stage 4 and Stage 5 bifaces are incorporated in our discussion because most of those examined for use wear were used for cutting (cf. Chapter 6, Table 10).

Edged tools are present at many sites (cf. Figure 221; Table 206); their presence generally is associated with other kinds of subsistence tools; they rarely are the sole subsistence related artifacts in an assemblage. They are particularly prevalent on Bitterroot Ridge in the Western Periphery and in the larger sites of the Eastern Periphery. Too, they are abundant in the Northern Corridor; five of the six sites in this area contain either used flakes or pressure retouched bifaces.

The occurrence of edged tools may have more to do with the locations at which things were processed for consumption than with the places at which resources were harvested. That they tend to occur predominantly in locations having at least one (and usually more) subsistence residue or artifact class present underscores this possibility.

Cooccurrence and Variation in Subsistence Indicators

Artifacts and residues associated with subsistence cooccur at sites on Bitterroot Ridge in the Western Periphery, at 26Ek3237 and 26Ek3251 in the Northern Corridor, and at several sites in the Eastern Periphery (cf. Figure 221; Table 206). In part, this pattern is undoubtedly attributable to the data recovery activities themselves: more extensively excavated sites have a better chance of yielding rarer classes of subsistence evidence. Some patterns of cooccurrence, however, are too strong to account for in this fashion, and instead may represent recurring prehistoric subsistence activities undertaken in conjunction with each other. We examine such patterns here, in order to elucidate what activities they may reflect. We also examine the evidence presented above in a composite fashion, comparing geographic areas in terms of the numbers of subsistence-related data classes present in each.

Groundstone presence/absence and edged tool presence/absence are closely correlated (chi square = 5.5, df=1 $p<.05$). Since cutting tools are useless in processing many food items that would have been ground, beaten, or mashed, this association suggests that many places were used for multiple resource procurement. In other words, a tentative interpretation of sites where groundstone and edged tools occur together is that they served as broad spectrum acquisition/processing localities.

Also, the numbers of tool classes present vary within geographic areas. We have discussed above the relatively abundant evidence of subsistence activities in the Western Periphery and a few sites in the Eastern Periphery and the Northern Corridor. When the number of classes of evidence for all sites (excluding quarry locations and isolated artifacts) are summed for each area (Table 206), Northern Corridor sites generally exhibit a greater variety of subsistence indicators; the Western and Eastern Peripheries exhibit less variety (Table 207). Subsistence-related artifacts reflect this pattern. Furthermore, sites with economic faunal remains (i.e., food bones) also exhibit more subsistence-related artifacts and more subsistence-related data classes than does any single geographic area (cf. Table 207).

Table 207. Frequency of Occurrence of Subsistence-related Data Classes by Geographic Area.

	North n	West n	East n	Sites w/ Economic Fauna
Total sites, excluding isolated finds	6	16	17	6
Total number of subsistence classes present	20	38	38	30
Mean number of classes/site	3.33	2.38	2.24	5.00
Total number of subsistence artifacts	135	287	138	280
Mean number of artifacts/site	22.50	17.94	8.12	46.67

Discussion

Unequivocal archaeological remains from prehistoric subsistence practices are scant at Tosawihi. Poor preservation no doubt has taken a toll of direct organic indicators of subsistence, but the degree of fossil attrition is unmeasurable. However, since the likelihood of encountering

organic remains in excavation is proportional to their original abundance, organic remains indicate (albeit skeletally) *where* subsistence activities are likely to have occurred. Upon examination, their occurrence corresponds well with expected locations of prehistoric subsistence activities.

Further support for our expectations is provided by indirect indicators of subsistence (i.e., ground stone, ceramics, projectile points, and edged tools). Although widely scattered, these artifact classes tend to follow the model of subsistence at Tosawihi presented above. Ground stone, for example, is most abundant adjacent potential water sources in the Western Periphery and perennial sources in the Northern Corridor.

The distribution of subsistence indicators varies. Ground stone is rare in the Eastern Periphery and in the main body of the quarries, probably because the Western Periphery hosts more abundant plant resources. As well, the Western Periphery appears to have had a long tenure of use, as indicated by projectile points and radiocarbon assays (cf. Chapter 19, Figure 209). The late, sporadic, occurrence of ground stone in the Eastern Periphery may owe to intensification of use of the quarries; the plant resources in this area are relatively poor, but exploitation may have been necessary during the Late Archaic (cf. Chapter 18).

Projectile points track a general pattern of change in how the Tosawihi landscape was used. The earliest time-sensitive series (Great Basin Stemmed) reflects little repetitive use of specific places; points of this series are widely distributed, commonly found on the surface with no other associations. In a few favored locations, where the scant subsistence resources of Tosawihi cooccur (e.g., Bitterroot Ridge and the Northern Corridor), a pattern of repeated use emerged during the mid-Archaic. The Eastern Periphery saw little use during the time represented by Elko and Rosegate Series points. Repetitive use of favored places became widespread during Desert times. Desert Series points and ceramics are the predominant subsistence and temporal indicators on sites in the Eastern Periphery, and many sites there appear to have been established and visited recurrently during the period. This pattern of land use, which we believe to have been related to subsistence practices, began in the Mid-Archaic and expanded during Desert times.

The pattern of change is provocative; while we cannot rule out the importation of food by prehistoric quarriers, subsistence appears always to have been an important determinant of how prehistoric groups organized visits to Tosawihi. If prehistoric groups provisioned forays in advance (cf. Binford 1978b:84), then some of our direct indicators of subsistence may consist of imported food packages. Under this scenario, subsistence resource acquisition at Tosawihi only supplemented extrinsic resources. Alternatively, if forays were self-supporting (living off the landscape while in it), then recovered subsistence residues evidence primary subsistence practices.

In either case, the observed patterns appear to reflect changes in how hunter-gatherers organized their use of the landscape. Whether social environment, natural environment, or both were the ultimate causes of change remains unclear. We can speculate that changes extrinsic to the quarries may have caused the archaeological record at Tosawihi itself to change; in that case, changes should be evident both at and away from the quarries. Alternatively, exploitation of the quarries may have changed absent extrinsic factors. In this case, there should be no contemporaneous change in the archaeological record away from the quarries.

Clearly, the resolution of such large questions requires a more regional perspective; since subsistence information is scarce throughout the northern Great Basin, however, it often will be similar to the evidence discussed above. In consequence, identifying and understanding changes in Great Basin land-use requires that *all* potential evidence be brought to bear in subsistence studies. This is why we have incorporated tools used to procure and to process food as evidence of subsistence along with direct indicators of subsistence such as floral and faunal remains. One advantage to this approach is that it skirts the problem of differential organic preservation. A second advantage is that it permits comparison with other studies, including surface surveys (cf. Thomas 1988). Through such comparisons, we eventually may address why hunter-gatherer subsistence patterns change through time.

Chapter 21

OPALITE REDUCTION TRAJECTORIES

Kathryn Ataman and William W. Bloomer

Lithic technological systems are comprised of one or more trajectories, that is, regular sequences of transformations resulting in final lithic products. The dominant patterns created by these sequences are dendritic trajectories, their nodes constituting stages along the reduction continuum. Nodes are visible where changes in reduction technique or approach occur. In large part, the patterns we observe probably resulted from repeated responses to recurrent situations arising within a specific technology during the reduction of a particular artifact class.

The trajectory concept is used here to examine strategies in the production of certain artifact classes; we inquire as well into the organization of work and the standardization of production. Various trajectories within a technological system may be interrelated, and in some cases they are quite complex. For example, flakes (by-products of the production of a particular artifact class) fall out of one trajectory at the point they are produced; if selected for further processing, they become incorporated into a separate trajectory. Breakage in manufacture, reworking, and resharpening also are elements of the trajectory, of which the end point is the broken or discarded tool.

In recent years studies of lithic technology have contributed insights toward understanding broad issues such as forager mobility strategies and technological responses to raw material availability. The trajectory concept increasingly has served some of these questions (Sampson 1985; Amick 1985; Bamforth 1986; Zeier and Elston 1986; Kelly 1988). Some analytic schemes are highly formalized (e.g., Elston 1986c) while others are extremely generalized (e.g., Muto 1971b). The notion of trajectory commonly has been used to contrast coexisting technologies using raw materials differentially, especially where, for example, exotic materials are used more intensively than local toolstone. Our concerns at Tosawihi differ from many of these studies, since primarily *one* type of raw material is present and there appears to be little constraint on its use (judging by the vast amounts of discarded debitage). We have opted for a scheme which follows an artifact from blank to finished or discarded item and notes where by-products leave the primary trajectory to be discarded, exported, or incorporated into a secondary trajectory.

At Tosawihi, bifaces are the primary focus of lithic production; almost all biface reduction can be subsumed by a single trajectory, although blank type, stage of heat-treatment, and stage of export vary. A wider variety of other tools was produced through other trajectories. The various trajectories are not completely discrete, however; the production of biface blanks may partake of the same processes used for flake tool blank production, and both forms may be obtained as by-products of biface manufacture.

As noted above, trajectories often vary with raw material; this is true at Tosawihi. Obsidian and basalt trajectories vary considerably from that of opalite, not so much due to material flaking qualities as to the raw form of the material and the intended final product.

Because Tosawihi is a production site and artifacts usually were exported in unfinished form, steps involved in finishing (in addition to much of the reworking and resharpening undertaken throughout the use-life of an artifact) often are not visible. Evaluation of Tosawihi materials produced expectations regarding the form of export and general use of the toolstone after it left the quarries. Various production stages have been defined in light of these expectations, but trajectories cannot be reconstructed completely without reference to the use of Tosawihi opalite outside the quarry area. As noted above, evidence concerning the ultimate fate of artifacts leaving Tosawihi is indirect. The trajectories into which we assume bifaces passed after leaving the quarries are discussed in the concluding section of this chapter.

We have observed two primary trajectories, reflecting biface reduction and flake core reduction. Secondary trajectories, initiated on primary by-products, also are present; most often, the end products of these trajectories are flake tools or projectile points. The relevant evidence is discussed below.

The Reconstruction of Trajectories

Lithic trajectories can be observed through examination of bifaces, flake tools and points, and debitage (as well as their distributions) across the project area, and through the incidence and nature of heat-treatment at sites within and beyond the quarry vicinity. Several categories of observation are discussed below.

Blank Production

Blank procurement is the first step in any kind of reduction. While blanks are removed from areas where they are produced, debitage characteristic of their production is found at quarries. Where flake blanks are produced from quarried chunks or blocks, this debitage consists of irregular flakes of various sizes, shatter, and fragments of matrix waste material. Blanks can be produced directly from bedrock outcrops as well, or from bedrock faces in quarry pits, leaving only negative scars as evidence of their production. Alluvial or colluvial cobbles also can serve as blanks, and can be reduced as blocks or used as cores for the production of flake blanks. The reduction of cobble blanks is signalled by flakes with cobble cortex while the use of flake blanks is signalled by flake blank characteristics on the ventral surfaces of early stage bifaces, by the presence of bulb removal flakes in the debitage, or by significant numbers of flake cores in association with biface thinning flakes. The use of block blanks can be inferred in cases of early biface reduction when cobble and flake blank evidence is absent.

Blank Morphology

Early stages of artifact production largely are dependent upon initial blank form. Blank form frequently can be determined on early stage, less reduced bifaces, but only infrequently on middle or late stage bifaces. In contrast to bifaces and projectile points, flake tools seldom are reduced extensively after obtaining the blank (unless made on biface fragments); consequently, blank form can be determined more frequently than on bifaces. Blanks used for the production of projectile points often are difficult to recognize; their form is observed more easily on points made on thin flakes reduced entirely by pressure flaking, since some portion of both surfaces may be left unflaked. In contrast, larger points tend to be made on percussion flaked bifacial preforms; evidence of blank form generally has been obscured. The lengths of blanks made on biface thinning flakes, provide indices of original biface size and stage of detachment, reflecting the points at which artifacts left the biface trajectory to enter a secondary trajectory.

Biface Staging

Like other lithic artifact forms, bifaces progress through successive reduction stages; they are reduced more extensively than many tool forms, however, and the stages through

which they pass are more numerous and easier to define. Many biface technologies are generalized over much of their reduction sequence, and a common analytical scheme (e.g., that of Callahan 1979) suffices to describe them. The scheme we have used is based on Callahan's but has been modified slightly (cf. Chapter 6). Although not every biface fragment can be placed within the staging framework (since our approach is based primarily on extent of reduction rather than metric attributes), we usually can assign any biface to a *general* stage (blank or edge preparation, primary thinning, secondary thinning, or finishing) and often can be more precise (e.g., early or late primary thinning). In most cases, the bifaces observed represent failures; many are broken, and some are badly proportioned. Cache bifaces, which we assume were prepared and stored at the quarries for recovery and perhaps additional processing at a later date, are an exception (cf. Chapter 6). Caches contain most of the unbroken bifaces recovered from Tosawihi. Characteristics such as blank type, size and proportion at different stages, as well as standard techniques of manufacture, can be understood more easily by examining complete (and, we assume, non-discarded) specimens. The proportions of different stages and the incidence and stage of heat-treatment in cache samples also can be compared to those in the assemblage as a whole to assess the form in which bifaces left the quarries, but many are reduced further along the reduction sequence than cache bifaces. Cache bifaces, then, may have been left at Tosawihi for later recovery, but they probably were processed further prior to export.

Debitage is also used to characterize stages of reduction and to reconstruct the operative trajectories. Presumably many bifaces were removed from the quarry vicinity, and because they do not break in equal frequency at all stages of reduction, the stages of exported bifaces are unlikely to be the same as those represented in the assemblage. It may be that debitage is a more accurate index of stage production than of stage at moment of export. Mass analysis and a typological technological analysis were used to characterize the debitage recovered from features, and this information also has been incorporated in our reconstruction. However, mass analysis does not allow fine-grained determinations of stage. Since only a small sample of material could be analyzed with more detailed analytical techniques, much of the analysis is based on examination of bifaces rather than debitage.

Reduction Techniques

Several categories of debitage are characteristic of different types and stages of reduction. These distinctions are discussed in detail in Chapter 10. In general, biface reduction can be recognized by the presence of significant frequencies of edge preparation flakes and biface thinning flakes.

Flaking mode, or the technique by which flakes are detached, is another category of evidence useful in reconstructing trajectories. This bears most significantly on questions about the standardization of production; hard hammer percussion may be used throughout the trajectory, or, at some point, may be replaced with soft hammer percussion or pressure flaking.

The distinction between hard hammer (usually hard stone) and soft hammer (antler, bone, wood, or soft stone) percussion flaking is difficult to recognize on the surfaces of bifaces or other tools, but its diagnostic attributes are more apparent in debitage. Unlipped platforms and prominent points and bulbs of percussion (indicative of hard hammer flaking), as opposed to lipped platforms, diffuse bulbs and vague points of percussion (soft hammer flaking) seem to be good separating criteria (Newcomer 1970; Ohnuma and Bergman 1982; Hayden and Hutchings 1989). Although unquantified in our study, soft hammer flaking probably was relatively common in biface reduction at Tosawihi. Supporting this view is the recovery of what appear to be two antler hammers (cf. Chapter 14; Schmitt and Carroll 1992), both from quarry pit contexts.

Pressure flaking may be recognized either from negative flake scars or from the presence of pressure flakes in the debitage, generally recovered only in 1/8 in. screened samples. Few bifaces in the assemblage appear to have been pressure flaked (all are Stage 4 or 5); most pressure flakes probably resulted from preform and projectile point manufacture. An antler pressure flaker was recovered.

Heat-treatment

Heat-treatment of opalite was a common practice at Tosawihi. Heat-treatment of silicious toolstone improves its flakeability, and changes its appearance. It is most useful for biface thinning and pressure flaking because less force is required to detach flakes and better control is possible. Patterns of heat-treatment provide evidence about the standardization of tool production, and more indirectly, about the intended use of the final product. The frequency of heat-treatment in the production of various artifact classes and the stage at which it was undertaken is compared, between sites within the quarry area and others farther away where artifacts, the production of which began at Tosawihi, were reduced further or were used. These data allow us to address the form of export and ultimate use of bifaces made at Tosawihi.

The incidence and stage at which heat-treatment was conducted can be recognized by differential luster on lithic surfaces, generally allowing us to distinguish among pieces heat-treated while still attached to a core, as blanks, or during the course of reduction. When a core is heat-treated and a flake then is detached from it, the entire ventral surface of the flake appears lustrous. However, when a flake is heat-treated, only negative flake scars produced *after* heat-treatment are lustrous. If heat-treatment has interrupted reduction, both lustrous and dull scars are present. When all flaked surfaces appear lustrous, such as in the case of late stage bifaces or finished or nearly finished projectile points, the necessarily earlier stage at which heat-treatment was undertaken cannot be determined.

Primary Trajectories

Biface Reduction

Most bifaces at Tosawihi went through a similar production sequence and appear to be products of a somewhat standardized technological system. However, variability in the shape of blanks required different approaches. Variability among individual knappers, using different tools and raw materials, also can affect the details of reduction but probably less so than blank form. So, although most Tosawihi bifaces were reduced at least part way through the following sequence of stages, the vast majority never reached Stage 5 and only 15% reached Stage 4, as they usually were removed from the quarry prior to finishing (Figure 222).

Stage 1 Blank Procurement/Production
Stage 2 Blank/Edge Preparation
Stage 3 Primary Thinning
Stage 4 Secondary Thinning
Stage 5 Finishing

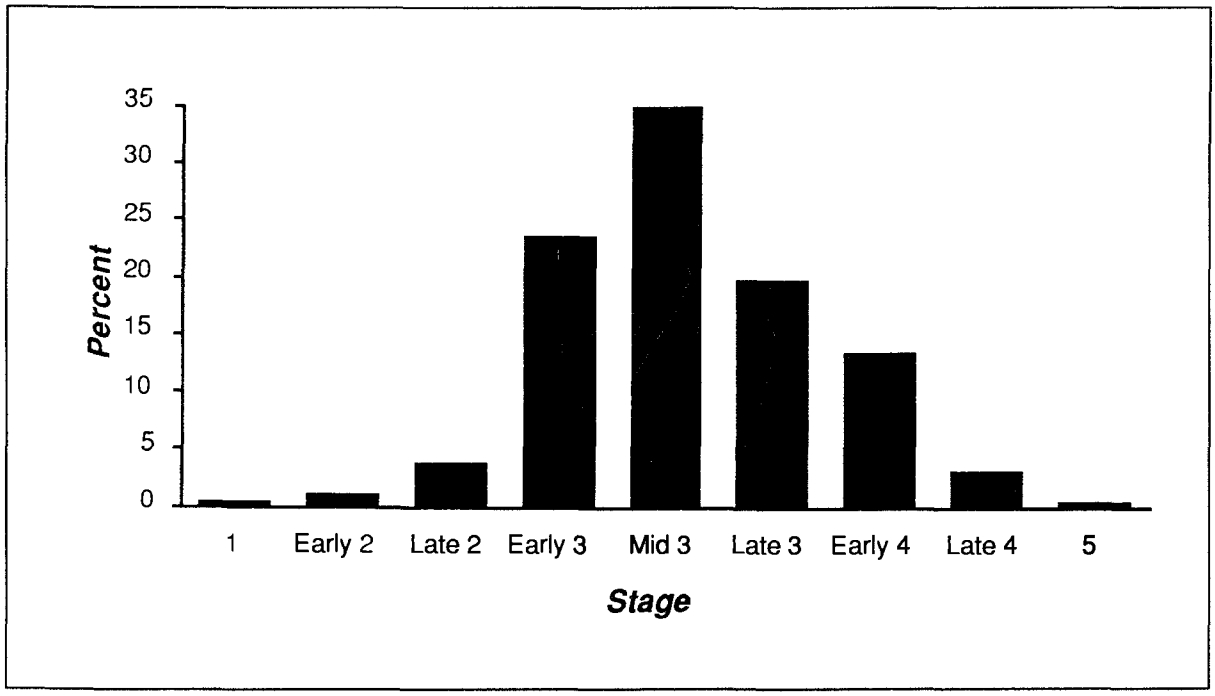


Figure 222. Proportions of bifaces by stage in opalite assemblage (indeterminate stages not included).

Figure 223 outlines the reconstructed Tosawihi biface reduction trajectory. Blank procurement consists of the process of obtaining blanks in the form of cobbles, blocks, or flake blanks. Flake blanks may be produced directly from bedrock or detached from cores, while cobbles may be collected from drainages or colluvial deposits; blocks usually must be extracted from a bedrock matrix. Blank type was recorded for only about half of the biface assemblage. Of these, 33% could be identified as flake blanks, and only 1% as cobble blanks. As noted above, blocks are recognizable primarily from an absence of contradictory data, but we assume they sometimes served as blanks. Also, there are few cores in the assemblage and it seems unlikely that they were the primary source for flake blanks unless further reduced into bifaces. Artifacts of this stage are difficult to recognize and cannot be distinguished from discarded, unselected quarry debris. Therefore, we have declined to identify bifaces from this stage in settings near toolstone sources. If removed from the immediate source, pieces suitable for biface production are assumed to have been selected from the quarry debris and are designated Stage 1 bifaces, although reduction has not been initiated.

In Stage 2, the blank is prepared for thinning with the intent of producing a bifacial edge on which strong platforms can be prepared. At Tosawihi, the processing of Stage 2 bifaces is quite variable, and is largely dependent on the original blank form; flake blanks require less preparation while cobbles and blocks require more. Thin, wide flake blanks can be edged for primary thinning with a minimum of effort, but blocks with thick edges need more extensive preparation. Blocks vary in shape from slab-like to very blocky and this variation also affects the process of reduction; slab-like pieces are reduced in a fashion similar to flake blanks. In this stage the flaking mode is primarily hard hammer percussion. Its by-products consist of characteristic edge preparation flakes and non-diagnostic flakes, some of which are large enough to be selected for inclusion in other trajectories. This stage was divided into early and late substages, which comprise 1.1% and 3.7% of the total classifiable assemblage. It is possible that some bifaces were exported at this stage.

Stage 3 reduction consists of primary thinning. The intention is to thin the biface without significantly reducing its width. In this stage, flake scars only infrequently extend beyond

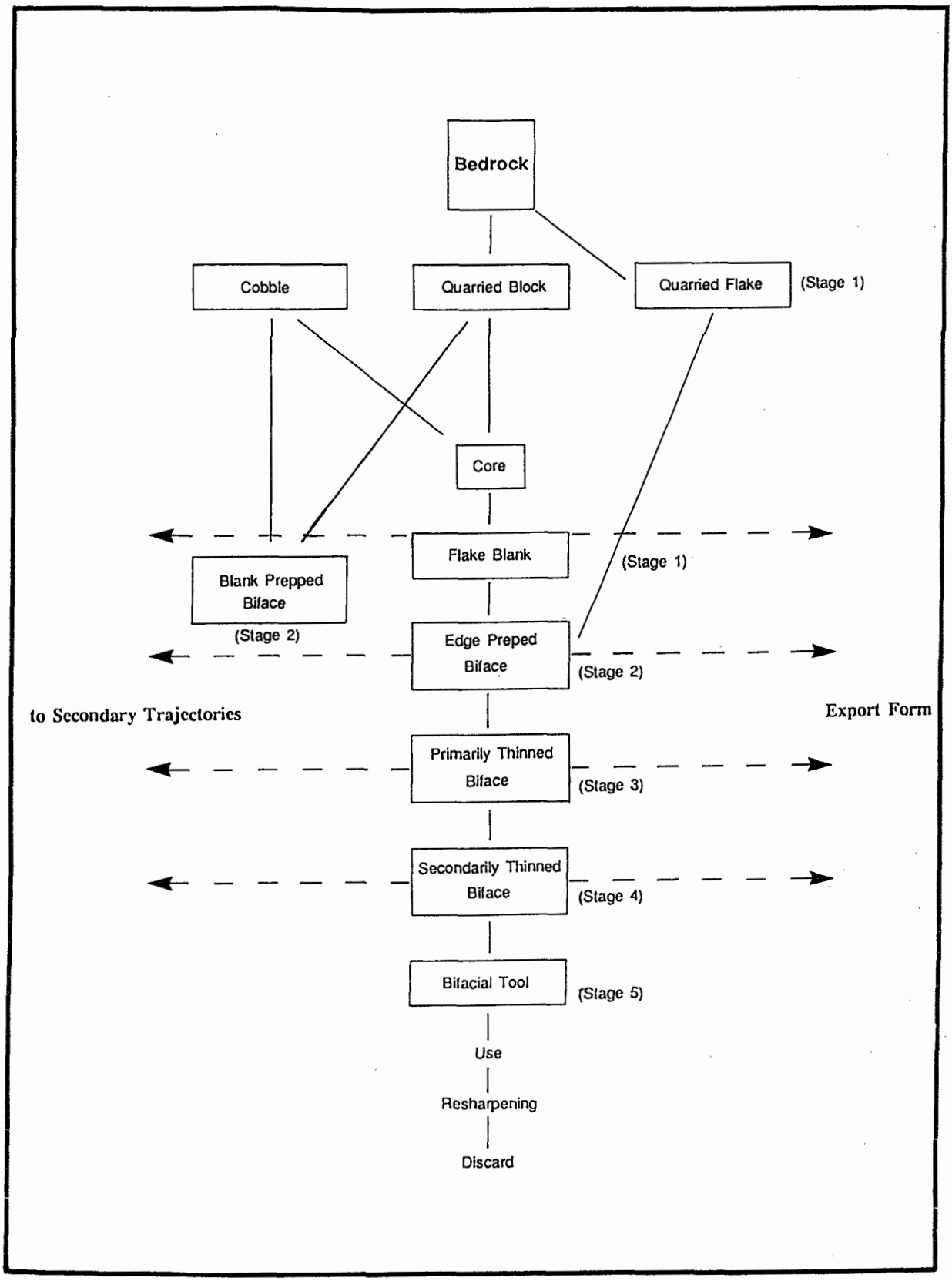


Figure 223. Biface reduction trajectory.

the mid-line of the piece and the general cross-section approaches a lenticular form. Flaking may be by hard hammer percussion, soft hammer percussion, or both. The primary diagnostic by-products of this reduction stage are biface thinning flakes, some of which are large enough for use as blanks for other tools, but not for bifaces. Some bifaces of this stage may have been exported from the quarries. This is the primary stage of reduction represented at Tosawihi, comprising 78% of the biface assemblage; it was divided into early (23.6%), middle (35.2%) and late (19.3%) substages.

In Stage 4 the biface is thinned further. The flake scars usually are smaller and may be produced with hard hammer percussion, soft hammer percussion, or both. These scars frequently extend across the midline of the biface and the cross-section is lenticular or flattened/lenticular. The by-products are primarily small biface thinning flakes suitable for the production of small tools or projectile points. This stage has been divided into early and late substages, representing 13.3% and 2.9% of the assemblage respectively. Some bifaces were almost certainly exported in this form.

Stage 5 involves regularizing the edge, preparing hafting elements, or further shaping and thinning, sometimes employing pressure flaking; a finished bifacial tool is the final product. At this point our staging scheme deviates from that of Callahan, which contains additional stages originally intended to describe the production of Clovis points. Only 11 Stage 5 bifaces were recovered at Tosawihi, testimony that few bifaces were exported from the quarries as finished tools.

If the primary reason for visits to Tosawihi was procurement and processing of toolstone, it is unlikely that many bifaces produced there reached the end of their use lives at the quarries. A sample of bifaces was selected from the most apparently finished specimens and examined for use wear traces. A small proportion evidently were used as cutting tools, but most recovered Tosawihi bifaces were broken in manufacture and discarded before becoming bifacial tools.

Many bifaces broke and were discarded (falling out of the trajectory) during the course of manufacture. If broken fragments were large enough, they were repaired and reduction continued. Thus, the frequency of breakage at a particular stage is not reflected accurately by the number of biface fragments; experimental replication is required to estimate the true frequency. Our replication experiments and examination of the incidence of breakage suggest that bifaces do not break often during edging (Stage 2), and that heat-treated bifaces are more likely to break at *any* stage (except perhaps, during pressure flaking) than are non-heat-treated ones. So, although most bifaces recovered from Tosawihi are classified as middle Stage 3 (35% of those that can be placed within the staging framework), this stage may not represent the primary form exported from the quarries.

Heat-treatment

At Tosawihi, some bifaces of every stage were heat-treated, the proportion increasing through the reduction sequence. Seven percent of Stage 1 bifaces were heat-treated, rising to 72% in Stage 5 (Figure 224). Heat-treatment appears to have been a standard step in the reduction continuum, intended to facilitate biface thinning and to increase knapping control. Our heat-treatment experiments show that while the failure rate due to overheating is low (it is more difficult to *reach* the required temperature than to exceed it), the incidence of breakage increases after heat-treatment. Thus, risk involved in heat-treatment is low while risk in thinning after heat-treatment is relatively high. Heat-treatment occasionally was initiated early in Stage 2, but more often undertaken during Stage 3.

Some variation in the incidence of heat-treatment by stage may be related (as are many other characteristics of biface production) to the shape of the original blank. If heat-treatment

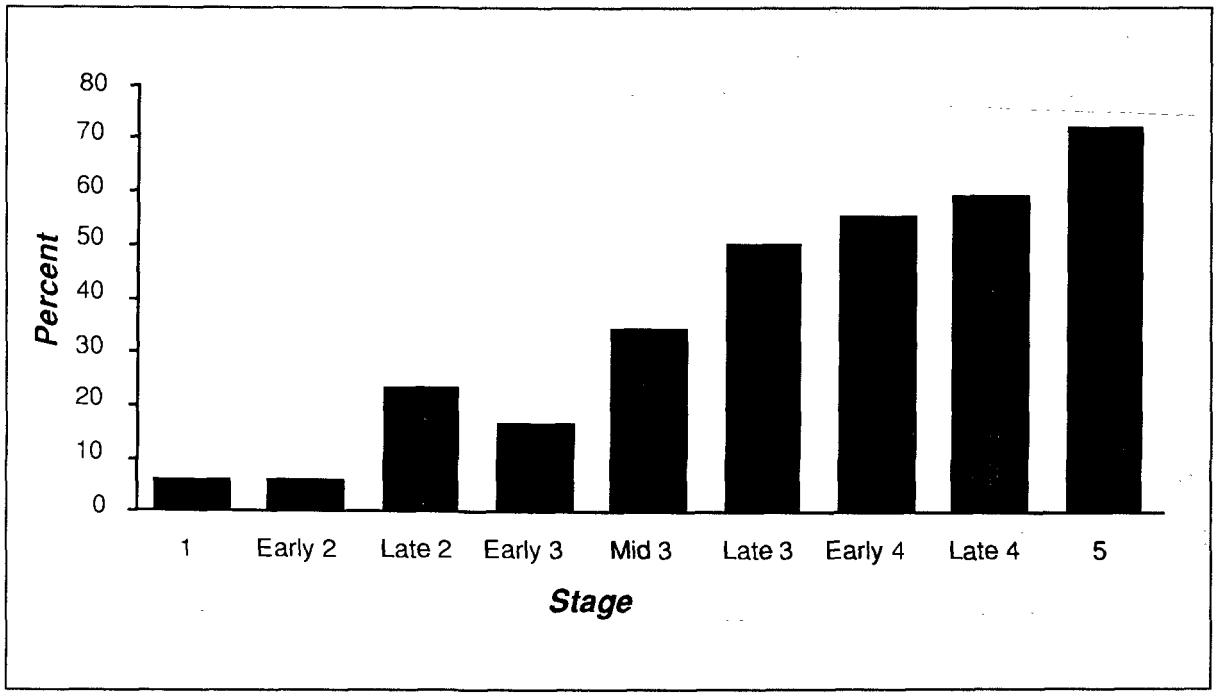


Figure 224. Heat-treatment of opalite bifaces by stage.

was initiated primarily to facilitate secondary thinning, relatively thin Stage 2 bifaces may have been heat-treated earlier in the reduction sequence than thicker but more reduced Stage 3 pieces. From another perspective, heat-treatment may have been undertaken at the point of the change in flaking mode (hard hammer to soft hammer percussion) which allows more controlled thinning.

In sites along the Northern Corridor, the size of early and middle Stage 3 bifaces is very similar, as is the incidence of heat-treatment in the two substages; in the assemblage as a whole, as well as within both of the other subareas, later stage bifaces are smaller and more frequently heat-treated. The pattern in the North suggests that small flake blanks, as well as partially reduced bifaces, were reduced at those sites.

Flake Core Reduction

Core reduction represents an independent trajectory when it involves the production of flake blanks for tools other than bifaces, but when used for the production of biface flake blanks it is part of the biface trajectory. A diagram of the reduction process involved in the flake core trajectory is presented in Figure 225. Cores can be produced either from cobbles or from quarried blocks, and early stage bifaces also may serve as cores. Considerably more cores than bifaces were made on cobbles. We assume that the production of flakes from cores for the production of bifaces and other tools was not common at Tosawihi. This assumption is based on recovery of few cores (137 cores as opposed to nearly 4500 bifaces); too, they are small relative to bifaces. If cores were reduced further (or transformed into bifaces) however, they may not be recognizable; in this case, the incidence of core reduction for the production of flake blanks may have been somewhat more common than is apparent. Although platform preparation may have occurred, cores at Tosawihi generally received little preparation other than rough shaping before flakes were detached. The types and sizes of cores vary widely, and

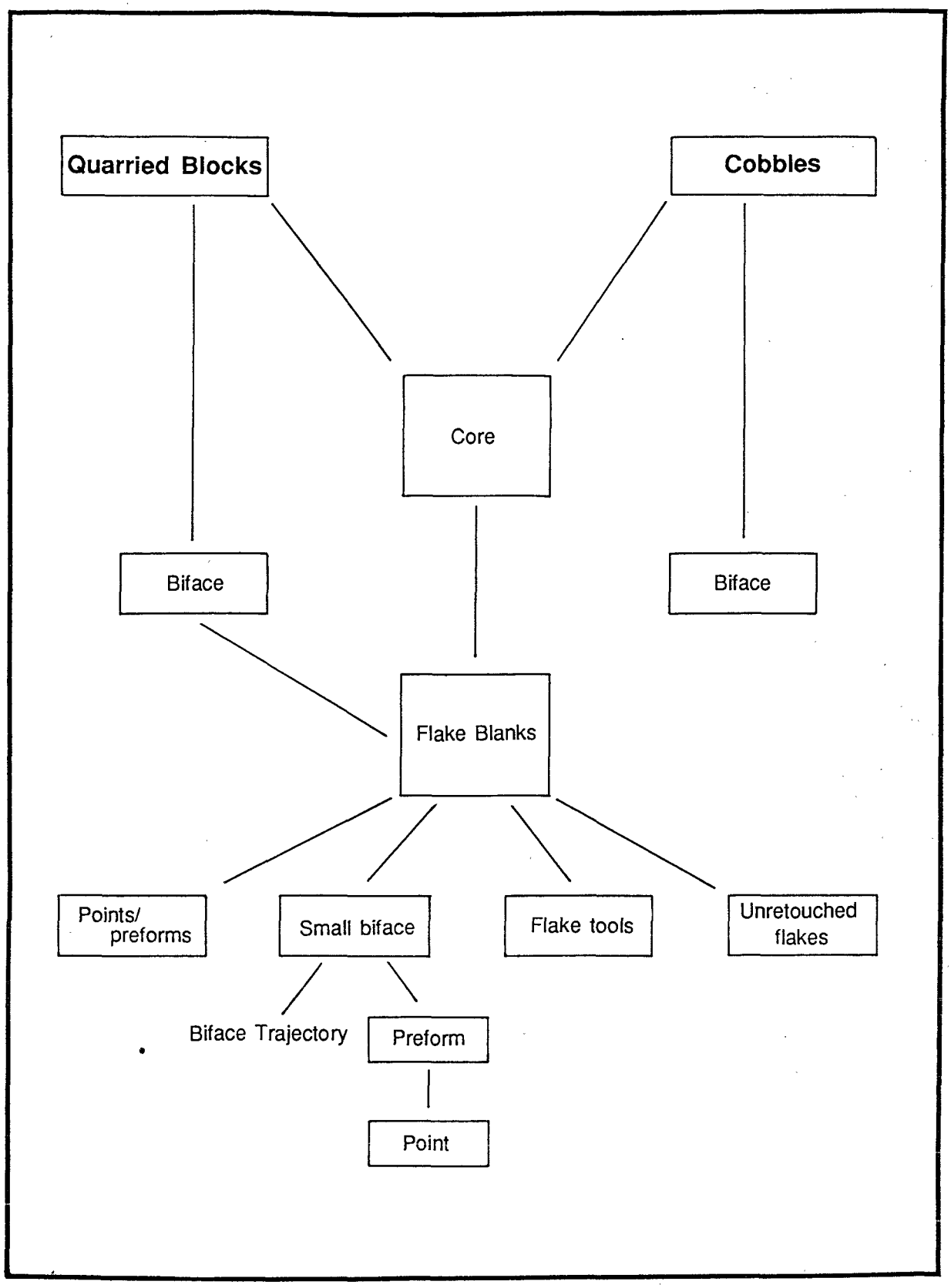


Figure 225. Core/flake reduction trajectories.

most are rather irregular; flakes produced from them could have been made into very small bifaces, flake tools, or projectile points. Hard hammer percussion probably was the flaking mode employed; its by-products would be non-diagnostic flakes.

Secondary Trajectories

Secondary trajectories represent sequences of reduction using blanks obtained as by-products of a primary trajectory. At Tosawihi, the primary trajectory providing blanks for secondary ones is the biface trajectory, although exhausted cores conceivably could be recycled into bifaces. Figure 226 reconstructs these secondary trajectories.

At several points along the biface trajectory, flakes suitable for the production of other tool categories are produced, usually during blank production, primary thinning, and secondary thinning; their size dictates the forms into which they subsequently are reduced. Flakes produced during blank preparation or primary thinning can be quite large, and could have been used for the production of almost any category of flake tool, point, or small biface; those produced during secondary thinning probably were used primarily to produce preforms for small projectile points. Since many of the blanks used in the production of flake tools, preforms, and points were made on biface thinning flakes and, we assume, because few flake cores have been recovered, biface reduction was the primary route by which blanks for flake tools, preforms, and points were obtained.

It is difficult to segregate flake tools broken in manufacture from those broken during use. Likewise, reworking is difficult to recognize on tools made on flake fragments. Projectile points and preforms have more standardized forms, and thus are easier to recognize than flake tools when broken in manufacture. Preforms are broken throughout the reduction sequence but very few were broken fatally during final finishing (at least, not during notching). Points commonly break in both manufacture and use, and the fractures produced by each kind of failure often are indistinguishable. Reworking of points is easier to recognize than in other tool classes; at Tosawihi 9% of the projectile points show evidence of reworking.

Use wear on flake tools reflects a wide range of functions at many of the larger sites. Many of these tools exhibit intensive wear but no evidence of use in multiple actions, indicating that they were made for specific purposes. While projectile points were manufactured, used, and reworked *in situ*, some points could have been imported in finished form. Projectile points were made in three ways: small points (arrowpoints) were made directly on thin flakes, while larger points (dart or spear points) sometimes were made on percussion flaked bifacial preforms with later pressure flaking; stemmed points were percussion flaked and edge ground, without pressure flaking finishing.

There are one third as many flake tools, preforms, and projectile points as bifaces in the assemblage. Our use wear studies indicate that only a small number of late stage bifaces were used *at* Tosawihi. Although only a sample of bifaces was examined, it is clear that most were exported unused and unfinished. This contrasts with the flake tool and projectile point assemblages, which almost certainly were produced primarily for *in situ* use.

Heat-Treatment of Flake Tools and Points

As with bifaces, the heat-treatment of flake tools and projectile points can be undertaken before the flake blank is detached from the core (or biface), as a blank, or during the process of reduction. About 20% of flake tools were heat-treated; this is a lower proportion

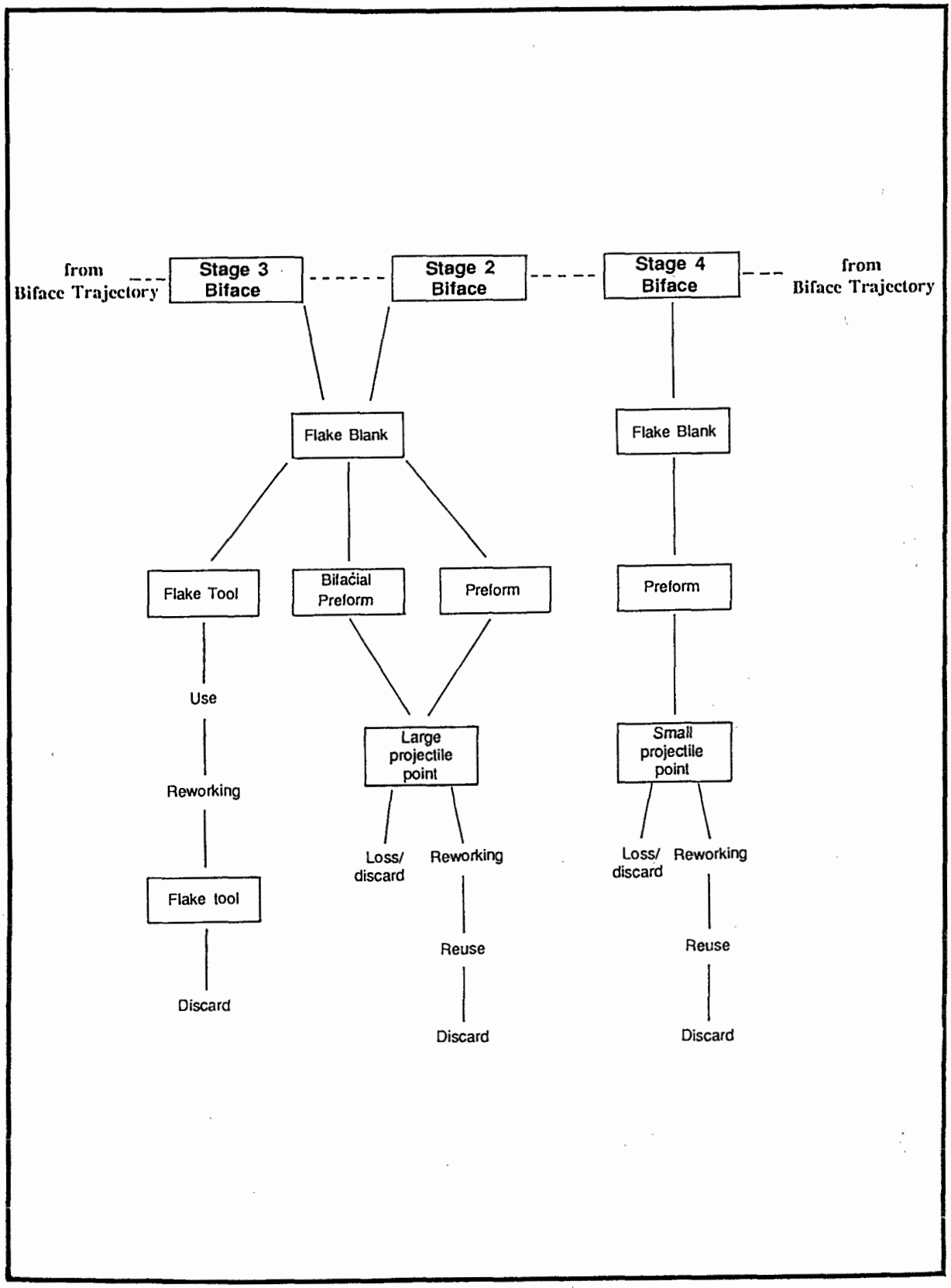


Figure 226. Secondary reduction trajectories.

than that for bifaces as a whole, while that for preforms and projectile points is quite high (60-80%). In these categories, heat-treatment appears to have been intended to facilitate pressure flaking.

Discussion

Length of Trajectories Represented in Various Subareas

It has been suggested that the length of trajectories present at particular sites may reflect the general function of those sites (Johnson 1989). The assumption is that tools are roughed out but not finished at quarry or short term extraction sites, and that a smaller segment of a particular trajectory may be present there than at maintenance activity sites where tools are finished, used, or resharpened. While this model generally may be true, it does not apply in all circumstances and varies with raw material and cultural system. For example, Gramly (1980) has described a quarry location where toolstone was quarried, tools were manufactured and finished, and exhausted tools were discarded; it contains the entire range of reduction stages.

Whether or not this concept can be used strictly to infer functional variation at Tosawihi, it is useful for comparing the portions of the reduction sequence present within the various subareas and contrasting these with the assemblages of sites outside the Tosawihi vicinity. Our four subareas exhibit distinctly different biface and tool assemblages. The Quarry subarea consists primarily of extraction sites where some processing and other activities took place. The Eastern Periphery contains some material sources but consists primarily of reduction stations, with limited residential activity. Sites in the Western Periphery and the Northern Corridor consist primarily of reduction stations or reduction stations with a residential component.

Figure 227 plots the segment of the opalite biface trajectory represented in each area. Two lines have been drawn for each subarea; that on the left marks the full extent of the trajectory present while that to the right signals only those stages represented by more than 1% of the local assemblage. Only the Quarry is represented by less than the full length of the trajectory. The more abbreviated lines are of similar lengths in all the subareas, but different portions of the trajectory are represented; the areas nearer the Quarry are earlier in the trajectory and those farther away are later. The line representing the trajectory fraction present at the sites we examined outside the Tosawihi vicinity is shorter, representing only the latest stages in the trajectory.

Consequently, while the bifaces from the Northern Corridor are more greatly reduced than those from the other subareas, the pattern still is more similar to that found at other sites within the Tosawihi vicinity than to those outside it. This suggests that all Tosawihi sites fall in a zone in which toolstone processing was the primary focus of activity.

Form of Export

We have inquired of the form in which bifaces and other tools were exported from the Tosawihi vicinity using data collected from both within and outside the immediate area. As noted in Chapter 6, cache bifaces, if stored for quick retrieval during short visits and intended for export without further reduction, should reflect the form in which bifaces were exported. They are, however, less reduced and less frequently heat-treated than the majority of bifaces

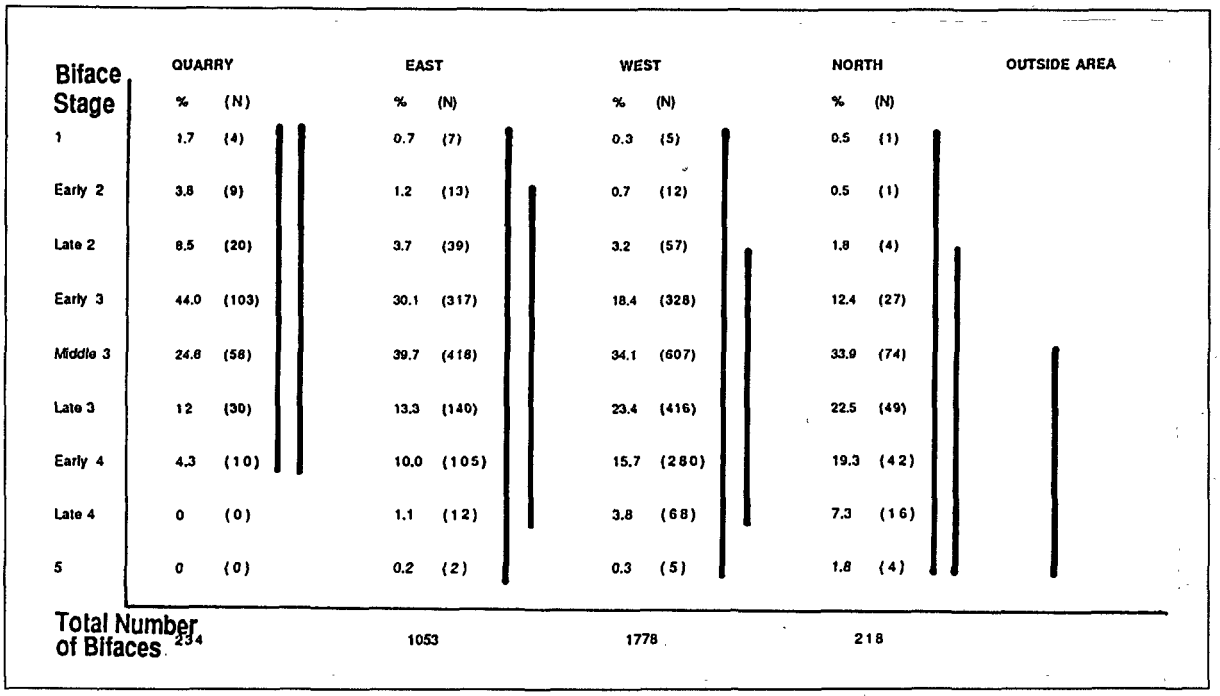


Figure 227. Length of biface trajectory represented in the subareas and outside the project area. Left bold line indicates full extent of trajectory present. Right bold line greater than 10% of trajectory present.

in the assemblage as a whole. Of 84 bifaces recovered from caches, the majority (77.4%) are early or middle Stage 3 and only two are heat-treated. It seems likely that these pieces probably would have been reduced further and heat-treated before export. As they clearly are not rejected products (in contrast to the majority of bifaces recovered), we have excluded them from the counts used in reconstructing the stage of export from fragmentary bifaces.

When subareas are compared, both stage of reduction and proportion of heat-treatment increase with distance from the quarry proper. This suggests that bifaces were exported from the quarry area at different stages, reflecting the distance of campsites from the quarry proper, and that bifaces were reduced progressively at campsites as the quarriers left the area.

As noted above, in order to investigate this further we also briefly examined material recovered at sites ranging from 12 to 60 km from the center of the quarry area. While Stage 1 and Stage 2 bifaces occur occasionally, almost all bifaces made of Tosawihi material at these sites are late Stage 3 or Stage 4 heat-treated specimens. This indicates either that bifaces were exported in a form later than early Stage 3 or that further reduction took place as they were transported. In addition, biface production debitage found at these sites almost exclusively is heat-treated, implying that most bifaces were heat-treated before export, or heat-treated before reduction was continued. It is unlikely that they were exported directly from the Quarry subarea because bifaces found there clearly are of earlier stage than those in the other subareas.

Most bifaces recovered at Tosawihi are middle Stage 3 (35.3%), and an equal proportion were reduced past that stage (cf. Figure 222). Most are broken, so we cannot assume that the proportions of stages present in our assemblage correspond directly to the proportions of each stage exported. Unequal breakage would affect the proportions of discarded pieces, and, in fact, replicative and archaeological studies (Amick 1985) as well as our own biface breakage data have shown that bifaces tend to break more frequently later in reduction. The difference in stage proportions of complete and broken bifaces in our assemblage can be seen in Figure 228.

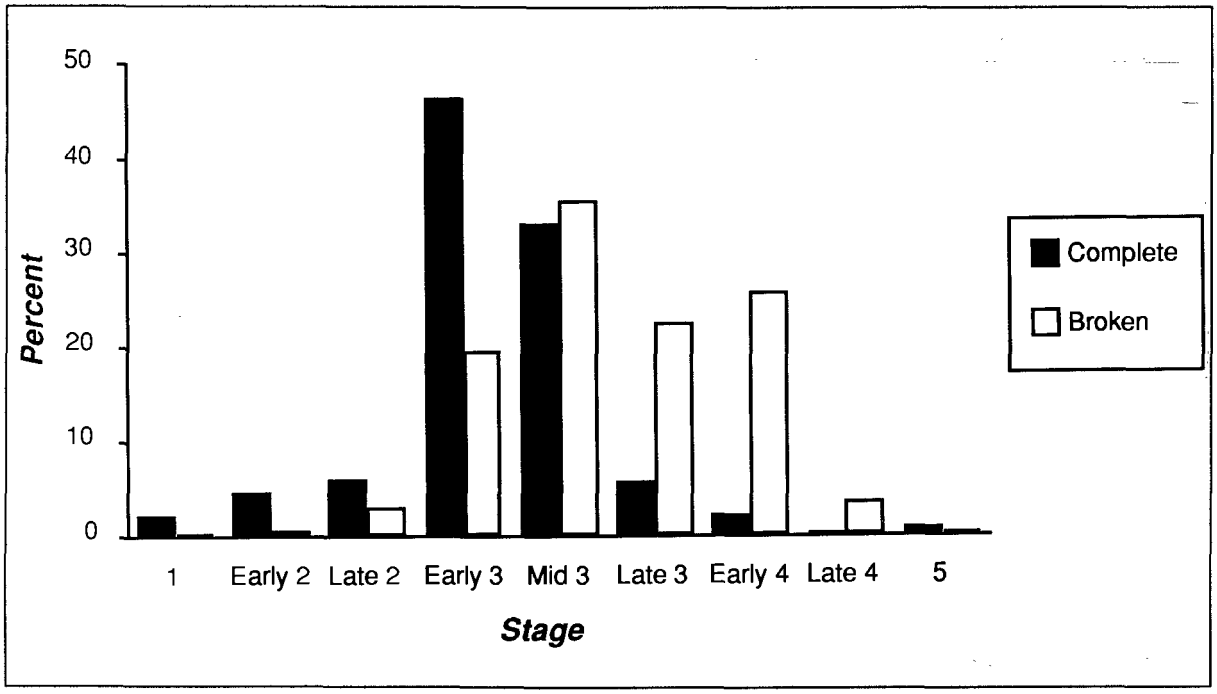


Figure 228. Proportions of complete and broken bifaces by stage.

When the differences between the samples of complete and broken specimens are compared, we see that breakage increases in middle Stage 3; broken pieces are significantly more frequent in late Stage 3. The proportion of broken pieces remains high in Stage 4, but the breakage rate may decrease somewhat toward the end of the reduction sequence. The point (late Stage 3) at which the steepest increase takes place probably reflects the point at which heat-treatment becomes common (Figure 229) and soft hammer billets may have come into play.

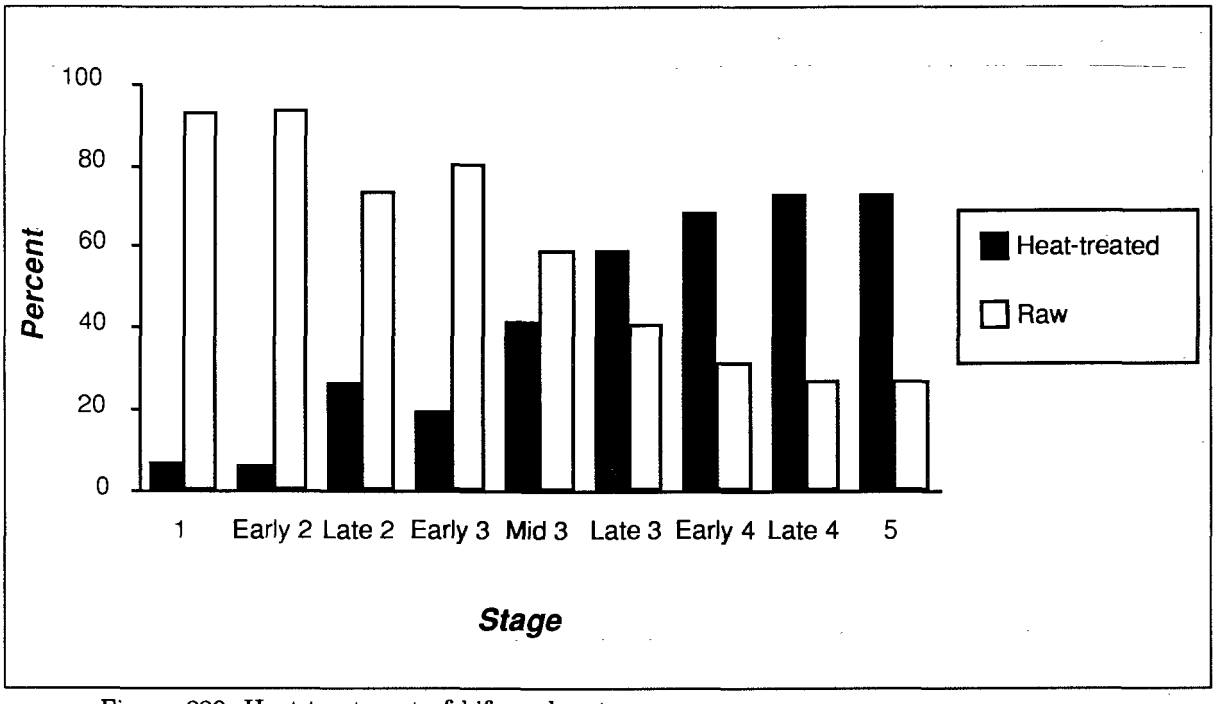


Figure 229. Heat-treatment of bifaces by stage.

Determination of the form of export is, thus, quite complex. In fact, it is easier to say what was not exported than what *was*. We already have rejected that most bifaces were exported in a form represented by cache bifaces and, likewise, we must reject the possibility that all bifaces were exported as middle Stage 3 forms, since 40% of those in our sample were broken during manufacture at a later stage. Few, if any, were exported as Stage 1, Stage 2, or early Stage 3 forms; these stages are rare in biface and debitage assemblages at sites away from the processing areas, and few are heat-treated.

This leaves a wide range of possibilities for export form, but the proportions of bifaces distributed among the stages in the assemblage represent failures; they were created by differential breakage rates increasing through the first half of the reduction sequence, rising most steeply between middle and late Stage 3 and leveling off subsequently. If no export is postulated until middle Stage 3, the breakage rates in each prior stage until that point should remain constant under various export scenarios. We already have determined that breakage increases from Stage 1 to at least Stage 4, and that all bifaces were exported at middle Stage 3 or later. Assuming a successful biface manufacture rate of 70% (Sassaman 1988) and a sample of 100 bifaces, patterns of export can be modeled and the derived breakage rates used to evaluate various scenarios.

Two rejectable possibilities are that no middle Stage 3 bifaces were exported, or that only Stage 5 bifaces were exported (i.e., that all bifaces were reduced to finished form). The darkened curve on Figure 230 illustrates the breakage rates which would have occurred in each stage under a scenario of no export until Stage 5. Neither possibility is acceptable because, irrespective of success rate, the large proportion of Stage 3 bifaces in the assemblage means that, while breakage rates should increase from Stage 1 to middle Stage 3, they necessarily would decrease after that point, which contradicts our observations. Therefore, at least some middle Stage 3 forms must have been exported, and we must conclude that the material leaving Tosawihi consisted of a *range* of forms, that is, middle Stage 3 bifaces and later stage forms. Most were heat-treated.

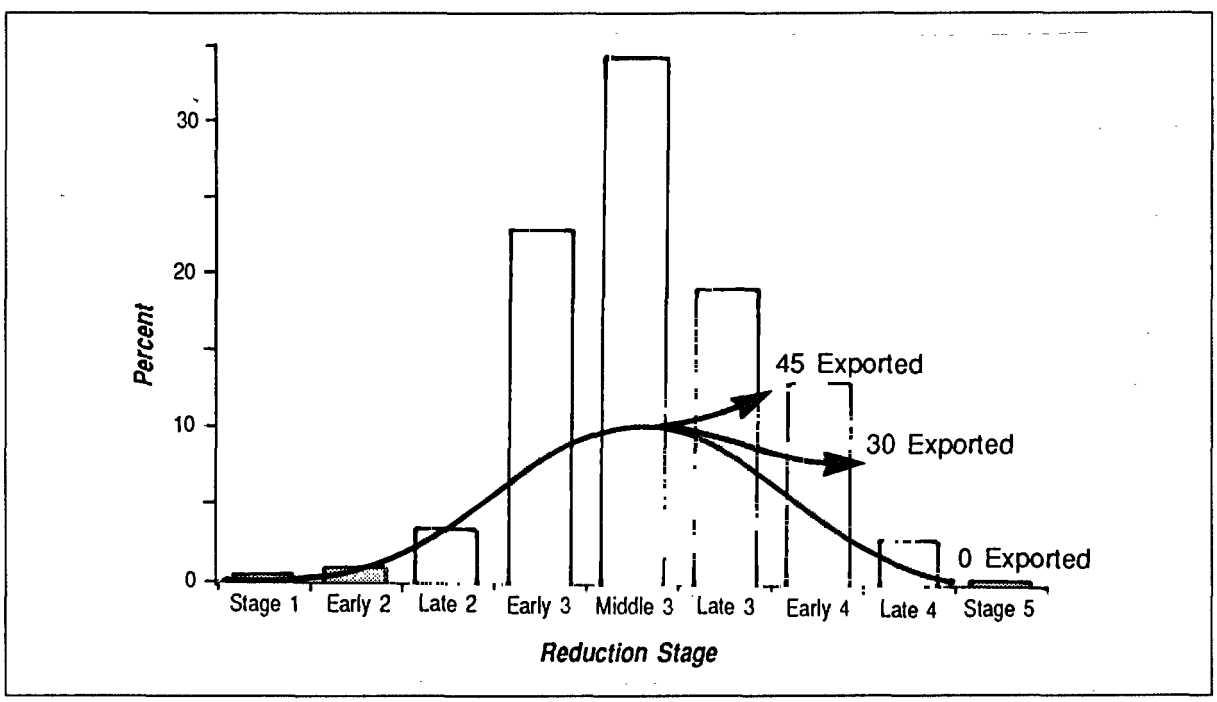


Figure 230. Estimated breakage rates with varying export in Middle Stage 3.

But can we be more precise about the mix of biface forms leaving the Tosawihi vicinity? If we spin out the same arguments, we can model various acceptable scenarios. Again assuming a 70% success rate, we modeled export of various frequencies and found constraints suggesting that 50-60% of the bifaces were exported at middle Stage 3, 15-20% in late Stage 3, and 15-20% in Stage 4. If 30 of the 100 sample bifaces were exported at middle Stage 3 (given the assumed success rate of 70%), the breakage rate in late Stage 3 would still be lower than in middle Stage 3 and, therefore, the number exported must be higher. If 45 of the 100 sample bifaces were exported at middle Stage 3, then the breakage rate increases dramatically between middle and late Stage 3. Thus, in order to effect an increase in the breakage rate between middle and late Stage 3, at least 50% of the bifaces exported must have left the system at middle Stage 3; if then, the proportion of remaining bifaces exported in late Stage 3 is greater than 50%, Stage 4 breakage becomes inordinately high, so we postulate approximately equal numbers of late Stage 3 and Stage 4 bifaces exported. Figure 231 illustrates possible export form bifaces.

Our conclusions concerning the export proportions are tentative; simulation programs could help explore the possibilities, by allowing us more easily to vary assumptions and to contrast the material exported from various subareas, but the conclusion that a mixture of stages was exported, with the highest proportion being middle Stage 3, seems secure. Whether this mixture should be ascribed to temporal changes in export form, varying preferences by different contemporary groups, or other reasons, cannot be addressed without better temporal control than presently available.

The export form of other artifact classes is even more difficult to determine. It seems likely, however, that, as noted above, tools other than bifaces were made primarily for *in situ* use.

General Function

Bifaces frequently are assumed to be cores (Kelly 1988), used away from quarry areas as sources for flake blanks for projectile points and other tools. Alternatively, they may serve as preforms for bifacial tools or knives. Since Tosawihi bifaces were exported in "unfinished" form, bifaces and debitage recovered from the project area can be used only indirectly to inform ultimate function. Heat-treatment provides one line of evidence; heat-treatment is an integral part of the Tosawihi reduction sequence, that by late Stage 3, (the principal stage at which bifaces were exported) more than half of the pieces were heat-treated. The size of flake tools and larger projectile points indicates that most were made on biface thinning flakes removed during early stage biface reduction. The size of preforms and arrowpoints shows that the blanks on which they were made could have been removed at any stage of reduction. The form in which they were heat-treated, however, indicates that they were not detached from heat-treated bifaces, and that most probably were made on early stage biface thinning flakes.

Almost all bifaces and debitage of Tosawihi opalite from sites away from the quarries were heat-treated, but projectile points were not made on flakes detached from heat-treated bifaces. This suggests not only that some number of raw flake blanks were exported in addition to bifaces, but also that at these sites bifaces did not often function as cores. Therefore, their reduction probably was in aid of the production of bifacial tools. Without further and more detailed examination of additional collections we can only suggest that most Tosawihi bifaces were intended to be knives; whether they were traded, and to what destinations, are questions awaiting further research.

Standardization of Production

The patterns observed in lithic reduction trajectories at Tosawihi indicate that, while the location of some elements vary, the sequence through which bifaces were reduced was quite formal.

Although we lack good chronological control for most samples, the quarry area clearly was exploited over a long period of time, and the patterns of toolstone procurement and processing observable there probably persisted for long periods. The quarries *could* have been exploited simultaneously by a number of groups, but, those groups must have shared approaches to the reduction of bifaces and may have shared a persistent technological tradition as well.

Whether specialist quarriers and knappers were the primary quarry users is impossible to address without more precise chronological control. As noted in Chapter 6, several special reduction techniques common to cache bifaces and in the assemblage as a whole may be peculiar to Tosawihi, and their presence may signal the presence of specialists. Other collections from production sites need to be examined to determine whether similar techniques are operating when future work at Tosawihi yields material with good chronological control, such questions can be examined more fully.

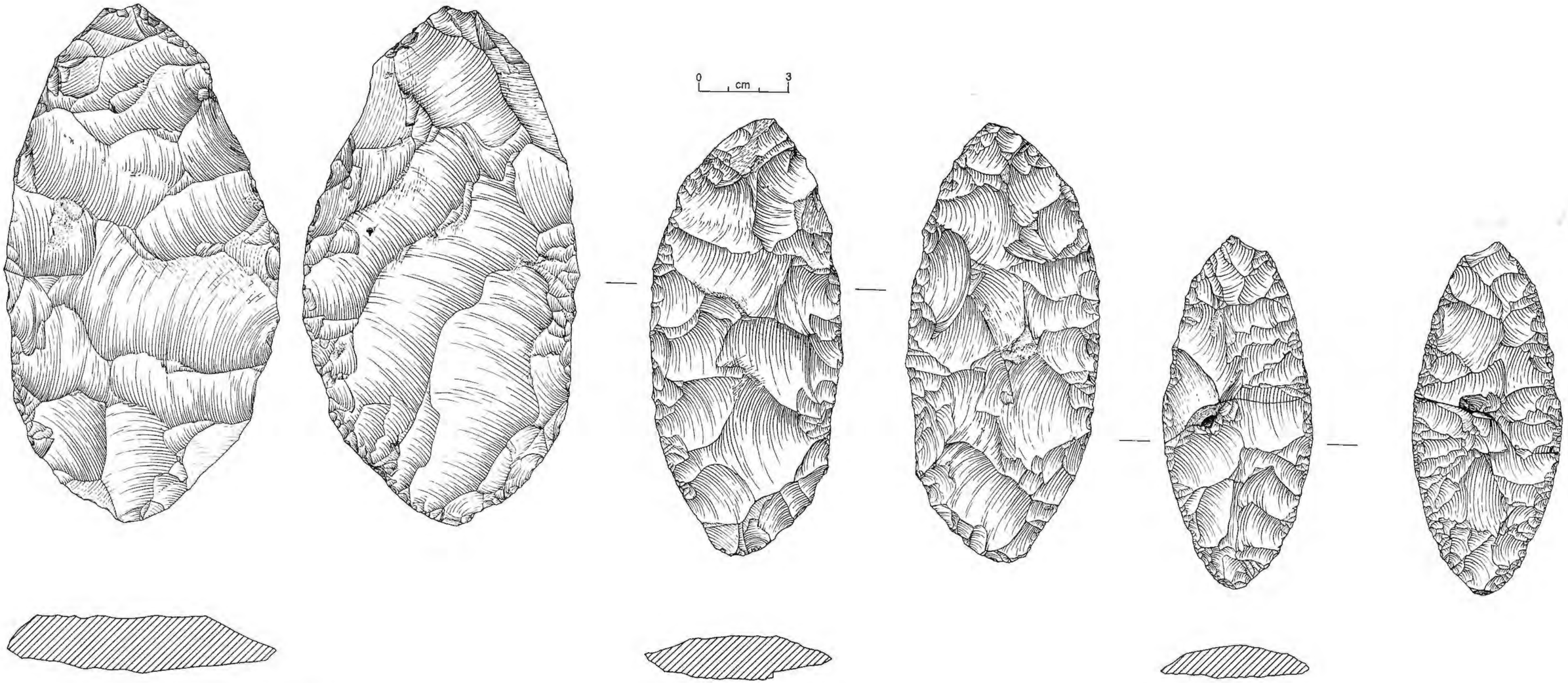


Figure 231. Possible export form bifaces. a. Late Stage 3; b. Stage 4; c. Stage 5.

Chapter 22

CREATION AND TRANSFORMATION OF TOOLSTONE EXTRACTION AND PROCESSING FEATURES

Robert G. Elston and Daniel P. Dugas

Among the many aspects of site creation and transformation, we focus here on the creation, development, and abandonment of quarry pits and associated toolstone processing features; we touch other domains peripherally.

According to Schiffer, archaeological inference is not simply a matter of assuming that past human behaviors were "the sole determinants of the present-day properties of the archaeological record" (1987:5), nor does one need only apply a set of correlates relating behavioral phenomena to their archaeological consequences in order to make reliable inferences. Schiffer (1987:7) cautions against taking the archaeological record at face value, as well as attempting to read behavior from it directly.

We suggested in Chapter 3 that, while Tosawihi is no Pompeii (Binford 1981b), its lithic deposits (and perhaps those of other quarries) are relatively unaffected by many processes that transform other kinds of artifacts and features in other contexts. We generally agree with Schiffer's admonition against taking the archaeological record at face value, but we are reasonably confident of our ability to define the archaeological consequences of lithic quarrying and processing from ethnographic analogy (Binford and O'Connell 1984; Binford 1986; Hayden 1979a; Jones and White 1988), and our own quarrying experiments (Carambelas and Raven 1991; Chapter 26, this report), and to recognize those consequences in the archaeological record. Surprises are possible, but we expect the range of residue-producing and deposit-disturbing prehistoric behaviors at quarries to be limited.

The interaction of cultural and natural processes creates the archaeological record. Our concepts of cultural and natural transformations are similar to Schiffer's (1976; 1987) C-transforms and N-transforms, but we are less interested in whether or not one set of processes has distorted the products of the other than we are in recognizing and separating their effects. Distinguishing human modification of cultural deposits from disturbance by natural agents is essential to interpret quarry pit stratigraphy correctly and account for the displacement or inversion of datable materials. Identification of natural agents and processes also helps avoid confusing certain natural features of site structure, such as root balls and depressed root zones, with cultural features.

Cultural and natural processes, moreover, act at different temporal and spatial scales. Natural processes operate more or less continuously, but are slowly incremental and tend to be overwhelmed when human agents are actively at work; cultural processes generate large volumes of material over relatively short periods of time. Thus, the ability to distinguish the products of natural and cultural processes allows one to estimate the volumes of material extracted and processed during a given interval, as well as to identify episodes of quarry pit abandonment. The extent of pedogenic modification to natural and cultural deposits also provides a clue to the relative time deposits have remained undisturbed by human agency.

Finally, if we are to understand why a particular quarry location was selected for exploitation, and understand the natural constraints on prospecting and mining it, we must understand the original extent of the outcrop as well as its degree of exposure, depth of colluvium, soil type, and other natural conditions prior to human disturbance.

In this chapter, we more fully develop models of site formation and transformation previously sketched (Elston 1988a 18-26; 1988b:32-39). Here, we describe the creation of

toolstone extraction and associated processing features based on ethnographic analogy and some results of our experimental quarrying, creating a general model of quarry site formation and cultural transformation of quarry site deposits. Drawing on our understanding of geomorphic processes and pedogenisis, we consider natural agents and processes that transform features created by humans. We describe the influence of bedrock morphology on quarrying strategies, and, finally, summarize the transformations to quarry sites expected after abandonment. Taken together, cultural and natural processes generate a model that accounts for the regular occurrence of certain types of surface and subsurface deposits in and adjacent quarries, and allows us to address such problems as the presence of inverted radiocarbon dates in some quarry deposits. Further support for this approach is provided by Wilke and Schroth (1989), who recently advanced a model of toolstone prospecting that closely parallels one of ours.

Creation of Toolstone Extraction and Processing Features

The ethnoarchaeological literature, particularly that of Australia, provides significant insights into the structure and content of lithic extraction and processing features (Jones and White 1988; Binford and O'Connell 1984; Binford 1986; Gould 1977, 1980:124-125; Hayden 1979a:51; O'Connell 1974, n.d.; Tindale 1965:140). When we apply these insights to the Tosawihi lithic terrane, we can make some quite specific predictions about the archaeological record. While the acquisition of toolstone is a continuum (like many other cultural processes), it can be divided for heuristic purposes into different activities corresponding to various aspects of search (including preparation and prospecting) and handling (including extraction and processing), as outlined in Chapter 3.

Procuring and Transporting Quarrying Tools

Fully embedded, encounter toolstone procurement of the type Binford (1979) attributes to the Nunamiut Eskimo requires no special preparation beyond ordinary outfitting to prepare for various contingencies of hunting and gathering. Intensive exploitation of toolstone at a quarry, however, might require some special preparation involving the procurement and transport of special tools needed for quarrying, lithic processing, and self maintenance. The acquisition of such tools involves costs and benefits distinct from the quarrying forays in which the tools eventually are employed, but it influences the costs and benefits of quarrying nonetheless. Tool transport increases travel costs (a component of search costs), but these may be balanced by decreased time and effort needed to procure tools at the quarry.

The benefits of transporting exotic tools depends on the availability of suitable local materials. For instance, Yolngu Aborigines procured quartzite hammerstones from a traditional named source some 60 kilometers from the Ngilpitji quarries and transported them to the quarries (Jones and White 1988:58). Although nicely rounded quartzite cobbles suitable for hammerstones and grinding tools are available in gravel bars along Willow Creek, none appears to have been transported the 12 km to Tosawihi. Aside from small obsidian artifacts, the most lengthy portage documented so far is a vitrophere metate carried 3 km to 26Ek3095 from its source to the east; the metate is not a quarrying tool, however, and may have been on its way elsewhere when it broke at Tosawihi.

Some transport of hammerstones occurred, but mainly involved more local materials moved over much shorter distances (cf. Chapter 11). Large basalt boulders obtained from Basalt Canyon were carried as far as 1.6 km to quarry pits on Butterscotch Ridge and Bordes Ridge. Smaller quartzite hammerstones obtained from Little Antelope Creek were used throughout the quarries, mostly for processing. This suggests that most quarrying, lithic

processing, and plant processing tasks were accomplished with tools made from local materials, without costly imports, and that people had time to collect them at the quarry, as well. Bison bone and elk antler tools recovered from quarry pits also might have been procured from kills at or near the quarries, but probably are personal gear procured prior to quarrying forays.

Prospecting

All toolstone is derived from bedrock, but weathering, erosion, and agents of turbation create and distribute rock fragments in soil and stream deposits as well. Thus toolstone may occur in massive bedrock surface outcrops, in beds buried by colluvium or alluvium, or as clasts in colluvium or alluvium. In lithically rich terranes such as Tosawihi, one may be confronted with lithic raw material in all its forms; in other places, only clasts may be present. *Prospecting* is the active search for lithic raw material; our usage of the term is somewhat broader than that of Wilke and Schroth (1989).

Encounter Assay

It is not unreasonable to assume that prehistoric people always were on the lookout for lithic raw materials, prospecting more or less continuously. We also assume that prehistoric people assayed likely rocks whenever time and opportunity provided by the lithic terrane allowed, following a "catchem up" strategy similar to that of the Nunamiut Eskimo (Binford 1979:258). Since it takes relatively little effort to scoop up a rock and detach a flake with another local stone, we might imagine such *encounter assay* occurring at frequent intervals as people moved through the landscape on their way to and from other business. Even were it impossible to stop and procure good stone, its location would be remembered, and the lithic terrane of the entire range would become mentally mapped in some detail. The greater time available, of course, the more reduction could be performed at the find locality.

Locating Toolstone at the Quarry

Once in the vicinity of a toolstone source, the first step in acquisition is to find a location where toolstone can be extracted. If a quarry already has been established, this may be fairly easy, since the surest alternative is to work in an existing exposure where the presence and quality of toolstone is known and the effort of extraction can be estimated closely. If previously exploited sources have been depleted, however, or the area is unknown, prospecting for new material must take place. Wilke and Schroth define "places where potentially flakable stone was assayed or tested for quality" as *lithic raw material prospects* (1989:146).

Upon arrival at the quarry, the first observed activity of both Yolngu Aborigines of Arnhem Land (Jones and White 1988) and Alyawara Aborigines of Central Australia (Binford and O'Connell 1984) was to wander over the area, looking at material exposed on the surface, and testing or assaying likely pieces by breaking them open and striking flakes from them. The Aborigines were not really interested in the surface material (which was too weathered to be useful), *per se* (Tindale 1965:140), but in what it indicated about the quality of subsurface rocks. The Yolngu paid special attention to places where previous lithic reduction had occurred, and members of both groups were interested particularly in partially buried boulders (Jones and White 1988:59; Binford and O'Connell 1984:411-412). The Alyawara used chunks of

toolstone as assaying hammers, while Yolngu apparently used the quartzite hammers they brought with them. The prospectors in both groups continually passed material back and forth, conferring on its quality.

Finally, at quarries the initial examination of surface material eventually is augmented by subsurface exploration, to which we extend the term "prospecting." Yolngu prospectors pushed over old trees in order to bring up subsurface clasts in their roots; both Yolngu and Alyawara excavated shallow pits, and expanded those that exposed good material. Small, shallow, exploratory pits abandoned without subsequent toolstone extraction are expected to fill in quite rapidly, and may be difficult or impossible to detect in the archaeological record.

Extraction and Processing

Whether or not to use surface material or expend time and energy to retrieve buried material appears to depend on the type of rock present in both surface and subsurface contexts, the task(s) for which stone tools are intended, and the time available for procurement (Gould 1980:124-125; Hayden 1979a; Torrence 1983).

Quarry pitting occurs when the payoffs in getting subsurface toolstone are higher than those of surface material. Gould (1977:163-164, 1980:124-125) observed the use of ubiquitous, medium to low quality surface rocks for expedient tasks, and their subsequent abandonment at the place of use (defined as *ephemeral stone acquisition and use sites* by Wilke and Schroth 1989:148). Nonetheless, Aborigines excavated one or two feet below the surface at sources of high quality white chert for unweathered, buried toolstone. While Hayden (1979a:51) saw no evidence of quarry pits at any of the Papuna opal sources he visited, one of his Walbiri informants recalled that people used to dig deeply for chunks of toolstone up to 50 cm in diameter (Hayden 1979a:51). Binford and O'Connell (1984) report excavation as an extraction technique for high quality material; Jones and White (1988) observed pits as deep as 55 cm.

Organization of Ethnographic Quarrying and Processing

Toolstone extraction and processing generates distinctive kinds of features and debris, including quarry pits and berms, adits, cobble concentrations, and dense flake scatters. The following description might well be of the Tosawihi Quarries, were we to substitute sagebrush for trees and opalite for quartzite:

> Between each rock exposure and clump of trees was a dense scatter of flaked and modified stone...Undulating depressions encircled by high densities of flake debris alternated with clusters of large blocks from which only a few flakes had been struck. Away from these clusters of 'big stuff', scattered on the sandier slopes or tucked under the edges of vegetation, were small, half-moon scatters of large flakes and a few chunks and blocks (Binford and O'Connell 1984:409).

Quarrying by Australian Aborigines was observed by Binford and O'Connell (1984) and Jones and White (1988). Although there is a logical order to assaying, extraction, and processing, these activities do not form stages in the strict sense. In both ethnographic examples and experimental quarrying, all three activities often occurred simultaneously, with some people prospecting and extracting while others processed extracted toolstone.

In all cases, a likely spot for quarrying was found by prospecting, as described above. Both Aborigine quarries contained quartzite clasts in a sandy soil matrix. The clasts seem to have been much larger in the Alyawara quarry than they were at Ngilpitji. At the Alyawara quarry, once a partially buried boulder was located, minimal excavation was conducted with digging sticks and hands to expose enough of the subsurface rock for assay (Binford and O'Connell 1984). This created a small, shallow pit around the buried rock, a slight berm of soil and waste rock (tailings) along the edge of the pit, and primary and secondary debitage, mostly in the bottom of the pit. Photographs provided by O'Connell (personal communication) show the first deposits of soil arrayed in fan shaped piles around the pit. When assaying returned satisfactory results, further excavation exposed and removed the buried rock, or, if the rock was too large, the "pit" came to comprise a trench around it. At the Alyawara quarry, larger boulders were moved with wooden levers, and were broken up using block-on-block and fire setting techniques; chunks of rock too large to move remained in the pit. According to Binford and O'Connell's map (1984:Figure 5), the three pits excavated at the Alyawara quarry were elongate and less regular in shape than those at Ngilpitji, ranging in maximum dimension from 150 to 225 cm; pit depths are not reported.

At the Alyawara quarry, pits were concentrated around a large surface boulder; distances between them varied only from 50 to 75 cm (Binford and O'Connell 1984:Figure 5). A large core separated from a boulder by fire was moved with a lever about 1 m to the pit margin. Unable to manipulate this block easily, the knapper worked around and around it, leaving a ring of debitage encircling the partially reduced core. Other, smaller cores (ca. 45 lb) were transported from 1 to 6 m from their pits of origin. The distance between individual processing locations varied from 3 to 5.5 m. At each processing location, the knapper sat on the ground with the core in front of him, striking platform facing to the right. Trailing away from the core to the right was an arcuate scatter of debitage with a radius of about 1 m, in which items appeared to grow smaller with distance from the core. Larger items, however, accumulated along the margin of the scatter away from the knapper, where they perhaps were tossed in order to keep the area around the core clear. The area to the left of the core was mostly free of debris. Items selected by the knapper for further reduction or later use were placed by his right knee. The total area in which the three Alyawara performed extraction and processing was approximately 72 m^2 or 24 m^2 per person in the three man work party.

Work at Ngilpitji quarry was divided into two sessions. During the first, pits were excavated, stones assayed, and one of the older men, Dhulutarrama, manufactured blades and flakes. In the second session more blades were produced by Diltjima, and blades were reduced to points by the younger Roger Yilarama. At Ngilpitji, most clasts were cobble to small boulder in size. Using a metal bar as a digging stick, one man excavated five roughly circular pits ranging from 30 to 120 cm in maximum diameter and from 20 to 55 cm in depth. Fire setting was known to the Yolngu Aborigine quarrymen observed by Jones and White (1988), but was not used during the particular foray described, apparently because there was no need for it in the extraction of relatively small clasts from their sandy soil matrix. Working into a face cut into the downslope side of the pit, the quarryman extracted small boulders of quartzite and piled them in berms along the sides of the pit as he worked, mostly in the uphill and downhill quadrants. The berms of boulders, soil, and coarse flakes appear from the map presented by Jones and White (1988:Figure 3) to range from 20 to 50 cm in width. The boulders were examined, likely ones assayed, and some selected for further reduction as cores.

At Ngilpitji, the distance between quarry pits ranged from 1.5 to 13 m. Cores were reduced by the two more experienced older men, Diltjima sitting about 1 m from the pit margin, and his assistant, Yilarama, 1 m to 2 m away from him. Dhulutarrama reduced cores about 7 m from the pit, where a fallen log provided a work surface. The total area occupied by quarry pits and reduction locations was 230 m^2, or 46 m^2 per person in the work party.

Diltjima placed cores in a shallow pit on a grass pad on his left side as he sat on the ground. The hammerstone was swung across the front of the body. Diltjima piled some of the primary flakes adjacent to the core on the side about 50 cm away from him; later, he inspected

each flake and placed it in a pile behind him, where they were culled by Yilarama for suitable point and tool blanks; the unused flakes formed an elongated elliptical scatter about 50 x 200 cm extending behind Diltjima. Small flake debris was swept away to the side with the primary flakes. While Diltjima reduced cores, suitable flakes were made into points by Yilarama employing direct percussion with the blank resting flat on an anvil stone, using another large flake as a hammer. In one case, small flake debris were dropped in a semicircle around him, in another, in a pile on his right. A pile of unretouched flake blanks was left here as well. Yilarama carried the finished points to a place about 9 m east, where other men had gathered to gossip, and some additional retouching was done there. This was only about 5 m east of the location at the fallen tree where Dhulutarrama had reduced several cores.

Experimental Quarry Pits

In experimental quarrying at Tosawihi, three quarry pits were excavated, comparable in size to the ethnographic examples described above (Carambelas and Raven 1991; Chapter 26, this report). Tools included hammerstones, a digging stick, cow scapula scoops, and a metal dish pan used as a "basket". All the experimental pits attempted to expose beds of opalite more or less parallel to the ground surface. The first was excavated blindly though soil and into unsilicified tuff in the vicinity of a prehistoric quarry pit, but toolstone never was encountered. Upon abandonment, this pit was roughly oval, 66 x 99 cm in plan and 75 cm deep, with a berm over 100 cm wide. A second pit was excavated at Locality 36 of 26Ek3032, where a backhoe trench had revealed a horizonal bed of opalite underlying about 50 cm of soil; moreover, a system of cracks in the opalite appeared to offer ingress into the rock. Extraction began in the bottom of the backhoe trench using hammerstones with wooden and antler wedges, but was extended into the undisturbed soil and bedrock on the upslope side, where a digging stick was employed as well. Upon abandonment, the pit was approximately oval in plan, about 140 by 90 cm, and 65 cm deep. An arcuate berm comprised of soil and waste rock about 110 cm wide lay around the downslope quadrant; this berm, however, had shifted position several times during excavation as the direction of work changed to take advantage of opportunities offered by cracks in the bedrock. A third pit was excavated through the center of a filled prehistoric quarry pit. The experimental pit was roughly circular in plan, about 120 cm in diameter and 70 cm deep, with a berm of soil and old quarry debris about 50 cm wide around the east quadrant. Bedrock was encountered at the bottom, but little was removed. The quarriers noted that while the pits were shallow, it was easy to remove loose soil and fine clasts by scrabbling it with bare hands or scooping it with scapulas. Only in pits deeper than 20 cm was it more efficient to fill the dish pan with soil and dump it.

Quarry Pit Anatomy

Neither the ethnographic nor experimental quarry pits described above are very complex features, but they share several attributes we assume will appear in any quarry pit created with similar technology; three components should be invariable. First is the pit itself, a cavity, circular or oval in plan, from which soil and rock have been removed. Second are deposits of soil and rock removed from the pit; tossed, scraped, scooped, or scrabbled, these tend to accumulate in a convex berm around pit margins; the inner slope usually is steeper than the outer, and deeper pits exhibit higher and wider berms. Third are deposits that fill the pit after abandonment. Together, the pit and berm contain several surfaces with different gradients, each influencing deposition and forming unique contexts for human activity. The surfaces include the pit bottom, inner slope, berm top, outer slope, and exterior (Figure 232).

Abandoned quarry pits eventually fill with material slumped, washed, or blown in; as discussed in Chapters 15 and 16, most pits at Tosawihi were visited several times, "migrating"

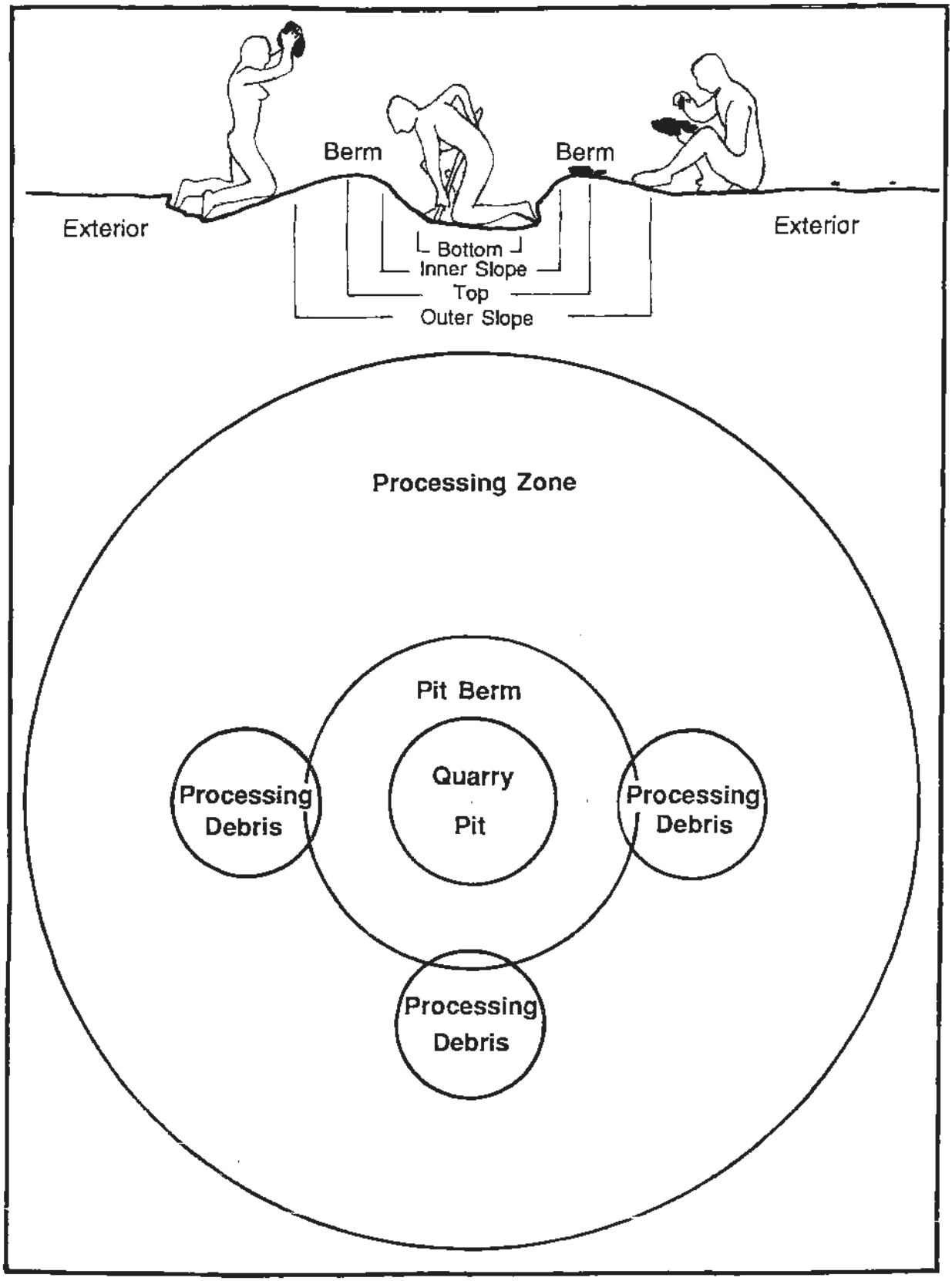


Figure 232. Quarry pit schematic model.

as new raw material was sought. The major strategies called into play involved working back and forth along the strike of a buried opalite layer or the face of an outcrop; where pits were sunk on opalite layers more or less parallel to the surface, work proceeded into the slope. Both strategies filled vacated portions of pits with the debris from current workings.

The mean plan dimensions of ethnographic and experimental quarry pits were 116 cm x 90 cm, with berms ranging between 30 cm and 110 cm wide. The pits were large enough to accommodate a single worker, but did not offer sufficient level space or proper substrate for toolstone processing; in fact, all ethnographic observed processing took place outside the pits. The mean distance of the processing knapper from the pit margin is quite similar in each case (Table 208). Of the nine ethnographic processing episodes, four occurred at 1 m, one at 2 m, and one at 2.5 m from the edge of the pit, so we might suppose that processing toolstone from a particular pit is most likely to occur in a zone about 2.5 meters from it. Since the arc of processing debris around each knapper is about 1 m in diameter, the processing debris from knappers closest to the pit overlaps the berm. In the real world, quarry pits and processing zones are rarely symmetrical and they vary in size. Nevertheless, the relationships shown schematically in Figure 232 serve as a general model.

Table 208. Distance of Ethnographic Toolstone Processing From Pit Margins*.

	Alyawara Quarry	Ngilpitji Quarry
	1.0	1.0
	1.0	1.0
	6.0	2.0
	5.5	2.5
		13.0
Mean	3.38	3.90
SD	2.75	5.13

*distances measured from maps presented by Binford and O'Connell (1984:Figure 5) and Jones and White (1988:Figure 3)

Quarry Assemblages and Deposits

The schematic model, based on experimental and ethnographic data, suggests that different processing activities are more likely to occur in certain places than others, and should produce variation in the spatial distribution of artifacts and types of deposits within and adjacent quarry pits. Types of deposits also should reflect the method used to extract toolstone and the type of deposit excavated. In the ethnographic examples above, the target resource is toolstone clasts in a soil matrix. The Knife River Flint quarries (clasts in outwash buried by loess) and the Potomac quarries (gravel bar clasts in alluvium) are soil matrix quarries (Ahler 1986; Holmes 1897, 1919). All of the Tosawihi quarries studied to date are bedrock quarries, more similar to the Flint Ridge, Ohio or Spanish Diggings, Wyoming quarries described by Holmes (1919); insight into deposits produced from quarrying bedrock was obtained only from experimental quarrying at Tosawihi.

Assay, Extraction, and Processing Assemblages

Ethnographic accounts suggest that assay generates quantities of primary flakes and assayed stones. Encounter assay and core reduction of isolated stones probably account for

many of the small, enigmatic flake scatters dotting most landscapes in the Great Basin. Many more of these scatters undoubtedly have disappeared, particularly those in streambeds and on geologically active surfaces. Assemblages derived from assay have been observed archaeologically by Wilke and Schroth (1989) in the Mojave Desert, and near Lake Mead, Nevada where they are defined as *Pattern I* assemblages (Kamp and Whittaker 1986:385-386). *Pattern II* assemblages result from largely unsuccessful reduction beyond assaying, and contain cores and the primary and secondary flakes removed from them. *Pattern III* assemblages result from successful core reduction, containing debitage from which desirable pieces have been removed selectively. *Pattern IV* assemblages are similar to Pattern III save that cores have been removed while flakes remain. Pattern III and IV assemblages are likely to be abundant at quarries, although all four patterns should be present. For convenience we refer to these assemblage types subsequently in this chapter, but the scheme is not used elsewhere.

Cobble Quarries

Where marginal quality toolstone occurs in abundant surface clasts or outcrops, assay alone, even on an encounter basis, might generate relatively dense scatters of debitage over generations. Such places should exhibit distinctive debitage profiles, with high proportions of primary and secondary decortication flakes; mass analysis should characterize the debitage as core reduction. Assayed cobbles and cores should be present, hammerstones, cores, and bifaces rare, and quarry pits absent. The scatter of surface artifacts should lack structure, but may be aggregated around bedrock outcrops or on stable surfaces (cf. Kamp and Whittaker 1986:384). This model parallels the lithic raw material prospect model of Wilke and Schroth (1989).

Although several such "cobble quarries" were recorded during surveys of Tosawihi and vicinity (Budy 1988, Elston, Raven, and Budy 1987, Raven 1988), only one was sampled during testing (Intermountain Research 1988b), a "nonfeature" portion of 26Ek3197 (cf. Table 166). Its debitage was not subjected to technological analysis, but mass analysis classified it as core reduction (distinguished mainly by relatively few, but large and heavy, items in the largest size class) with weights and counts close to the means for all core reduction assemblages. The formed artifact assemblage shares several, but not all features, with the model. Other kinds of activities were performed on the site, so we probably can assume some overprinting; with only one example it is difficult to interpret deviations.

An unexpected feature is the lack of assayed cobbles. Cores also are absent, but, as we have seen elsewhere, biface production at Tosawihi did not involve cores to any great extent; neither cores nor assayed cobbles are abundant in any assemblage. The model predicts the absence of bifaces and hammerstones; however, three bifaces constituted the only formed artifacts from this area of the site. Perhaps, in the absence of a core technology, bifaces are created during assaying, or perhaps the production of bifaces is not spatially bound. Bifaces are common in other parts of the site. No hammerstones were present in the cobble quarry area, but hammerstones occurred elsewhere on the site in discrete features.

Outcrop Quarries

Where surface materials of sufficient quality occur, testing may pass seamlessly into extraction without the excavation of quarry pits. In this situation, assemblages should be similar to those from quarry pit sites, containing the hammerstones, cores, and later stage bifaces that are absent from accumulations of assaying debris described above. This was tested

at Tosawihi through surface scrapes in several sites field classified as "Outcrop Quarries", where surface outcrops were exploited without quarry pitting. The assemblages of these sites, shown in Table 209, are predicted fairly well by the model. Bifaces dominate and hammerstones are plentiful. Cores and core-like modified chunks are rare, as in most places investigated to date at Tosawihi. Sixty-three percent of bifaces are stage 3, thirty four percent, stage 2; only two are heat-treated. The presence of flake tools is enigmatic; perhaps they were employed in maintenance of extraction tools. Debitage assemblages were not subjected to technological analysis, but all were classified by mass analysis as core reduction.

Table 209. Debitage and Tool Assemblages from Outcrop Quarry Sites.

Site	Feature Wt.	Ave. Deb.	Bifaces	Flake Tools	Percuss. Tools	Modif. Chunks	Cores
26Ek3032, L98	1	9.5	9	1	1	-	-
26Ek3193	1	5.6	3	-	-	-	-
26Ek3195	1	5.9	2	1	-	-	-
26Ek3196	1	0.7	8	1	4	1	1
26Ek3198	14	8.7	8	-	2	-	-
26Ek3201	4	1.2	13	1	1	-	-
26Ek3203	-	1.4	6	-	-	2	-

Pit Quarries

Irrespective of the nature of toolstone deposit, surface prospecting and assaying should produce a background of overlapping, relatively diffuse, Pattern I assemblages (Kamp and Whittaker 1986) over the entire quarry site. Pattern I assemblages also may occur within the quarry pit if raw material is assayed as it is encountered, or on the berm if raw material is stockpiled there to be tested, as at Ngilpitji. Breaking down large clasts to remove them from the pit results in debris comprised of large primary and secondary flakes and chunks superficially resembling Pattern II assemblages. Use of fire adds thermal spalls, chunks, charcoal, and smoke-stained rock. Similar assemblages are produced by quarrying bedrock, but particles tend to be larger and more abundant. Extraction assemblages are likely to contain hammerstone spalls and broken hammerstones, particularly in bedrock quarries; in rare cases, perishable quarrying tools of bone or antler may be present. Whether any of this material remains in the pit or is removed to the berm or beyond depends on where in the quarrying cycle it is created, and whether the pit migrates in search of new material. Quarrying debris created toward the beginning of a quarrying episode is more likely to be removed than material created at its conclusion. Material excavated as a pit migrates is likely to end up as backfill in older portions of the pit.

Processing Assemblages

In the ethnographic examples, all toolstone processing (reduction of cores, preparation of blanks, and initial stages of manufacture) were performed on the pit margin and beyond.

Reduction of massive cores in the processing zone can create large quantities of coarse debitage superficially resembling quarry debris, but such processing produces Pattern II (unsuccessful core and all flakes), Pattern III (exhausted core and incomplete flakes), and Pattern IV (core removed, all flakes remaining) assemblages. All these assemblages were produced in the ethnographic examples.

Deposits of Soil Matrix Quarries

All quarrying for buried toolstone begins with the removal of soil and colluvium covering beds of bedrock or enclosing bedrock clasts (Figure 233a-d). Larger clasts are likely to be separated as encountered; if tossed out into the exterior zone, they may be dispersed. If, however, clasts are tossed to the top or outer slope of the berm, they can roll down and accumulate at the foot of the outer slope where they subsequently may be buried (the closer quarry pits are to each other, the more likely it is that material removed from one pit will fill another). If clasts are placed on the pit berm, particularly if stacked along the pit margins (as at Ngilpitji quarry), they form, in part, coarse deposits comprising the berm (Figure 233a). The soil matrix and finer clasts are likely to be scrabbled out with the bare hands or moved with scoops or in baskets, forming lenses of fine material. Since it is removed first, topsoil may be found unconformably atop undisturbed soil under the berm at the pit margin, but also may be found overlying coarser deposits, particularly if the pit has been extended into fresh areas during excavation. Fire setting to break up larger clasts produces thermal spalls, smoke blackened rocks, and charcoal (Figure 233b). Thus, as shown schematically in Figure 233a-d, deposits produced by quarrying clasts in soil matrix are likely to be restricted to fine grained sediment, coarse accumulations of culled clasts, and fine to coarse debris from toolstone assaying and processing if fire setting has been employed.

Deposits of Bedrock Quarries

All the deposits produced by soil matrix quarrying also are produced in bedrock quarrying when soil overburden must be removed from bedrock (Figure 233c). If, however, clasts in the soil matrix are not the object of quarrying, there may be less tendency to stack them on pit margins, and debitage from assaying and processing is likely to be less abundant in fine grained deposits. If quarrying begins in or at the foot of a bedrock outcrop, the removed overburden may consist of angular colluvium with little or no fine grained soil.

Bedrock quarrying at Tosawihi generated certain types of deposit to which we attached special terms in Chapters 15 and 16. *Chunks* and *shatter* are angular opalite or tuff clasts of various sizes, not considered flakes or cores. *Chips* are fine opalite fragments (2 mm—3 cm) that tend to be thin and sharp but lack flake morphology and probably are products of battering. *Flakes* are the recognizable product of conchoidal fracture with platforms and diagnostic features of dorsal and ventral surfaces.

Hash refers to very fine opalite chips mixed with clay, silt, and pulverized tuff, created by battering tuff and opalite bedrock with hammerstones. Hash is not likely to be present in a soil matrix quarry, but it almost always occurs within deposits filling bedrock quarry pits, rather than in berms, and often is the first deposit in the pit fill, directly overlying bedrock. Although much hash may lie on the quarry floor in primary position (Figure 233c), more undoubtedly is washed there. Bedrock quarrying at Tosawihi is a dusty business; the fine components of hash (pulverized tuff and opalite, silt, clay) coat everything, ready to be washed into the pit bottom by the first rain. Exactly this sequence of events occurred on completion of the first quarrying experiment described above.

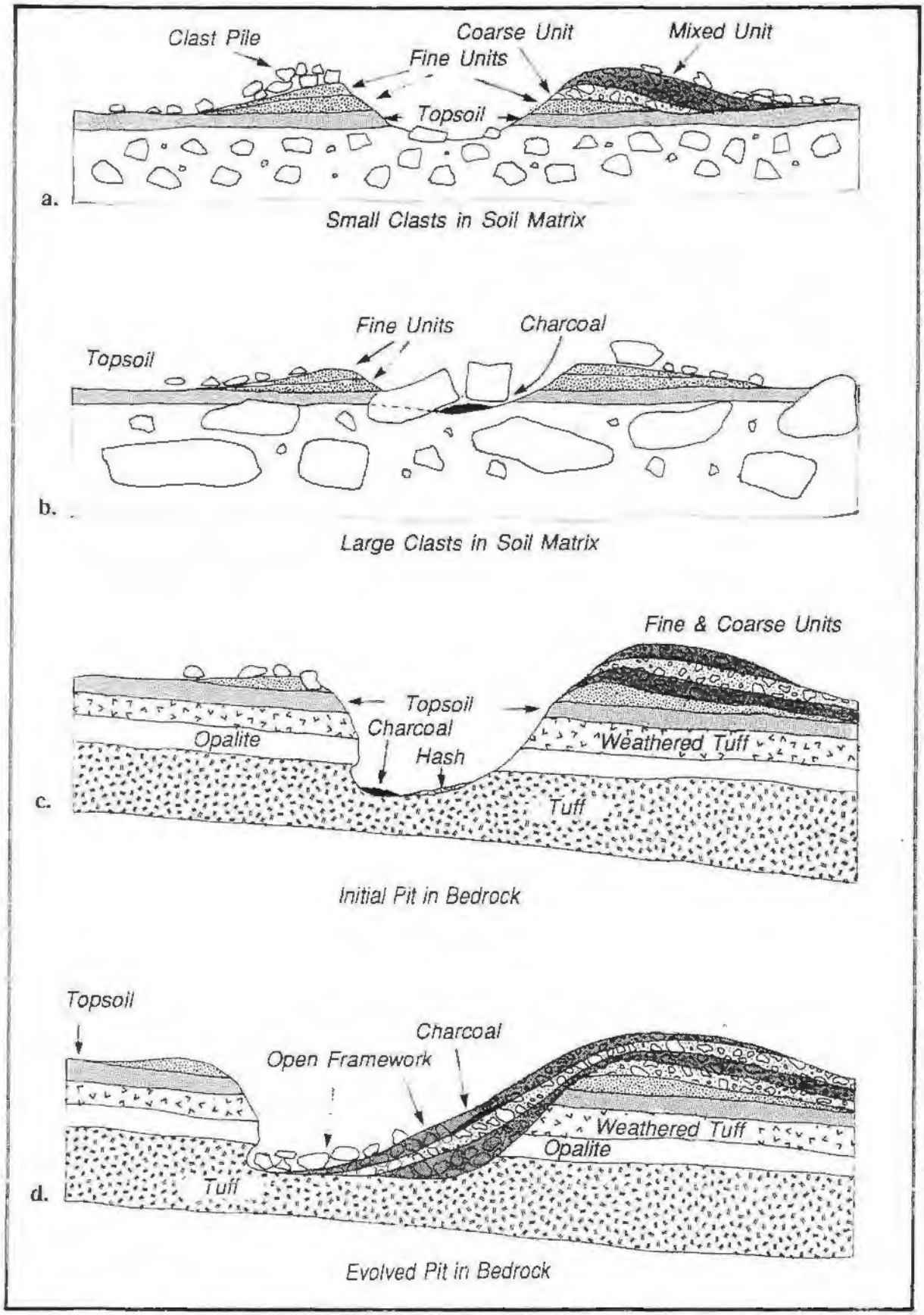


Figure 233. Schematic cross-sections of quarry pits.

Experimental bedrock quarrying produced coarse chunks of opalite and tuff, mixed with large opalite flakes and pieces of shatter; experimental firing produced thermal spalls and smoke blackened stones, as well as deposits of charcoal. Coarse material also was created by initial reduction of extracted toolstone. Battering with hammerstones produced hammerstone spalls and fragments, and these often are components of coarse deposits. Coarse material commonly occurs in prehistoric deposits at Tosawihi; in Chapters 15 and 16, stratigraphic descriptions refer to layers and lenses of coarse to medium *open framework*, or *clast-supported* deposits, in which pieces of rock lie against or upon one another with abundant spaces between them (Figure 233d). When open frameworks are deposited, larger flakes and chunks tend to fall to the bottom and sides of the pit in subhorizontal layers, and coarse units and open frameworks are more common in prehistoric quarries at bedrock outcrops than in pits excavated to horizontal beds of toolstone. Typically, this coarser material is accompanied by a sparse matrix of fine sediment, probably incorporated into the deposit by infiltration. When the matrix is so abundant that larger pieces do not rest on one another, the deposit is described as *matrix-supported*.

Deposits produced during major hiatuses in quarrying derive mostly from colluvial slopewash and eolian deposition. Colluvial slopewash constitutes the downslope movement of sediments, caused by periodic rains and/or gravity, that commonly are dominated by silty matrix, with matrix-supported pebbles, opalite chunks, chips, flakes, and tuff chunks. Later stage reduction debris is present as lenses in some pit fill, particularly in units near the surface. This probably results from periodic episodes of toolstone reduction in areas peripheral to the center of the active quarry pit; a partially filled pit makes a better work space than one newly excavated. It also is probable that, like disturbed open framework strata, some finer pit fill units have been redeposited. Such redeposition is suggested by jumbled units in which most opalite flakes are matrix-supported, with random, non-horizontal orientations. These, however are difficult to distinguish from undisturbed slopewash units.

If open framework deposits are pushed back or scraped away during later quarrying (as previously modeled in the interpretation of inverted radiocarbon dates at 26Ek3208), a randomly piled, jumbled mass of clast-supported materials results. Mixtures of various proportions of tuff and opalite chunks, chips, soil from pit margins, and charcoal are produced easily when berms shift or pits are excavated through older quarry debris (cf. Figure 233d).

Homogenization of Quarry Assemblages

Since size sorting of extraction and processing debris occurs commonly as products of both human and natural agents, it is not unreasonable to assume similar variation in the distribution of artifacts associated with quarry features. Our model of quarry site formation suggests that extraction and processing tasks are likely to be horizontally segmented, which should result in patterned variability in the distribution of artifacts. We believe this to be the case. Further consideration of the model, however, also suggests that processing assemblages from the berm and processing zone around the quarry pit are likely to overlap and become mixed with extraction debris cleaned from the pit. Occasionally, when pits are sufficiently large, processing may take place within the pit itself; this can occur any time during extraction or after abandonment, as the pit fills with natural and cultural debris. Thus, we should see a high degree of homogenization in and adjacent quarry pits, with more discrete features and assemblages at increasing distances.

We examined this proposition with data provided by the technological analysis of debitage from stratigraphic samples taken from trenched quarry deposits (cf. Chapter 5). In each sample, technological analysis flagged the presence of products of one or more of four reduction stages: core reduction, blank preparation, Stage 2 biface reduction, and Stage 3 biface reduction. Some samples contained no diagnostic debitage and were not included in

analysis. The location of each sample was obtained from profile drawings, reflecting pit interiors, inner slopes, berms, outer slopes, and exteriors. Cross-tabulation of reduction stage and quarry pit context produced a matrix of data (Table 210) remarkable for its symmetry on any axis; all four reduction stages have virtually the same proportions in each context. A χ^2 test fails to reject the null hypothesis (no significant difference in the locations of reduction stages in quarry pit samples). While our sample obviously is biased (most samples are from pit interiors), it is difficult to escape the conclusion that assemblages and deposits of quarry pits are highly homogenized. This does not mean that one cannot find individual lenses of unmixed extraction and processing debris, but they are difficult to recognize in the field; further investigation of the problem will require more systematic sampling of contexts.

Table 210. Cross-Tabulations, Quarry Pit Context by Reduction Type.

		Core	Blank	Biface 2	Biface 3
Interior	*Count*	59	28	31	5
	Row %	48	22.5	25.4	4.1
	Col. %	60.6	56.1	59	50
Inner Slope	*Count*	24	12	12	3
	Row %	47.5	23.2	23.2	6.1
	Col. %	24.4	23.5	21.9	30
Berm	*Count*	11	8	7	1
	Row %	40.4	28.8	26.9	3.8
	Col. %	10.9	15.3	13.3	10
Outer Slope	*Count*	3	3	2	0
	Row %	40	33.3	3.8	0
	Col. %	1.4	5.1	3.8	0
Exterior	*Count*	1	0	1	1
	Row %	33.3	0	33.3	33.3
	Col. %	0.5	0	0.5	0.5

Formation and Transformation Processes

Geological and biological processes begin to transform archaeological sites as soon as they are created. Discerning natural and human agents of modification in and around a site is perhaps the most challenging problem in studying site formation processes. Natural agents of deposition include the disintegration of surface outcrops by frost wedging, frost heaving, soil creep, rooting, clay shrinking and swelling, silt infiltration under clasts, and slopewash. For instance, it sometimes is difficult to distinguish whether accumulations of cobble-sized objects in pit fill and on pit margins resulted from of human collection and sorting or from natural agents (such as frost heaving) acting on otherwise undifferentiated quarry waste.

All these processes may cycle opalite fragments to the surface from buried surfaces. Other than the morphology of opalite debris, which may signal its human or natural origin, the redeposition of such material at the surface may be difficult to distinguish from initial deposition by human agents. In addition, we note that prehistoric prospectors must have been aided in their search for toolstone by natural cycling of opalite clasts to the surface from buried bedrock.

The notable agencies of non-cultural site transformation at Tosawihi are slope movement, eolian and alluvial deposition, and bioturbation by burrowing animals. Most slopes

exhibit soil movement through solifluction and slopewash; discrete lithic scatters on slopes typically are fan-shaped, with the apex of the fan upslope. Eolian and alluvial deposition has buried archaeological deposits, now visible on the surface only in tailings of animal burrows. Some open sites have been churned thoroughly by burrowing animals. Coverage of site surfaces by annual tailings where burrowing animals are active appears to range from five to twenty percent per annum, suggesting complete redistribution every decade or so.

Since the distinction between human and natural processes and their consequences is important to our analysis, we define them in the following section and discuss means by which they may be distinguished. It is useful to think of formation processes in terms of four types of effects: deposition, dispersion, aggregation, and degradation; each can be produced by both human and natural agents.

The distinctive nature, stratigraphic position, and morphology of most material resulting from the human utilization of a quarry or lithic processing site allow ready identification of its artificial nature. Identification of some quarry materials, however, is problematic due to overprinting of natural surface processes and the intrusion of naturally derived sediments. Difficult interpretive situations also can arise in the identification of bedrock surfaces modified by natural weathering as opposed to quarrying. The recognition of natural or human processes acting to move artifacts or natural materials around sites, especially on surfaces outside quarry pits, also can be difficult.

Recognizing Quarried Bedrock Surfaces

Several lines of evidence help identify quarried bedrock surfaces. First, natural weathering tends to follow natural plains of weakness along more easily weathered tuff contacts or stringers of tuff internal to masses of opalite; weathered depressions that form in opalite or tuff are irregular in shape and depth. Quarried surfaces, on the other hand, exhibit distinctive morphology resulting from the removal of opalite. Typically, quarried surfaces exhibit oval or round pit shapes, usually with relatively smooth bottoms, particularly when exhausted (cf. Feature 7, 26Ek3171; Feature 3, 26Ek3208). These excavations often crosscut the structure and banding of opalite and tuff bedrock. Tosawihi quarriers utilized naturally weak zones in the bedding, and pits eventually cross-cut the natural bedrock structure. In comparison to undisturbed bedrock, quarried surfaces commonly are more massive, often showing signs of battering (myriad intersecting ring cracks and shatter marks) and conchoidal fracture, reflecting direct percussion rather than natural fracturing.

Additionally, one of the best indicators of absence of quarrying is found in the soil overlying the bedrock surface. As noted elsewhere, red clay paleosol develops on bedrock within a meter or two of the surface (virtually everywhere at Tosawihi). The presence of intact and well developed soil structure in the red clay covering bedrock surfaces indicates that no quarrying has occurred. An abrupt clear contact between the clays and overlying gray silts also indicates lack of disturbance. Subsurface weathering of opalite or tuff bedrock in association with the clay soil also results in a reddish iron oxidization or kaolinization of the tuff, and in the gradual infiltration of expandable clays into cracks, facilitating further fracturing. These signs of weathering are not present on quarried surfaces.

In certain contexts, however, caution is advised in using soil as a reflection of human activity, where slope wash and soil creep have created disturbance, or where the shrink and swell activity of clays in the red paleosol may have re-established soil structure and weathering after disturbance. These cases are more common on steeper slopes or in the earliest quarry deposits. In either case, other evidence (such as site morphology and the appearance of abundant quarried opalite debris) considered in relation to soil conditions make the identification of quarried bedrock more reliable.

Processes of Degradation

Degradation is the deterioration of materials and objects through biochemical or mechanical processes, including mechanical and chemical weathering (patination, hydration, thermal stress, etc.) and organic decay. While the vast majority of artifacts at Tosawihi are of relatively immutable stone, the forces of organic decay effectively have removed most artifacts of hide, textile, fiber, wood, and bone. Bone and antler quarrying and processing tools are preserved only in coarse open work quarry pit deposits that do not retain water to foster a decay-inducing moist environment.

Organized conchoidal fracture isolates culturally produced opalite debris. Alternatively, naturally derived opalite debris often has undergone processes of both surface and subsurface weathering that leave identifiable evidence. Opalite can be degraded and fractured naturally by hydration, frost wedging, thermal expansion and contraction, salt weathering, plant rooting, chemical weathering by lichens, and impaction from rockfall or stream cobble transport. These processes are slow, and their products clearly discernible as multiple surficial and internal fracturing (making the material unsuitable for toolstone production) by a yellowish oxidized weathering patina typical of degraded surface materials in the Tosawihi area, and by a tendency to be more rounded than quarried materials.

Degradation by natural impact generally can be discounted because most quarry localities are not near areas where these processes occur; this may prove more problematic in quarries perched on the margins of Velvet Canyon, each with its own talus of quarry debris. In minor rockfalls associated with quarry features, however (such as at 26Ek3208, Features 2 and 3), large-scale mass wasting was limited and is unlikely to have produced impacted natural debris mistakable for cultural products. In the case of fractures produced during stream transport, broken clasts fresh enough to retain angularity should be accompanied by many more rounded pieces typical of stream beds. Thus far we have far observed no extensive natural opalite cobble or fragment accumulations mistakable for quarry deposits or human refuse.

Processes of Deposition

Deposition frequently is created by human discard or loss; natural agents include wind (eolian accumulation of loess and sand), gravity (colluvial deposition), and water (alluvial deposition). Natural deposition at Tosawihi occurs as loessial silts, colluvium, or alluvium. Loessial silt typically is grayish brown and well sorted, although it occasionally contains common to abundant pebbles and gravel (reflecting the addition of fine colluvium by slopewash and bioturbation). These silts mantle nearly all surfaces at Tosawihi save steeper slopes and bare bedrock outcrops. In areas with soil cover, silts typically contact the underlying red clay paleosol abruptly. Only minor evidence suggests pedogenic horizonation in the silts, although it may be that extensive rooting by sagebrush, grasses, other vegetation, and animal bioturbation has contributed to soil homogeneity.

Generally, the silt mantle is thickest on the northwestern and western sides of hill slopes, leeward of prevailing winds, and thinner on the southeast sides. This is similar to conditions observed by Chadwick and Davis (1990) for loessial silt accumulations on shoreline terraces of the Lahontan Basin west of Tosawihi. It is possible that Tosawihi silts derive from a similar source, probably the eolian deflation of lowland basin floors (particularly the Humboldt River Basin and Carson Sink; cf. Eckert et al. 1989). Some silt may be of local derivation from the weathering of volcanic tuffs.

In addition to the windward control of eolian deposition, the silt mantle at Tosawihi often is thicker on ridge crests, perhaps owing to reduced slopewash. Silt accumulation is

thicker at the toes of slopes in stream drainages as well, where it apparently has accumulated by slopewash from above and because of the higher density of dust-trapping vegetation; conversely, vegetation generally is thickest in areas of thick silts. We suspect this causality to be reciprocal.

Within quarry pits, loessial silts are difficult to distinguish from those introduced by slopewash because they infiltrate readily into void spaces and mix with quarry debris. We found a few examples of depositional units in quarry pits (e.g., 26Ek3195, Feature 2, Unit 18, and 26Ek3208, Trench 2, Unit 44) where well sorted silts with little or no sand or fine gravel indicate eolian deposition. Such deposits may have been enhanced by establishment of vegetation such as grasses which trapped fine silts blown into the pit. The abundant silts in the area also may have effected aggregative processes in the area (see discussion below).

Colluvium is derived from bedrock scarp erosion, from surface weathering, and from soil processes acting on buried bedrock especially from active clays in the paleosol—bioturbation and the erosion by slopewash of unconsolidated Pleistocene terrace sediments. Debris from quarrying activities join the colluvium. Mixing of colluvium with fine soil materials occurs by bioturbation, clay shrinking and swelling, silt infiltration, frost heaving, solifluction, and gravity creep.

The most prevalent means of colluvial addition probably is by slopewash during rainfall and perhaps by gravity; the poorly sorted nature of some quarry filling units (cf. Trench 3, 26Ek3208) with common rounded pebbles and silt suggest their derivation by wash from adjacent pit walls. It is difficult, however, to discern the relative natural vs. human agency in several of these depositional unit types because fine quarrying debris can be mixed so readily with naturally derived materials.

Alluvium occurs as both remnants, now perched high in the landscape, of ancient (Pliocene and Pleistocene) stream activity, and in the beds and low terraces of currently active streams. While the most recent stream deposits bear little on prehistoric quarry activity, except for providing hammerstones, their relationship to non-quarry sites can be important; 26Ek3092 is an example.

Processes of Dispersion

Dispersion is the movement of material from its place of deposition, either as individual particles or artifacts, or as masses or groups of these. Common human agents of dispersion are excavation, cleaning, scavenging and transport; common natural agents include bioturbation, slope movement (frost heaving, solifluction, slope wash), and the erosional activity of water and wind. Trampling by both humans and animals may contribute to dispersion under certain circumstances of slope and substrate.

While subsurface bioturbation in quarry debris can include both faunal or floral agents, the dispersive activity of plants at Tosawihi is much more pronounced than that of animals. The roots typically found in quarry debris are very fine, although occasional coarse sagebrush tap roots are present. Rooting depth ranges from a thin near-surface veneer to a meter or more, sometimes reaching bedrock. Mechanical dispersion and destruction of stratigraphic relationships by rooting leads to homogenization of deposits. Rooting mixes materials of different sizes and thus obscures some of the size sorting created by human agents. It also blurs or distorts the boundaries between stratigraphic units. Dispersive activity was most pronounced in debris units with abundant silty fine matrix, such as in Trench 1 at Locality 36, 26Ek3032 (IMR, in progress), as opposed to deposits dominated by coarser opalite debris, such as Features 2 and 3 at 26Ek3208.

Another aspect of plant rooting, perhaps more a depositional agent than a dispersive one, is its role in the accumulation of infiltrating fines in quarry debris. Although fine grained sediments, washed or blown onto coarse pit deposits with abundant void space, tend to infiltrate downward, evidence of a trapping mechanism responsible for inhibiting infiltration often can be seen in matrix-rich, fine grained depositional units overlying coarse open framework units of angular opalite cobbles and flakes. This may owe to growth of a root mat accompanied by gradual deposition of fine sediments. Roots trap and stabilize sediments, while the fine grained matrix enhances the water holding capacity of debris, promoting the further growth of vegetation and rooting. Of course, roots may grow into the fines after their establishment as a capping unit by some other mechanism. It may be that fine units overlying coarser ones arise by the gradual mechanical accumulation of fines which eventually form 'bridges' across voids and between clasts, similar to the accumulation of clays or carbonates in some soils; examples, however, usually occur in much finer grained material in natural soil settings. Such root structures were observed, for example, at 26Ek3195 (Unit 18 of Trench 1, Feature 2).

As noted previously, animal disturbance is less prevalent. Angular quarry debris is unsuitable for digging or construction of dens, and there is little evidence of burrowing by small animals. Some ant activity was noted in association with quarry debris but typically was limited and shallow in extent. Animal trampling does not appear significant (except, possibly, by cattle). Animal burrowing *is* extensive in non-quarry areas (cf. profiles of 26Ek3092).

Slope movement as a dispersive agent comes about variously; mechanisms include frost heaving, solifluction and soil creep, slopewash, and rain drop impact. Frost heaving occurs when frost under clasts or artifacts, where moisture tends to accumulate, forces them and other soil material upward perpendicular to the slope. When frost thaws, objects drop. Objects thus are moved progressively downslope, dispersed from their initial resting place. Solifluction is similar, occuring where soils creep in the presence of water.

Slopewash may be an especially strong dispersing agent where moderate slope and poor infiltration combine to enhance the movement of sheets of water across the surface. Depending on the amount and velocity of water, even gravel size objects may be moved. It is also possible that, given massive deluge, debris flows can be created by the mixing of fine and coarse grained sediments into dense fluid slurries. Evidence for such flows, however, are very limited at Tosawihi, perhaps restricted to certain units in Trench 3 at 26Ek3208.

A final mechanism that may be of importance is raindrop impact which can move objects not only mechanically, but also by washing sediments away from objects, creating pedestals; the resulting pedestals eventually collapse downslope, moving objects with them.

Processes of Aggregation

Aggregation is the collection or concentration of objects and materials. Humans frequently aggregate materials during collection and in storage. Extracted clasts were aggregated at Ngilpitji Quarry by stacking them around pit margins; pit berms are created by the aggregating process of least effort disposal of quarry debris. Most non-quarry lithic features at Tosawihi are aggregations of artifacts created by performing repetitive processing tasks in the same place. The Tosawihi biface caches are aggregations of stored goods. Natural agents of aggregation include gravity accumulation, foundering, and lag concentration.

Aggregation of artifacts or quarry debris can result in either selectively size sorted or poorly sorted deposits. Accumulation by gravity fall and mass movement may account for much of the size sorting that occurs in pit fill not otherwise attributable to the selective

production of debris of a certain size. Gravity acts easily on piles of unconsolidated quarry and processing debris, particularly on masses of thin, slippery flakes. It is difficult in many cases, however, to discern the mechanisms of sorting; large opalite cobbles, for example, may be tossed selectively to a certain area at the bottom of the trench during quarrying, while gravity may sort coarse opalite debris naturally. Larger clasts are less likely to be trapped in cavities and tend to travel farther down the slope because their volume, mass, and momentum increase as the cube of their diameter, while surface area, and therefore friction, increase only as the square (Young 1972).

Slumping of over-steepened pit walls appears to have been a natural mechanism depositing poorly sorted debris. This is recognized most easily where re-excavation and truncation of older units has taken place and a small talus of debris can be seen clearly to have slumped into the pit.

Additionally, lag concentration can take place in or outside the pit. Within the pit, it involves the infiltration of fine materials through courser debris leaving behind the coarser materials. Although this undoubtedly takes place, it may be difficult to distinguish from gravity sorting or primary production of coarse debris as described above. Beyond the pit berm, lag accumulation of artifacts and other debris can occur either by the removal or addition of accompanying fine sediments. In the case of removal, coarser artifacts and debris are left behind while slopewash removes finer materials mechanically transportable as functions of rainfall abundance, intensity, and slope.

The *addition* of fines can create a lag of objects wherein coarser objects, previously buried, are raised to the surface and concentrated, or founder, sinking slowly, finally to form a layer of clasts that appears to be in primary position. When a soil dries after rainfall, for instance, the particles surrounding a coarse object shrink and pull away from it. When this occurs, finer grained materials such as eolian silts and silty material fall into the voids, especially beneath the object. The net result is progressively more soil deposition under the object and its progressive rise to the surface (McFadden et al. 1987). This also can occur with the slight lifting of clasts by frost heaving and the subsequent infiltration of fines. With sufficient time, coarse objects may cover the surface, giving the appearance of a lag of materials similar to desert pavement. Although a true desert pavement with an armoring gravel cover is not present in the Tosawihi area, this process appears to have taken place, as attested by the amount of eolian silts.

Bedrock Morphology and Quarrying Strategies

Although quarry pits themselves are strong modifiers of site condition, altering subsequent site formation processes, it is useful to examine the preexisting conditions promoting or inhibited initial selection and subsequent formation of quarry features. Assessing the original nature of the outcrop is essential for understanding later site formation processes, both natural and human.

Bedrock geology around Tosawihi is described in Chapters 2 and 5. Modification of surface morphology has occurred by isolated faulting, stream channel incision and terracing, and slope retreat. Bedding typically has a dip of 15° to 30°o to the southeast. The hydrothermal emplacement of opalite was controlled to a large degree by pre-existing bedding in airfall and ashflow tuffs. The relative quantity of opalite or tuff ranges from minor tuff lenses interspersed with massive opalite, to massive tuff with isolated opalite bands, to evenly bedded occurrences of both rock types. It appears that a combination of both was most ideal for extraction of opalite; tuff lenses or bands allowed adits to be created along the softer tuffs, thus allowing isolation of opalite overhangs where larger blocks of potential toolstone could be exploited. Where opalite was too massive, it may have been difficult to extract large blocks without

damaging their internal homogeneity, since battering often introduces fractures and stress. Outcrops *too* tuff rich, on the other hand, may have been uneconomical to quarry.

Assessment of bedrock morphology and its degree of exposure time prior to utilization sometimes is equivocal, owing to modification of the outcrop by quarrying as well as to movement of soil and colluvium, which may have covered or uncovered opalite surfaces. With these constraints in mind, the configuration of opalite bedrock exploited by prehistoric quarriers at Tosawihi falls into three morphological types (cf. Chapter 5): above surface ledges or outcrops, subsurface bedrock with bedding intersected by the surface slope, and subsurface bedrock with bedding parallel to the surface. The development of quarries in each situation presents different sets of problems and advantages that we characterize in terms of three quarry types (Figure 234) described below. Quarry features investigated during the present study are classified in Table 211.

Table 211. Quarry Types at Tosawihi Quarries.

Site No.	Type 1	Type 2	Type 3	SOIL/COLLUVIUM*
26Ek3084-F1-T2		+		
26Ek3085-T1	+	+	+	+
26Ek3032-L19	+			
26Ek3032-L23-T1		+	+	
26Ek3032-L26-T1		+?	+	
26Ek3170-F1-T2			+	+
26Ek3171-F2-T2		+	+	+
26Ek3171-F7-T3		+	+	+
26Ek3184-F20-T1		+	+	
26Ek3195-F2-T1,2	+	+?		+
26Ek3195-F4-T1		+?	+	
26Ek3198-F4		+		
26Ek3198-F14		+		
26Ek3200	+			
26Ek3208-F2,3	+			

*indicates presence of substantial soil and alluvium cover

Type 1 Quarries

Type 1 Quarries exploit a surface ledge or outcrop, typically on moderate to steep slopes of fault scarps (26Ek3208, Features 2 and 3) or in stream cuts (26Ek3195, Feature 2) where bedding intersects the eroded slope (Figure 234a-c). Other sites of this type include 26Ek3085, 26Ek3032 (Localities 19 and 26), 26Ek3195 (Feature 2), and 26Ek3200 (Table 211). The steep slope and enhanced slopewash and mass wasting in these areas assured easy access to the outcrop by keeping it generally free from soils and colluvial cover. This provided opportunities for easy initial assessment of the quality and potential quantity of the opalite source, while imposing constraints on the freshness of the source due to surface weathering.

Surface ledge sites typically are accompanied by talus cones of both natural and quarry debris. The internal morphology of the talus consists of bedded depositional units which, when nearest the bedrock face, slope into the outcrop. Farther from the outcrop face, deposits tend to slope more naturally, parallel to the hillslope; ideal examples are deposits at 26Ek3208 (Features 2 and 3), and 26Ek3195 (Feature 2).

On steeper Type 1 sites, less soil matrixes incorporated into the quarry debris, generally because the steeper slopes have a higher ratio of angular colluvium to soil and because working

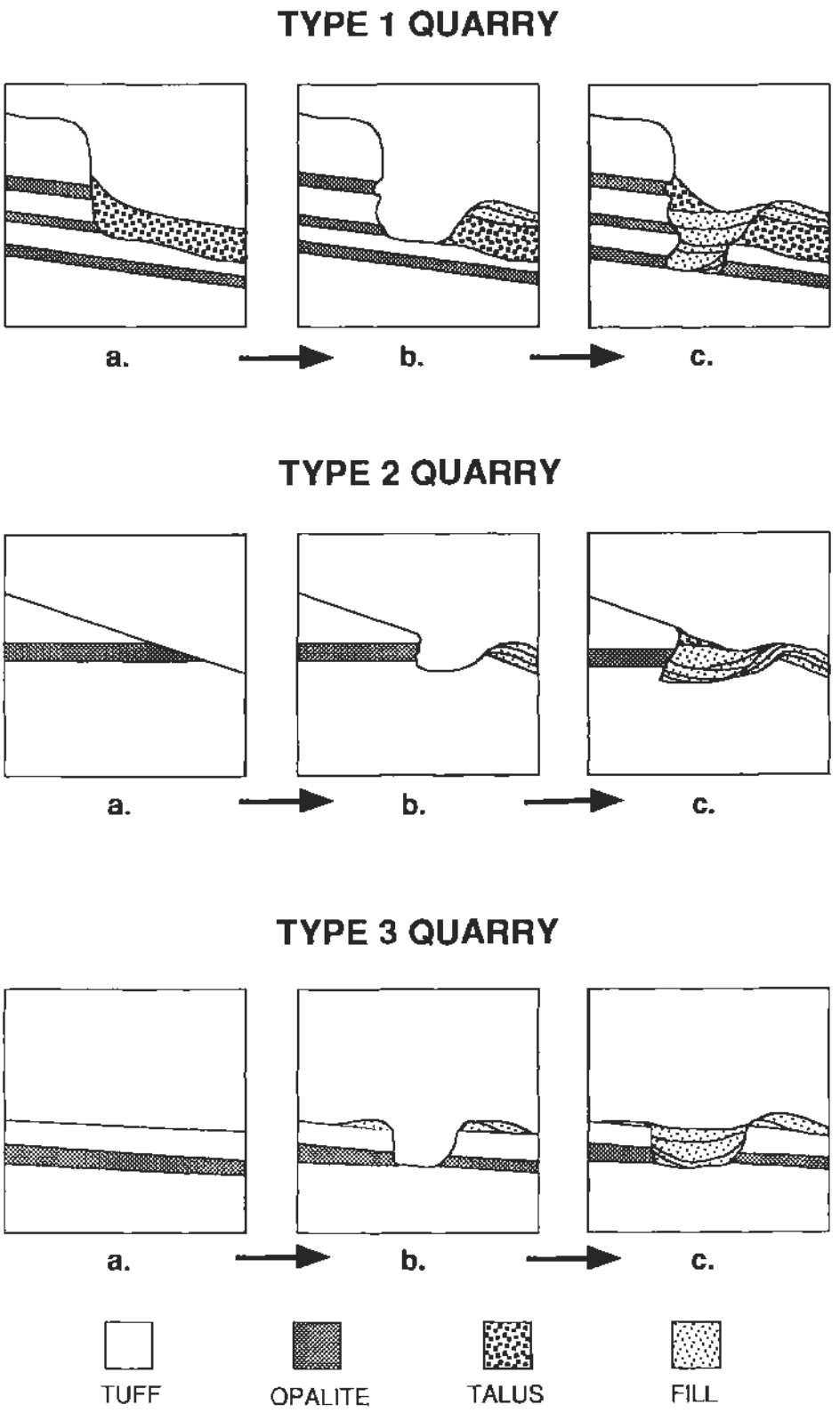


Figure 234. Tosawihi quarry types.

of the opalite face involved less disturbance of the surrounding soil. Also, the thinness of soils on steeper slopes results in less vegetation, and therefore less opportunity for bioturbation and soil mixing. Alternatively, steeper slopes may enhance slopewash and soil creep, thus actively introducing upslope sediments into pit features.

The final quarrying phases at Type 1 sites might have been caused by the exhaustion of opalite deposits; alternatively, outcrops may have been quarried far enough into the hillside that the effort of removing debris from the working face became too great. These probably are the two main causes of abandonment in nearly all quarrying situations.

Type 2 Quarries

The second type of opalite source consists of subsurface toolstone strata whose bedding is intersected by the slope in which they occur (Figure 234c-d). Although several such outcrops are known, the circumstance is commonest on gently-sloped crests of ridges where the predominant dip of geologic beds allows greatest intersection of bedding and surface. Sites of this type include 26Ek3084 (Feature 1), 26Ek3085, 26Ek3032 (Locality 23), and 26Ek3198 (Feature 14). Other bedding intersections may occur along stream banks as well, as in the case of bedrock near Feature 2 of 26Ek3195.

Type 2 sites are related to Type 1 sites, in that the latter, also, are typically formed by the intersection of opalite beds with slope surfaces. They usually differ, however, in the angle of slope and, as a consequence, in the amount of soil (owing to reduced surface erosion on gentler slopes). In such cases, more soil often fills quarry pits than at Type 1 sites. This promotes greater bioturbation both by plants and animals. That toolstone beds are less exposed at the surface and dip into the slope may increase the difficulty of toolstone extraction, resulting in the earlier abandonment of Type 2 quarries.

Type 3 Quarries

Type 3 sites occur where bedrock is covered by soil and colluvium and the toolstone stratum lies parallel to the surface; the surface slopes gently, either on the dipping side of fault blocks or on remnant erosional alluvial terraces Figure 234g-i). Opalite typically is exposed as a massive floor of bedrock at the bottom of quarry pits. Soil constitutes more of the pit fill than at other site types. Much less slope erosion occurs, natural soil is thicker and more abundant, and natural coarse colluvium is a only minor component. 26Ek3171 is an ideal example of this bedrock type. Other sites include 26Ek3170 (Feature 1), 26Ek3184 (Feature 20), and 26Ek3195 (Feature 4).

This kind of setting is the most problematic in terms of understanding how initial prospecting was done. Although soil activity and bioturbation may bring bedrock pieces to the surface, there may be surface little evidence to indicate exactly where good subsurface deposits occur. Exploratory excavation through the silt soil and clay paleosol beneath would be quite risky (as our experimental quarrier Carambelas discovered), but might be the only way to determine the potential of a location accurately. Once a suitable source is found, the opalite is relatively easy to follow. Such bedrock should not have suffered surface weathering, and therefore might be fresher and less fractured than at other kinds of sources. On the other hand, the relative difficulty of quarrying at Type 3 sites also is influenced by the massiveness of the bedrock. Bedrock with few cracks is hard to penetrate with hammerstone technology. Once a Type 3 quarry pit was started, quarriers may have taken pains not to allow the working face to become too smooth and convex for detachment of blocks and flakes. The

smooth, bowl-like floor of Feature 7 quarry pit in 26Ek3171 is a case in point. This pit was completely emptied in order to estimate the total volume of toolstone removed from it (about 24 m^3), and experimental quarrying attempted subsequently. The smoothness and massiveness of the stone, however, defeated our attempts.

Site Abandonment

Considering that pit features are modifications of several previously existing conditions, they clearly become part of the geomorphic environment and affect the processes taking place within it. Excavation of quarry pits disturbs the soil and removes vegetation, allowing more effective surface runoff and more sediment movement around sites. The pit itself becomes an ideal catchment for some of this material if its berm does not impair influx. Within the pit, especially on its marginal walls, sediment wash, infiltration of sediments into void space both by water flow and by eolian influx, slope failure, and slumping of debris are common. Later, as vegetation is reestablished on the quarry debris, root turbation occurs.

Upon abandonment, it is likely that the processes most dominant prior to quarrying resume, although changed by the new morphology of the site. On steep slopes characteristic of Type 1 sites, for example, colluvial activity is still be an important element of geomorphic processes operating there; at the large quarry on Red Hill (26Ek3208), extremely large pits were filled almost completely with colluvium. Where soil originally was abundant, such as more gently-sloped Type 2 or 3 sites, relatively large amounts of soil will be incorporated into pit fill, acting as a substrate for pedogenic processes so that plant communities and soil development are likely to be re-established.

Chapter 23

ASSEMBLAGE DIVERSITY AND COMPOSITION

Eric E. Ingbar

Why stone tool assemblages differ in composition is a question central to many archaeological studies. The debates between Francois Bordes and Lewis and Sally Binford in the 1960s sharpened awareness of just how crucial this question is to interpretation of the archaeological record. The focus of argument during this exchange was how best to *interpret* differences in assemblage composition. That there actually *were* differences in the composition of the assemblages was never in question.

In this chapter, differences in assemblage content are *not* taken as self-evident. Instead, determining differences is the focus of inquiry. How different are the tool assemblages recovered from different parts of the Tosawihi vicinity? In what ways do they differ? Are there distinctive patterns in the composition of Tosawihi tool assemblages? Our proximate goal is pattern recognition in a variety of measures of diversity and assemblage composition. Because Tosawihi is a major toolstone source, tool assemblages obviously should differ from those found in areas lacking toolstone. How different are the Tosawihi tool assemblages from those found in other parts of the Great Basin? And in what ways do they differ?

Ultimately, the patterns examined here must be interpreted. Some patterns are products of sample size; others are not explicable in this light, and most likely result from how different places in the Tosawihi landscape were used. While this chapter does not attempt to interpret all patterns of assemblage composition (cf. Chapters 24 and 25), distinguishing the effects of sample size on assemblage composition allows some untangling of the complicated relationships among tool assemblages. Our goal is to distinguish patterning that *may* be due to prehistoric use of the landscape. Patterns of assemblage composition are sought as indicators of dimensions of variation in assemblage composition. As subsequent chapters reveal, differences in assemblage content resonate through interpretation of activities undertaken in the Tosawihi landscape (cf. Chapter 24) and interpretation of how they were placed on the landscape (cf. Chapter 25). Thus, pattern recognition and the elimination of spurious patterns resulting from sampling properties set the stage for more concise discussions of prehistoric behavior at Tosawihi.

Pattern recognition is approached in two ways here. Various measures of assemblage diversity are examined first. *Diversity* has no precise numerical meaning, since it consists of three different families of measures: richness, evenness, and heterogeneity (Bobrowsky and Ball 1989). Only the first two measures are examined here. Also, we examine and compare the contents of assemblages aside from overall diversity measures. This approach builds on patterns of assemblage richness and evenness. Assemblage composition analyses in theory are independent of diversity patterns, since assemblages that differ in composition may have the same diversity values. Thus, compositional analyses provide insights into diversity patterns and additional patterns exclusive to this approach.

Tosawihi Tool Assemblages

Recent research has shown that sampling effects have a pervasive influence on interassemblage comparisons using both intuitive and statistical models (Bobrowsky and Ball 1989; Grayson 1981, 1985; Leonard and Jones 1989; Jones et al. 1983, 1989; Thomas 1988). The logic underlying these difficulties is simple: larger samples tend to have more rare

members of a population. Hence, the number of types, classes, species, etc., present in a sample tends to correlate with sample size. Since almost all measures of sample diversity employ in some form the number of classes present, sample size has far-reaching effects on intuitive and explicit measures of diversity.

Classification itself plays a pivotal role in forming the relationship between diversity and assemblage size. For example, in a classificatory scheme with an infinite potential number of classes, *sample richness* (the number of classes or types actually present) can increase without bounds. Yet, for any finite number of classes (as in most archaeological classification schemes) a point is reached where all classes have constituent members, so richness ceases to increase. This *saturation* point, and the resulting richness value, is determined by many factors; to compare richness values across assemblages requires that all assemblages be classified in the same fashion.

For the purposes of this chapter, an assemblage (i.e., a sample) consists of the tools from discrete site areas. When possible, a subarea within a site (designated as a locus) was considered a distinct sample (cf. Chapters 16, 17, 18). The results of artifact analyses (cf. Chapters 6 to 13) were used to classify tools into 47 *types* (Table 212). Debitage was not included. Some types are combinations of specific analytical categories (e.g., scrapers of all forms are considered a single type here). A useful reduction of these data collapses types into six functional *classes* (Table 212), following Thomas (1988).

Table 212. Tool Classes and Tool Types.

Class	Types	n	%	Class Total	Class %
WEAPONS	(Projectile Points)			392	7.1
	Cottonwood	31	0.56		
	Desert Side-notched	54	0.98		
	Rosegate Series	34	0.62		
	Elko Series	29	0.53		
	Gatecliff Series	19	0.35		
	Humboldt Series	13	0.24		
	Large Side-notched	9	0.17		
	Stemmed	18	0.33		
	Clovis	1	0.02		
	Out of key	27	0.49		
	Fragmentary points	157	2.86		
FABRICATING/PROCESSING BYPRODUCTS				2009	36.6
	Cores (all types)	123	2.24		
	Preforms (all stages)	252	4.59		
	Modified Chunks	67	1.22		
	Bifaces, Stages 1 to 3.4	1567	28.50		
QUARRYING EQUIPMENT				6	0.11
	Bone scoops	1	0.02		
	Bone, antler wedges	1	0.02		
	Large quarry hammerstones	4	0.07		
FABRICATING/PROCESSING TOOLS				374	6.80
	Scrapers (Types 1 to 3)	178	3.24		
	Pointed tools (Types 4 to 7)	103	1.83		
	Notch/denticulate	61	1.11		
	Microdenticulate	6	0.11		
	Abrader, shaft abrader (Types 5 and 6)	9	0.16		
	Scratched stone	14	0.25		
	Bone awls	2	0.04		
	Bone flakers	1	0.02		

Table 212, continued.

Class	Types	n	%	Class Total	Class %
GENERAL UTILITY TOOLS				2583	47.00
	Bifacial flake tool (Types 9 to 11)	21	0.38		
	Misc. ret'd. flake (Types 14 to 16)	298	5.42		
	Fragments of tool (Types 21 and 22)	117	2.13		
	Crudely retouched flake	13	0.24		
	Discoidal tool	10	0.18		
	Flake chopper/hammer	12	0.22		
	Other flake tool	5	0.09		
	Choppers, scraper/planes, hammer/choppers (Types 2, 5, 6)	41	0.75		
	Shovel	3	0.05		
	Bifaces, Stages 3.5 to 5	1946	35.40		
	Hammerstone	116	2.11		
	Expedient bone tool	1	0.02		
DOMESTIC EQUIPMENT				132	2.40
	Mano	23	0.42		
	Metate	66	1.20		
	Mortar	6	0.11		
	Pestle	4	0.07		
	Brownware[a]	8	0.15		
	Grayware[a]	3	0.05		
	Indeterminate ware[a]	2	0.04		
	Bead, bead preform, pipe, misc. exotica (Types 7 to 10)	18	0.33		
	Bone beads	2	0.04		
	GRAND TOTAL	**5496**			

[a]Minimum number of vessels (cf. Chapter 13).

Five of these classes were defined by Thomas for analysis of tool assemblages from Monitor Valley (1988); their constituents are used here for comparison between Tosawihi and Monitor Valley. In addition to adding a new class to Thomas's scheme (Quarrying Equipment) and dropping another (Ornamental), there are some differences between our class definitions and those used by Thomas. Our *General Utility* tools probably differ from Thomas's original conception of tools with multiple uses. At Tosawihi, hammerstones probably are related more closely to the fabrication of stone tools than to other uses. Likewise, discoidal tools probably are large quarry hammerstones. Stage 3.5 and later stage bifaces, while generally useful, may be also products of toolstone processing (but not toolstone procurement) rather than general utility tools. Nonetheless, these three tool types *potentially* are of general use, regardless of their probable roles functions. Hence, they are retained in the General Utility tool class.

In addition, for some analyses two simple environmental variables, water and toolstone (cf. Chapter 2), were encoded for each site. Assemblages were given values for their distances from these resources according to distance classes of less than 250m, 250-500m, and more than 500m.

One hundred three assemblages are considered here (Appendix O). Discretionary test units in the Eastern Periphery and sites not systematically collected are excluded from the dataset, referred to below as the *pooled Tosawihi assemblage sample*. Many of the following

analyses of the pooled Tosawihi assemblage sample, or portions of it, required logarithmic transformation of both sample (assemblage) size and the dependent variable under investigation to create an approximately normal distribution with linear properties (Velleman and Hoaglin 1981).

Assemblage Richness and Evenness

Ecologists and statisticians usefully distinguish three information measures to characterize data in discrete categories. *Richness* is the number of classes present in a sample, regardless of how many variates (tools, in this study) occupy each class. The theoretical richness maxima for type and class data are 47 and 6, respectively (we recognized 47 types of things, assignable for 6 classes). Measures of *evenness* examine the equitability of variate distributions across categories. An assemblage of 100 tools in only two classes is less even than an assemblage of 100 tools equally frequent in 10 classes. Pielou's J statistic is used here as a measure of evenness (cf. Kintigh 1989; Brobowsky and Ball 1989), although it, too, is correlated with sample size. Lastly, measures of *heterogeneity*, such as the Shannon-Weaver index (Shannon and Weaver 1949), attempt to summarize the joint characteristics of sample evenness and sample richness. Heterogeneity measures are appealing because they evoke an intuitive definition of diversity as related to both richness and evenness. However, Peet (1974, 1975) has shown that the Shannon-Weaver index and other similar measures are sample size dependent. Furthermore, Brobowsky and Ball (1989:7-8) contend that heterogeneity measures present inherent difficulties, since they combine two different sample properties (richness and evenness). For these reasons, no heterogeneity measures are used in this study.

Both type and class richness are calculated easily by counting the non-null classes. Evenness was studied using Pielou's J statistic (Pielou 1975) and rank-order correlations (Whittaker 1972).

Type and Class Richness

Richness is a simple measure. Its utility has been questioned due to its correlation with sample size, but several profitable ideas on how the richness: size relationship can be useful have been advanced. Kelly (1985) and Thomas (1988) have argued that different patterns of hunter-gatherer land use should generate archaeological assemblages with differing slopes of the richness:size curve (Figure 235). Places where a limited number of tool types or classes were discarded repetitively should exhibit a low richness: size slope coefficient. Assemblage size increases at a relatively rapid rate relative to the variety of tool classes because the same tool classes are discarded redundantly. Activities such as gathering plant foods within the diurnal foraging range may create such assemblages. More diverse tool discard patterns, perhaps associated with longer-term use of places, has a somewhat steeper slope, since the number of tool classes discarded increases more rapidly relative to assemblage size. Still longer-term place use produces an even wider variety of tool-discarding activities, and so yields the steepest richness: size slope coefficient. This idealized scheme of slope values expected under various patterns of place use ignores multiple uses of the same place. Consequently, it is not expected that a group of archaeological assemblages always will fit these patterns. Nor does finding such patterns necessarily indicate that the pattern of place use conformed to the idealization suggested by Thomas. Nonetheless, comparison of regression slopes, when calculated over subdomains of an entire set of assemblages, can provide useful insights into how a landscape as a whole may have been used. For example, Thomas (1988:383, Figure 144) suggests that from lowest to highest, slope coefficients of the richness: size regression equation may equate with diurnal, logistical, and residential use of places.

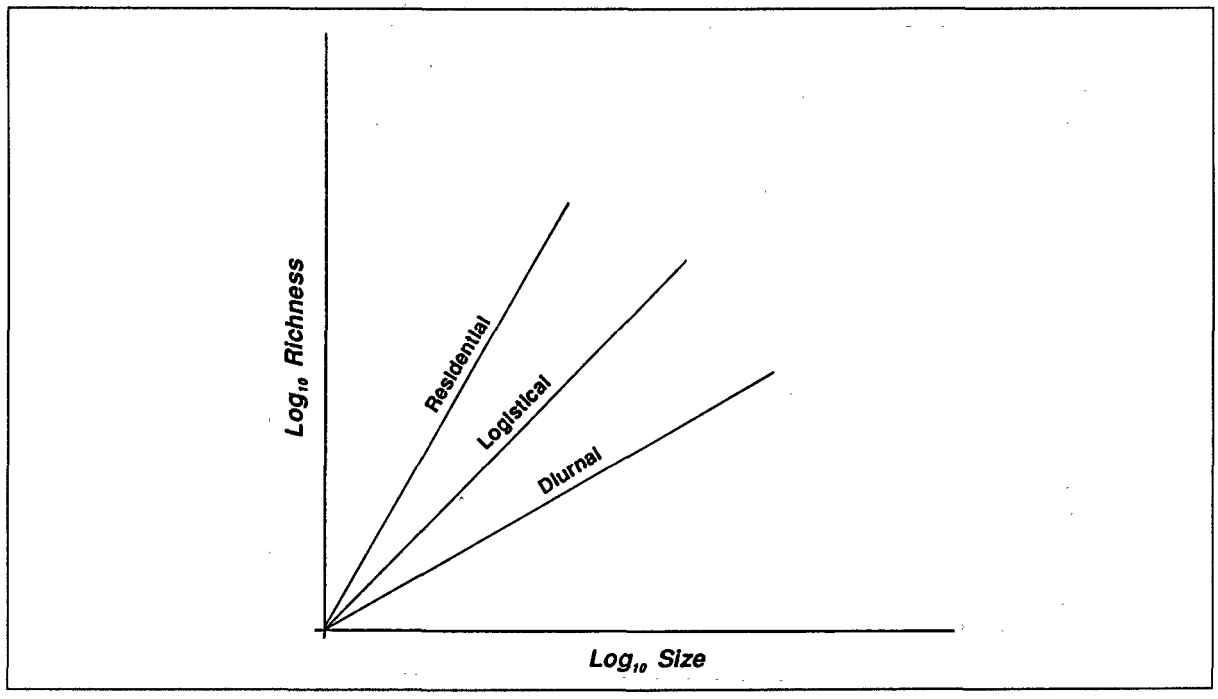


Figure 235. Expectations of richness: size relationship.

Tosawihi offers no obvious environmental strata akin to those used by Thomas (1988) in his Monitor Valley study. However, because water and toolstone are critical resources, the assemblages were stratified by proximity to each in three strata (within 250m, 250m to 500m, greater than 500m). Regression coefficients were calculated for each stratum and significant ($p<.05$) regressions compared. T-tests between regression slope coefficients showed no significant difference between any pairs of significant correlation coefficients.

Examination of variety values for individual cases can be done in two ways. One technique examines outliers to the richness: size relationship. These reside in the confidence limits of the regression equation. A second technique simulates the expected variety values for assemblages of different sizes, given overall class frequencies for a particular group of assemblages (or, better still, some *a priori* expectation of the proportions of classes; cf. Kintigh 1984, 1989); outliers to the richness: size relationship then are highlighted for further examination.

The relationship between artifact type richness and sample size is depicted in Figure 236 for all Tosawihi assemblages containing more than one tool type. The 81 assemblages follow the expected trend of increasing richness of types and increasing sample size (r-squared=0.94, $p<.001$). Although the relationship between assemblage size and class richness is similar (Figure 237), and also is significant (r-squared=0.61, $p<.001$), the point swarm has a greater spread because the number of classes is more variable at a given level of sample size.

Since assemblage richness and size are highly correlated, outliers to this regression must differ somehow from cases within the expected range of richness. For this analysis, only assemblages with at least ten tools were employed, since below this the empirical slope of the richness: size relationship is steeper (cf. Figure 236). A regression line and 99% confidence intervals were calculated, and outlier assemblages determined by inspection (Figure 238; Table 213). Due to the wide variation in assemblage size associated with different values of class richness, this approach was not employed with the class data.

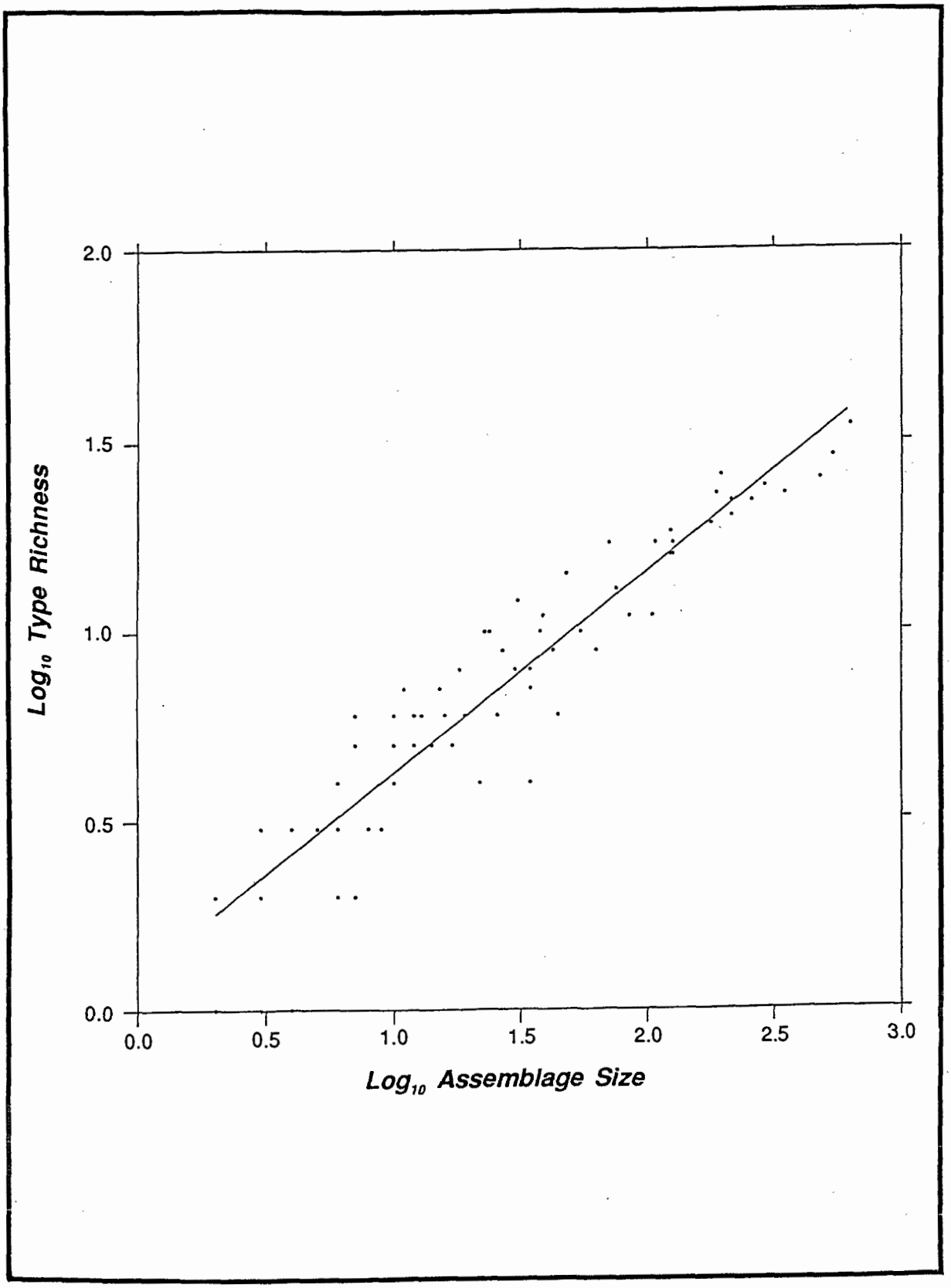


Figure 236. Type richness vs. sample size.

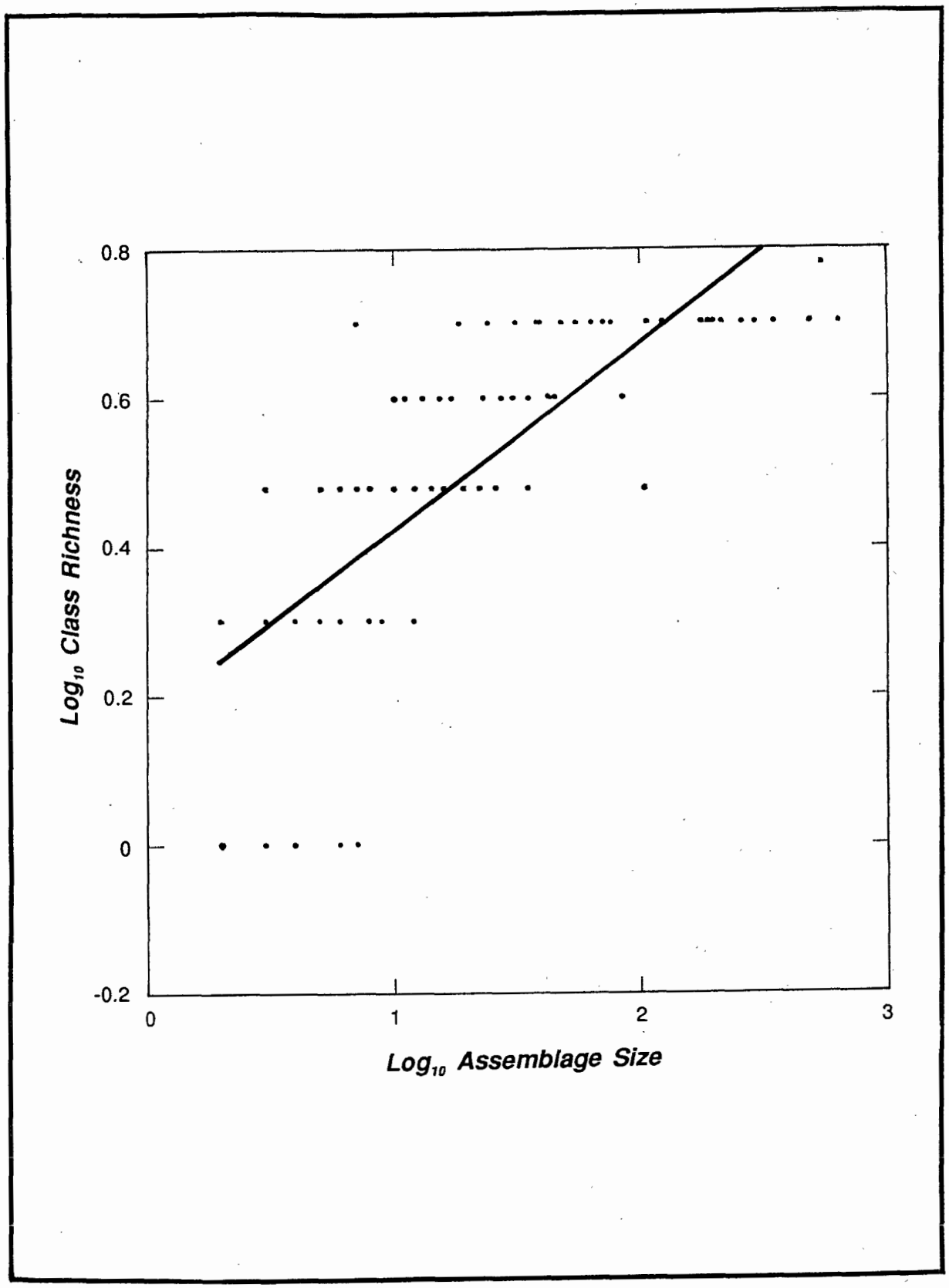


Figure 237. Class richness vs. sample size.

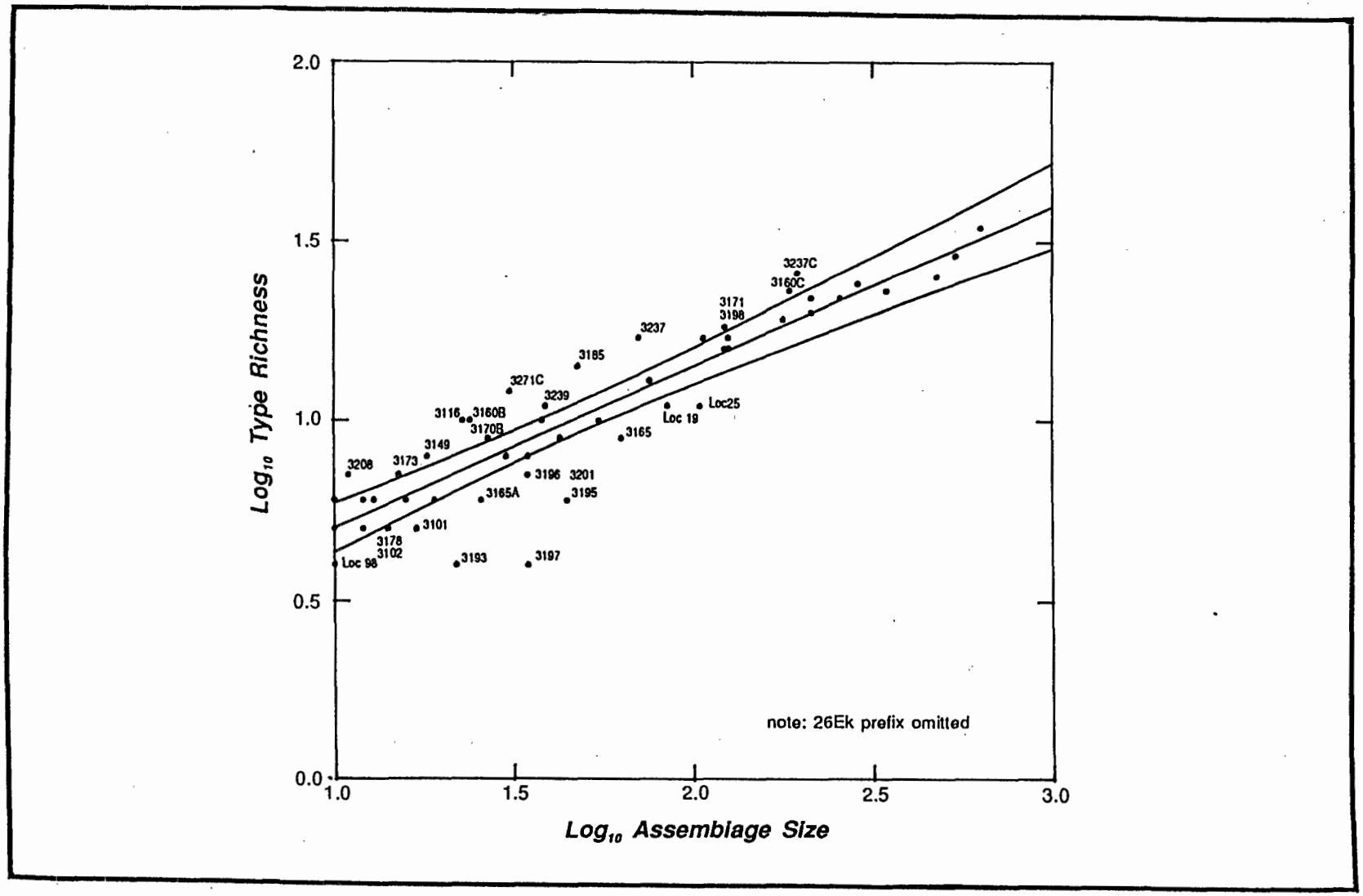


Figure 238. Type richness vs. assemblage size with 99% confidence intervals.

Table 213. Outliers to Type and Class Richness Relationships to Assemblage Size.

Site (locus)	Outlier to 99% confidence limits, regression of type richness on assemblage size	Outlier to 2 standard error boundary of simulated type richness	Outlier to 2 standard error boundary of simulated class richness
3032/19	-1	-1	-1
3032/25	-1	-1	-1
3032/98	-1	0	0
3101	-1	0	0
3102	-1	0	0
3116	1	0	0
3149	1	0	0
3160	1	0	0
3160B	1	0	0
3165	-1	-1	0
3165A	-1	0	0
3170B	1	0	0
3171	1	0	0
3173	1	0	0
3178	-1	0	0
3184	-1	-1	0
3185	1	0	0
3193	-1	-1	0
3195	-1	-1	0
3196	-1	-1	0
3197	-1	-1	-1
3198	1	0	0
3201	-1	-1	0
3208	1	0	0
3237	1	0	0
3237C	1	0	0
3239	1	0	0
3271C	1	0	0

1 = above expected values
-1 = below expected values
0 = within expected values

The detection of outliers can be extended using a technique developed by Kintigh (1984, 1989) in which expected richness values are determined from a Monte Carlo simulation. In this technique, simulated assemblages of specified sizes are generated by random selection of class members. The simulation model is constructed so that the probability of choosing any given class or type is dictated by its proportion in the pooled sample of all assemblages, or some other *a priori* expectation. For the Tosawihi data, the overall proportions of types and classes were employed as the mean probabilities (cf. Table 212). Two datasets were generated, one based on class proportions, the other on type proportions; each consisted of 50 simulated assemblages at eight sample sizes (n = 10, 20, 40, 80, 150, 300, 600, 1000). Means and standard errors for richness were calculated, transformed to logarithms, and the assemblage data for assemblages of 10 tools or more were plotted against two standard error boundaries (an approximate 95% confidence interval) of the simulated data.

The type richness data contain only outliers less rich than expected (Figure 239). Eight of the ten outlier assemblages also are outliers to the regression relationship (only 26Ek3184 and 26Ek3160 are not; cf. Table 213). The class richness data contain three outliers to the simulated boundaries (Figure 240; Table 213), all below the expected richness values and also outlying both regression and simulated boundaries of type richness.

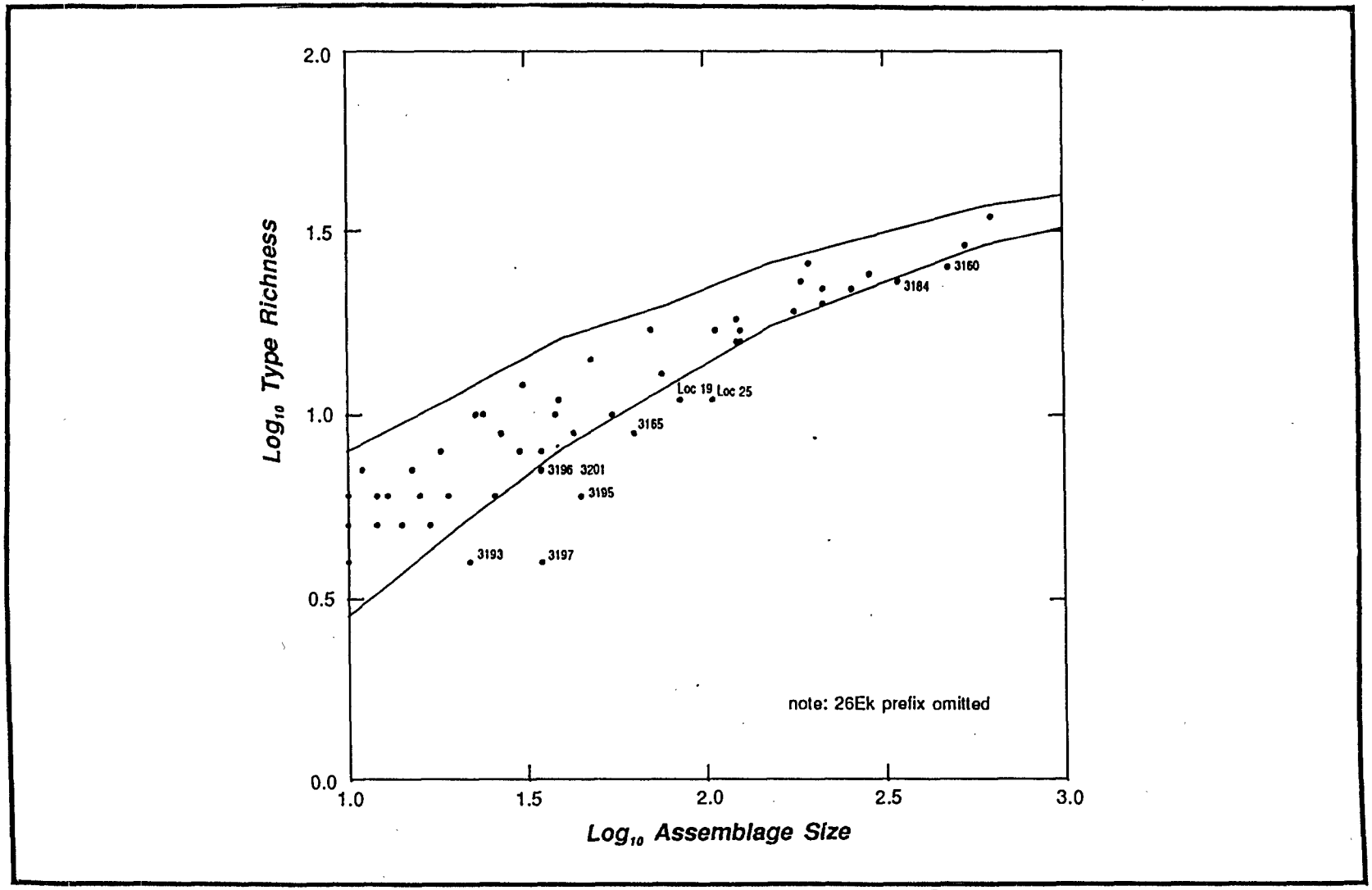


Figure 239. Type richness vs. assemblage size with upper and lower boundaries of 2 standard deviations around mean of simulated data and outlier assemblages.

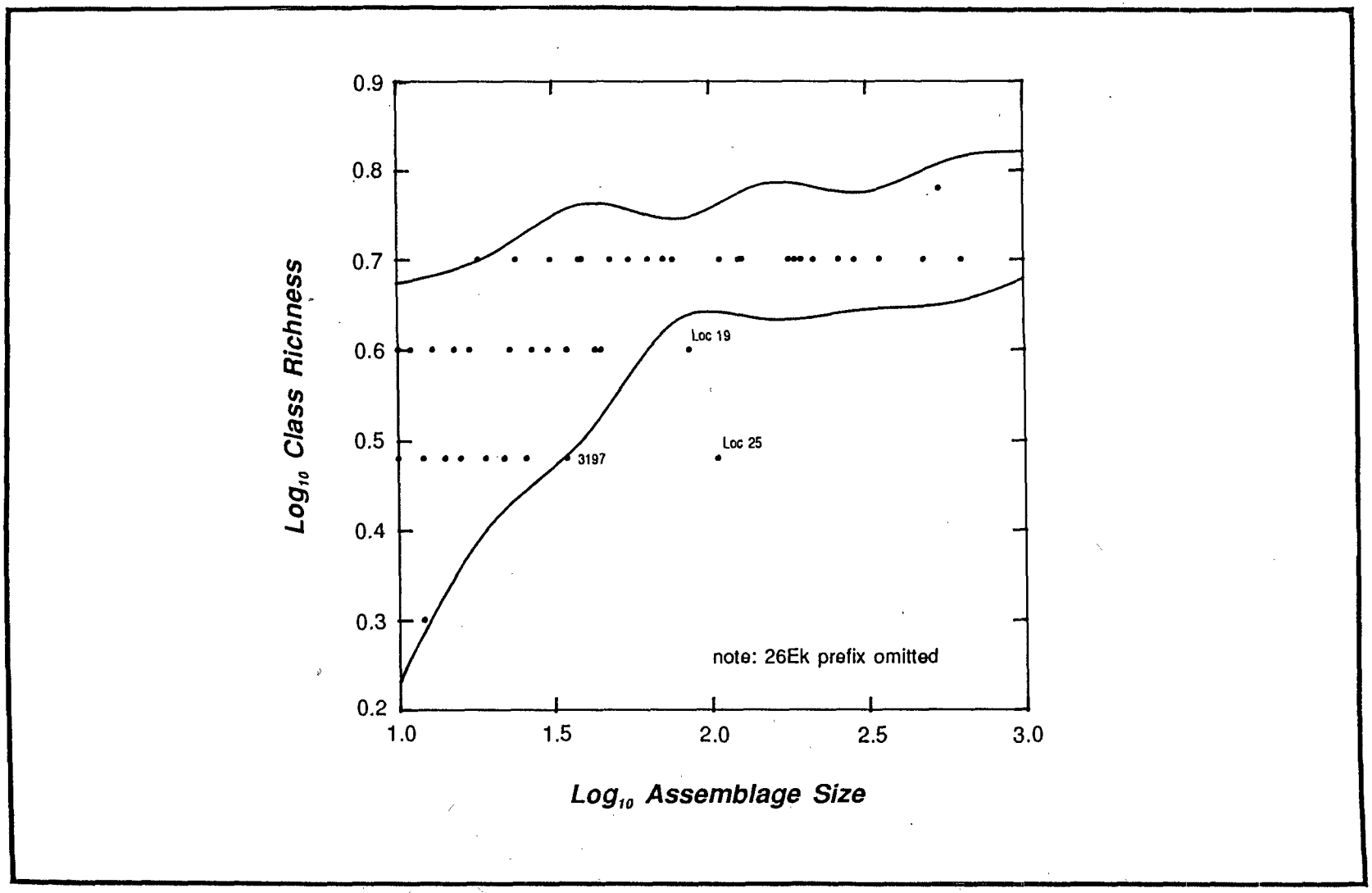


Figure 240. Class richness vs. assemblage size with upper and lower boundaries of 2 standard deviations around mean of simulated data and outlier assemblages.

Overall, type and class richness values are both dependent upon sample size. Type richness is more responsive to sample size than class richness, probably because with a reduced number of classes the variance in assemblage size at a given level of class richness is much greater. Patterns are distinguishable in richness values; ten assemblages lie outside the confidence limits of the richness: size regression, and eight are also outside the two standard error boundaries of simulated richness data for tool type assemblages. Thus, no matter how one constructs the "expected" boundaries of richness for assemblages of tool types, eight assemblages fall outside of it. Outliers to expected values of richness simulated for assemblages of tool classes also were found in this fashion.

Type and Class Evenness

Evenness measures the relative frequency of type or class constituents. Evenness was studied at Tosawihi in two ways: through rank order correlation coefficients and with Pielou's *J* statistic. Calculation of Pielou's *J* statistic is done by calculating the Shannon-Weaver index (a heterogeneity measure) for each sample and dividing it by the logarithm of the maximum number of types or classes (cf. Kintigh 1989). Here, the denominators are log (47) and log (6) for types and classes, respectively. Calculation of rank order correlation coefficients was undertaken using the proportion of classes as one set of values, and calculating Spearman's *r* for each assemblage compared to the proportion of classes in the pooled Tosawihi assemblage sample. Assemblages not significantly correlated with the overall rank ordering differ in evenness from the pooled Tosawihi sample. The reason for poor correlation of any single assemblage lies in its composition, but here we seek aberrant assemblages as indices of evenness (cf. Whittaker 1972).

Pielou's *J* statistic is partly dependent on sample size (Brobowsky and Ball 1989; Kintigh 1989). Consequently, examination of evenness using this statistic follows the same logic as the examination of outliers above: *J* statistics were calculated for simulated assemblages (both type and class) and two standard errors. Tool type evenness (Figure 241) is correlated only weakly with sample size ($r=.21$, $p>0.1$). Over half the assemblages ($n=56$) lie outside the simulated boundaries. Thirty-three assemblages are less even, and one more even, than expected (Table 214). The simulated boundaries for class data (Figure 242) have fewer outliers (9 less even, 4 more even, than expected; cf. Table 214), probably due to the large standard deviation of the simulated *J* values (illustrating why *J* values cannot be compared across different typologies; cf. Kintigh 1989:35-36).

Table 214. Outliers to Type and Class Evenness Relationships to Assemblage Size.

Site (locus)	Outlier to 2 standard error boundary of simulated type richness	Outlier to 2 standard error boundary of simulated class richness
3032/19	-1	0
3032/21	-1	-1
3032/23	-1	0
3032/25	-1	-1
3032/98	-1	0
3092	-1	0
3093	0	-1
3095	-1	0
3101	-1	0
3102	-1	0
3104	-1	0
3106	-1	0
3107	-1	0
3149	0	1
3160	-1	-1
3160A	-1	0
3160C	-1	-1

Table 214, continued.

Site (locus)	Outlier to 2 standard error boundary of simulated type richness	Outlier to 2 standard error boundary of simulated class richness
3165	-1	0
3165A	-1	-1
3171	-1	-1
3178	-1	0
3184	-1	-1
3185	0	1
3192	-1	0
3193	-1	0
3195	-1	0
3196	-1	0
3197	-1	-1
3204	-1	0
3208	1	0
3237	-1	0
3237C	0	1
3238	-1	0
3251	0	1
3271	-1	0
3271A	-1	0
3271B	-1	-1

1 = above expected values
-1 = below expected values
0 = within expected values

Spearman rank order correlation coefficients were calculated for all tool class assemblages, but not tool *type* assemblages, since the many infrequently occurring tool types would have yielded spurious correlations. Outlier assemblages have a Spearman's r not significant at the $p = 0.05$ probability level (i.e, Spearman's $r < 0.829$ and $r > -0.829$, since n is fixed at 6). Assemblages not correlated with the overall tool class proportions are less even *relative* to the pooled assemblage sample: they differ in the proportions of tools in classes and consequently have a different ranking.

Sample size plays an important role in determining the membership of this group (Figure 243). Small assemblages (often single artifacts) are much more common in this group than in the sample as a whole. Because the curve of the point swarm flattens after sample size equals ten, assemblages having more than ten tools probably are true outliers independent of sample size (Table 215). The compositional differences between these assemblages and the pooled Tosawihi tool assemblage sample are discussed below.

Examination of evenness in the Tosawihi assemblages is dominated by the effects of assemblage size. Both measures of evenness employed are subject to sample size dependency. Isolating outliers to expected values of Pielou's J statistic showed that approximately half the tool assemblages, when examined as types, are less even than expected. A smaller percentage are lower than expected when the same statistic is calculated for assemblages of tool classes. This suggests that many of the assemblages are dominated by tool types or tool classes having higher frequencies than the pooled proportions indicate. The same pattern is evident in the rank order correlation examination of evenness, but in the rank order examination, a non-significant result can be achieved by having a higher proportion of a *particular* tool class than the pooled assemblage.

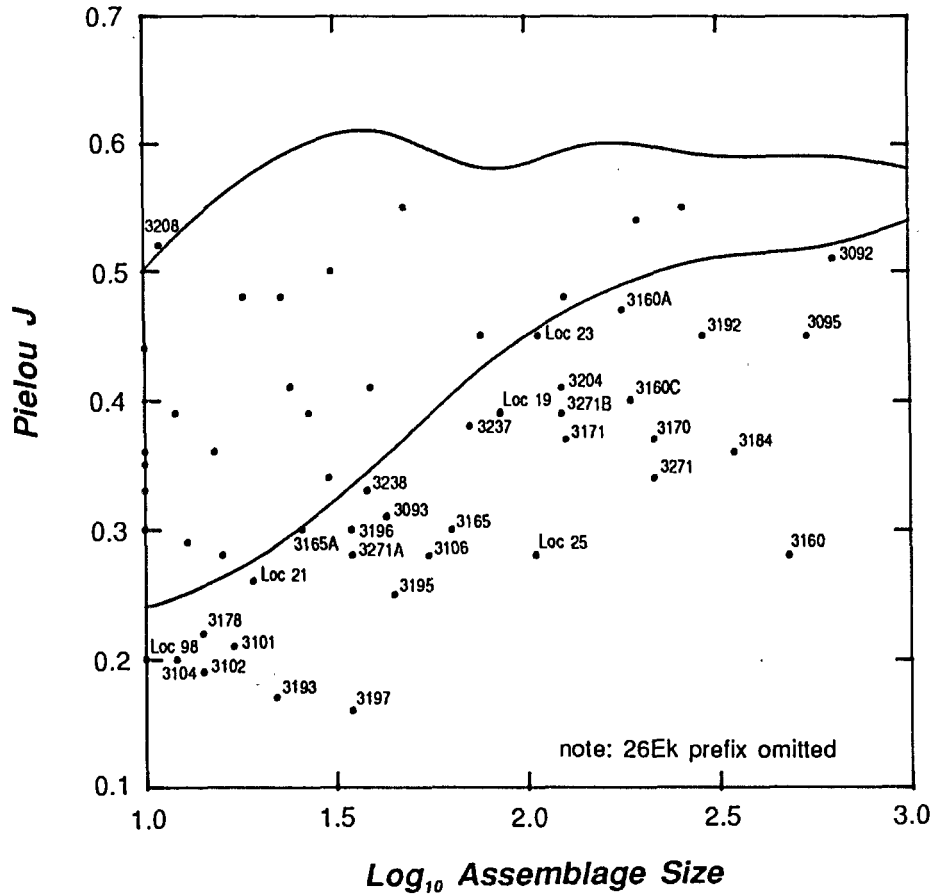


Figure 241. Type evenness vs. assemblage size with upper and lower boundaries of 2 standard deviations around mean of simulated type evenness and outlier assemblages.

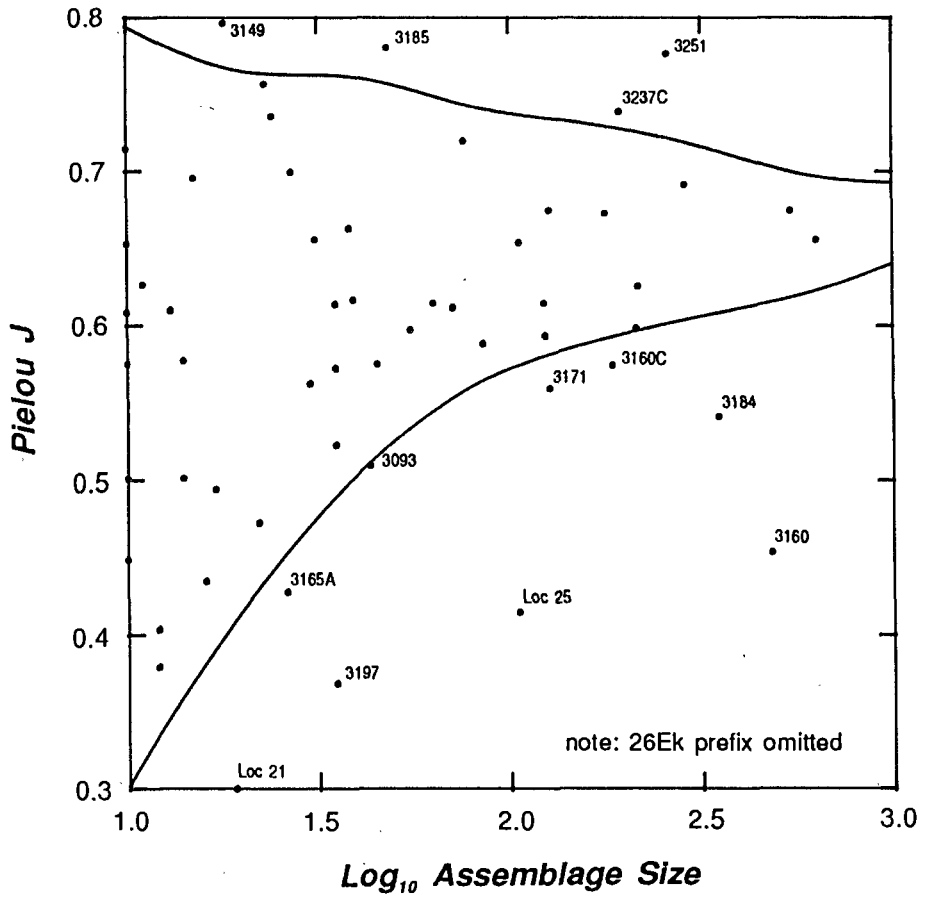


Figure 242. Class evenness vs. assemblage size with upper and lower boundaries of 2 standard deviations around means of simulated class evenness and outlier assemblages.

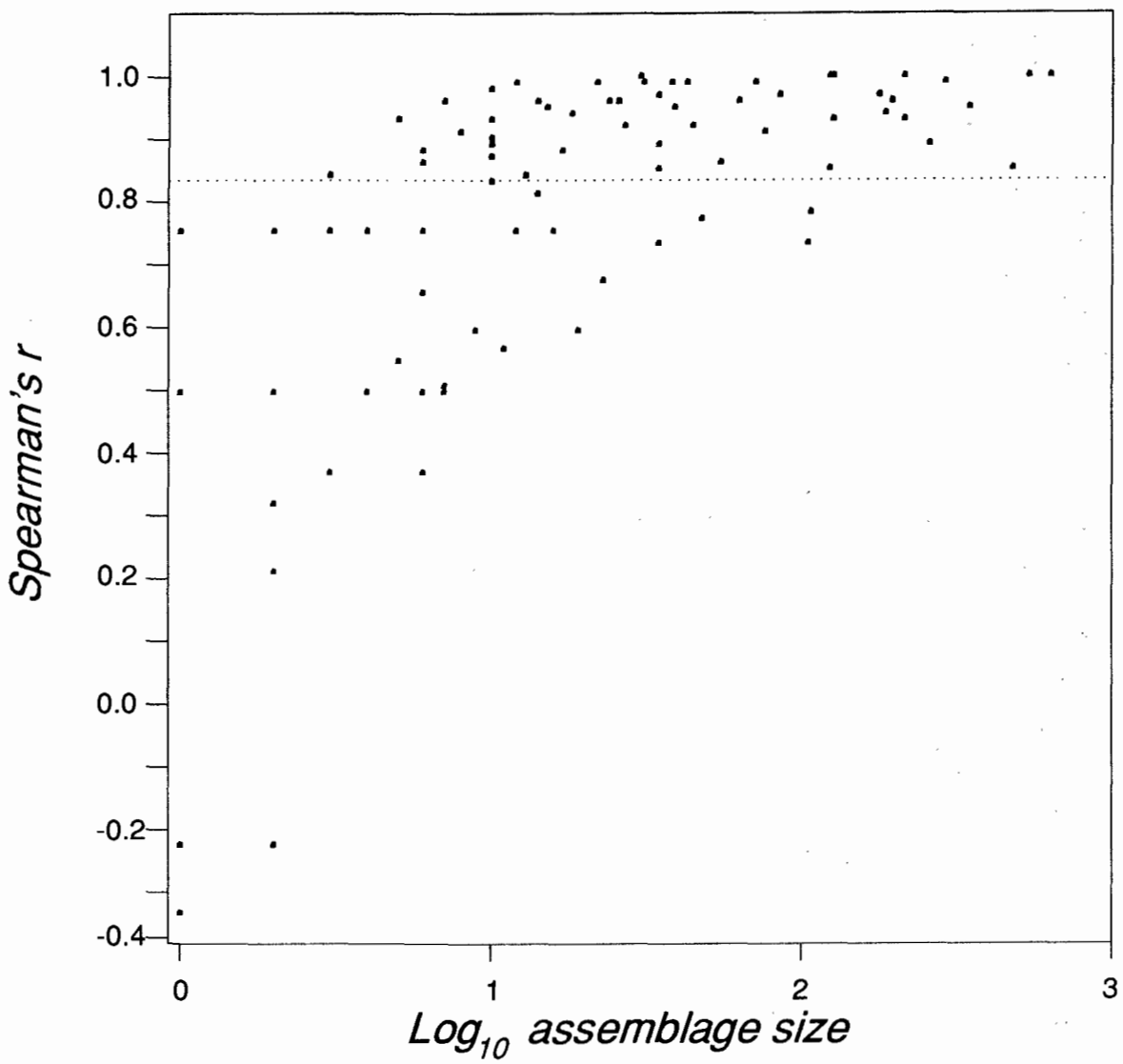


Figure 243. Spearman's r vs. assemblage size. Assemblages with rho<0.829 are not significant.

Table 215. Assemblages Having Insignificant Rank Order Correlations with the Pooled Assemblage Sample, based on Tool Class Proportions.

	TOOL CLASS							
Site/Locality	Quarry	Weapons	Fabricating/Processing Byproducts	Tools	General Utility	Domestic Equipment	N	Spearman's Rho
26Ek3032/093	0	0	0	0	0	1	1.00	-0.351
26Ek3144	0	1	0	0	0	0	1.00	-0.235
26Ek3032/028	0	1	0	0	0	0	1.00	-0.235
26Ek3125	0	1	0	0	0	0	1.00	-0.235
26Ek3142	0	1	0	0	0	0	1.00	-0.235
26Ek3032/107	0	1	0	0	0	0	1.00	-0.235
26Ek3032/072	0	1	0	0	0	0	1.00	-0.235
26Ek3032/004	0	1	0	0	0	0	1.00	-0.235
26Ek3032/040	0	1	0	0	0	0	1.00	-0.235
26Ek3032/158	0	1	0	0	0	0	1.00	-0.235
26Ek3123	0	1	0	0	0	0	1.00	-0.235
26Ek3075	0	1	0	0	0	0	1.00	-0.235
26Ek3032/152	0	1	0	0	0	0	1.00	-0.235
26Ek3154	0	1	0	0	0	0	1.00	-0.235
26Ek3162	0	1	0	0	0	0	1.00	-0.235
26Ek3148	0	1	0	0	0	0	1.00	-0.235
26Ek3032/024	0	0	1	0	0	0	1.00	0.489
26Ek3100	0	0	1	0	0	0	1.00	0.489
26Ek3155	0	0	1	0	0	0	1.00	0.489
26Ek3262	0	0	1	0	0	0	1.00	0.489
26Ek3110	0	0	0	0	1	0	1.00	0.746
26Ek3186	0	0	0	0	1	0	1.00	0.746
26Ek3032/138	0	2	0	0	0	0	2.00	-0.235
26Ek3237B	0	1	1	0	0	0	2.00	0.201
26Ek3174	0	0	0	0	1	1	2.00	0.313
26Ek3234	0	0	2	0	0	0	2.00	0.489
26Ek3189	0	0	2	0	0	0	2.00	0.489
26Ek3085	0	0	0	0	2	0	2.00	0.746
26Ek3088	0	0	2	1	0	0	3.00	0.359
26Ek3183	0	0	0	0	3	0	3.00	0.746
26Ek3231	0	1	1	0	1	0	3.00	0.746
26Ek3087	0	0	4	0	0	0	4.00	0.489
26Ek3091	0	0	3	0	1	0	4.00	0.747
26Ek3179	0	0	0	2	3	0	5.00	0.539
26Ek3086	0	0	4	2	0	0	6.00	0.359
26Ek3232	0	0	6	0	0	0	6.00	0.489
26Ek3032/026	0	0	5	0	1	0	6.00	0.652
26Ek3177	0	2	2	0	2	0	6.00	0.746
26Ek3203	0	0	7	0	0	0	7.00	0.489
26Ek3237A	0	2	1	1	2	1	7.00	0.499
26Ek3032/022	0	0	8	0	1	0	9.00	0.593
26Ek3208	0	1	0	3	6	1	11.00	0.558
26Ek3181	0	0	1	0	9	2	12.00	0.754
26Ek3178	0	3	7	0	4	0	14.00	0.81
26Ek3096	0	0	11	0	4	1	16.00	0.75
26Ek3032/021	0	0	16	1	2	0	19.00	0.585
26Ek3116	0	6	4	5	8	0	23.00	0.667
26Ek3197	0	0	26	1	8	0	35.00	0.727
26Ek3185	0	8	19	9	11	1	48.00	0.765
26Ek3032/025	0	0	75	6	24	0	105.00	0.732
26Ek3032/023	1	6	57	16	26	0	106.00	0.784

Assemblage Composition

The examinations of richness and evenness relative to assemblage size presented above clearly indicate that sample size is an important contributor to the diversity (in its inexact sense) of Tosawihi tool assemblages. In the diversity inquiry the potential importance of specific constituent tool types or classes within a sample, i.e., assemblage composition, was largely ignored. In theory, the actual classes or types present in a sample are not *necessarily* conditioned by sample size, but in practice the presence of rare tool classes must be conditioned by the size of the sample. Indeed, this is the rationale for Monte Carlo simulations of richness and evenness values using type or class proportions (Kintigh 1989; Rhode 1988). Thus, outliers to measures of diversity are likely to differ in composition from non-outliers of the same sample size.

Another important aspect of the richness and evenness calculation is that individual tool types or tool classes are all given equal weight. For example, it is immaterial whether an outlier assemblage to the type richness: size regression contains five tool types from the same tool class, or five tool classes represented by one tool type each. So, patterns in assemblage composition based on contrasts of outlier and non-outlier samples *could* indicate assemblage types or profiles but they need not do so. Rather, it is far more likely that such contrasts indicate the *dimensions* along which assemblage composition varies and not different global patterns of assemblage composition. Differences in assemblage composition are *not* used in this study to construct a higher order classification of assemblages. The dimensions found in this fashion need not accord with site function, landscape position, etc., because the contrast still presumes equal importance of each tool class or tool type. In the real world of archaeological things, however, we rarely presume equal importance of different kinds of artifacts. Debitage types, for instance, rarely are considered significant evidence of subsistence actions (although they might be). *Weighting* values for different tool types or classes would of course vary according to the needs of a particular analysis.

The research question guiding the initial inquiry into assemblage composition is: what are the axes of variation in assemblage composition? Only the tool class data are used in examining assemblage composition, to promote replicability between regional samples by avoiding overdependence on the Tosawihi typology, even though General Utility tools may have a somewhat different meaning in the Tosawihi context (cf. above). First, outliers to the boundaries of the richness: size regression, richness: size simulations, and evenness:size simulations are compared to the composition of the assemblages that are not outliers. Next, assemblages that are outliers to the evenness comparison made using Spearman rank order correlation coefficients are contrasted with assemblages correlating with the tool class proportions of the pooled Tosawihi assemblage sample. In all of these analyses, tool classes are not differentially *weighted*, since the aim is to discover what the most variable tool classes are and how they are related to each other. Nor are individual assemblages of particular interest, for the same reason.

The second part of this inquiry examines individual assemblages in comparison to the pooled Tosawihi sample and weights their attributes. Individual outlier assemblages are found through differences in the frequencies of particular tool classes by comparing tool class proportions of each assemblage to the tool class proportions of the pooled Tosawihi assemblage sample. A differential weighting of one tool class is examined next. Assemblages with Domestic Equipment class artifacts are segregated and pooled (hence they are given a different weighting) for contrast with all other assemblages. Finally, attributes of assemblages extrinsic to their composition are examined by giving analytical weight to the distance of an assemblage from water and toolstone sources.

The methods of comparison used are similar to those employed by Thomas (1988). Since all of the contrasts are a comparison of the frequencies of tool classes for a single assemblage or pooled totals for groups of outlier assemblages vs. pooled non-outlier assemblages, a matrix

of two by six cells contains the basic data. Chi-square tests of independence of this matrix and Kolmogorov-Smirnov two sample tests of cumulative proportional differences were employed to assess compositional variation. The former test seeks to reject the null hypothesis of independence of tool class distribution relative to outlier status. The latter test seeks to reject the null hypothesis of equal proportional frequency of tool classes between the two pooled groups.

If both tests rejected their respective null hypotheses at a level of significance of $p=0.05$, further examination of the two samples was undertaken to examine *how* they differ in composition. Details of compositional differences were examined using adjusted standardized residuals, which yield an estimate of the deviation of each cell from its expected value under a model of independence (Everitt 1977). Deviations from expected chi-square values having a probability of less than 0.05 (adjusted residuals greater than 1.96 or less than -1.96) are considered indicators of important departures from independence. Residuals for each pooled outlier sample are illustrated graphically (cf. Figure 244). Since adjusted residuals in a 2 by n matrix are always equal for adjacent cell pairs, the residual pattern for the nonoutlier group always mirrors the residual pattern of the outlier sample or group.

Assemblage Composition of Outliers to Type and Class Richness

Assemblages below, within, and above the 99% confidence limits of the type richness : size regression (Table 213, Figure 238) were compiled into three pooled samples. Assemblages above the limits are richer than the overall Tosawihi assemblages, those below, less rich than expected. Tests of the similarity of tool class composition were performed between the less rich (i.e., below the 99% confidence interval limits) and the within limits groups, and the more rich and the within limits group.

The 13 less rich assemblages differ in composition from the 62 assemblages that fall within the limits (chi-square=46.168, $p<0.001$; $D\max=.055$, $D\text{crit}=.052$ at $p=0.05$, $n1=855$, $n2=3394$). Assemblages less rich than expected tend to have fewer artifacts in the Weapons and Domestic Equipment classes, and more tools of the General Utility class (Figure 244a). (The same pattern is present in the outliers to *simulated* type richness relative to size, since the same assemblages compose this group.) The four assemblages richer than expected are also different in tool class composition (chi-square=89.166, $p<0.001$; $D\max=.113$, $D\text{crit}=.045$ at $p=0.05$, $n1=1235$, $n2=3394$; Figure 244b), having less than expected frequencies of Fabricating/ Processing byproducts and greater than expected frequencies of artifacts in the Weapons and General Utility classes.

The same examination was undertaken using the boundaries of two standard deviations around the mean simulated class richness values. The three outliers to the simulation of class richness values (all lower than expected values; cf. Table 213, Figure 240) form a sparse matrix with 30% of its cells having counts below five. The statistical results therefore are not ideally reliable, although they are significant (chi-square=67.205, $p<0.001$; $D\max=.183$, $D\text{crit}=.093$ at $p=0.05$, $n1=225$; $n2=5259$). The residuals show lower than expected frequencies of tools in the Domestic, General Utility, and Weapons classes, and higher than expected frequencies of Fabricating/Processing Byproducts (Figure 245).

In general, all of the less rich outliers (whether calculated from regression on type richness or simulation of class and type richness values) show lower than expected values of the Weapons and Domestic tool classes. Fabricating/Processing Tools and Quarry Equipment are not highly variable in frequency from less rich to average richness assemblages. General Utility and Fabricating/Processing Byproduct tool classes vary in their relationships to the average richness sample, depending upon the particular contrast employed, although in both type and class simulation contrasts, Fabricating/Processing Byproducts are higher than in the

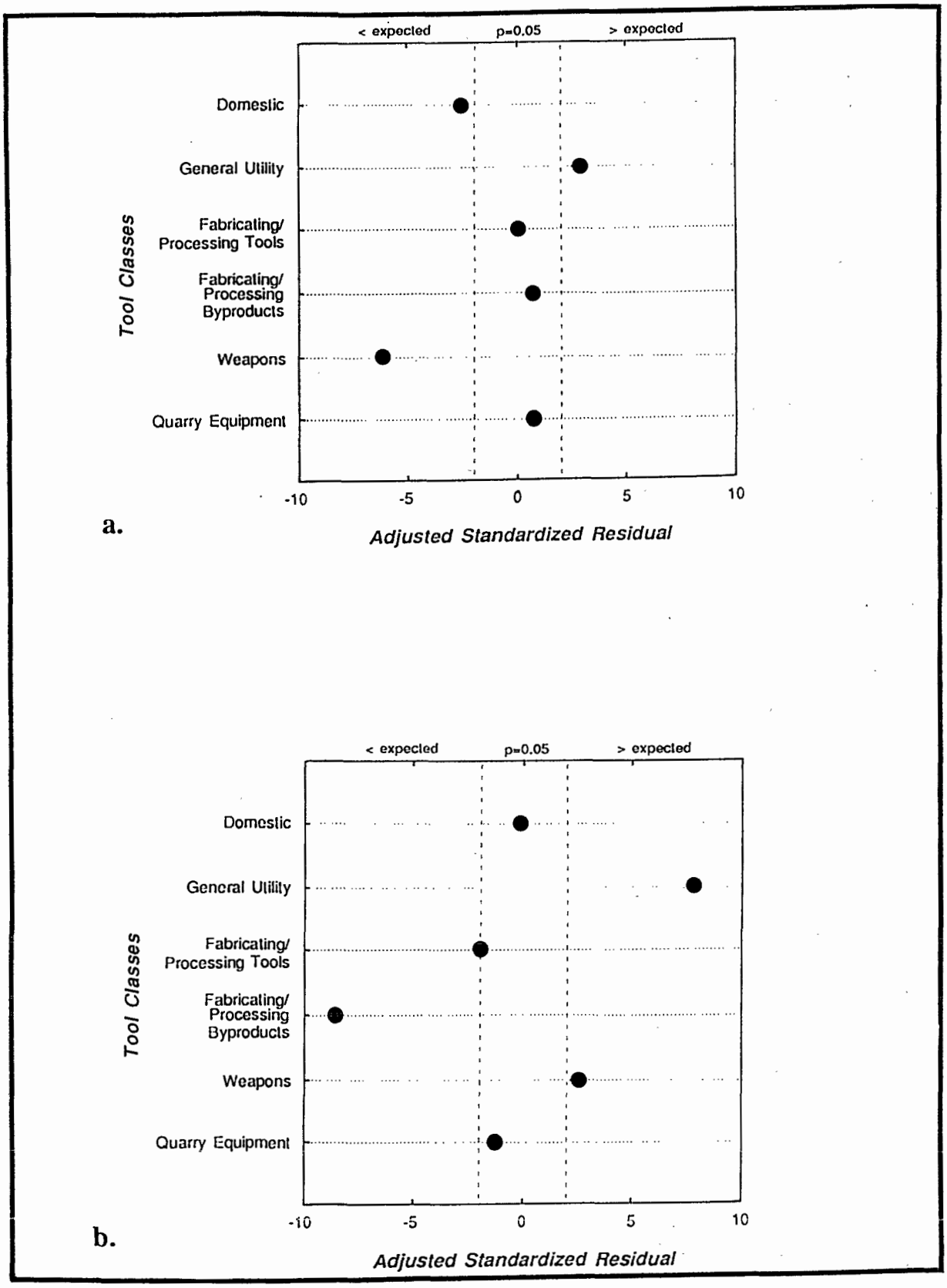


Figure 244. Adjusted standardized residuals for (a) assemblages less rich and (b) more rich than the type richness:sample size regression.

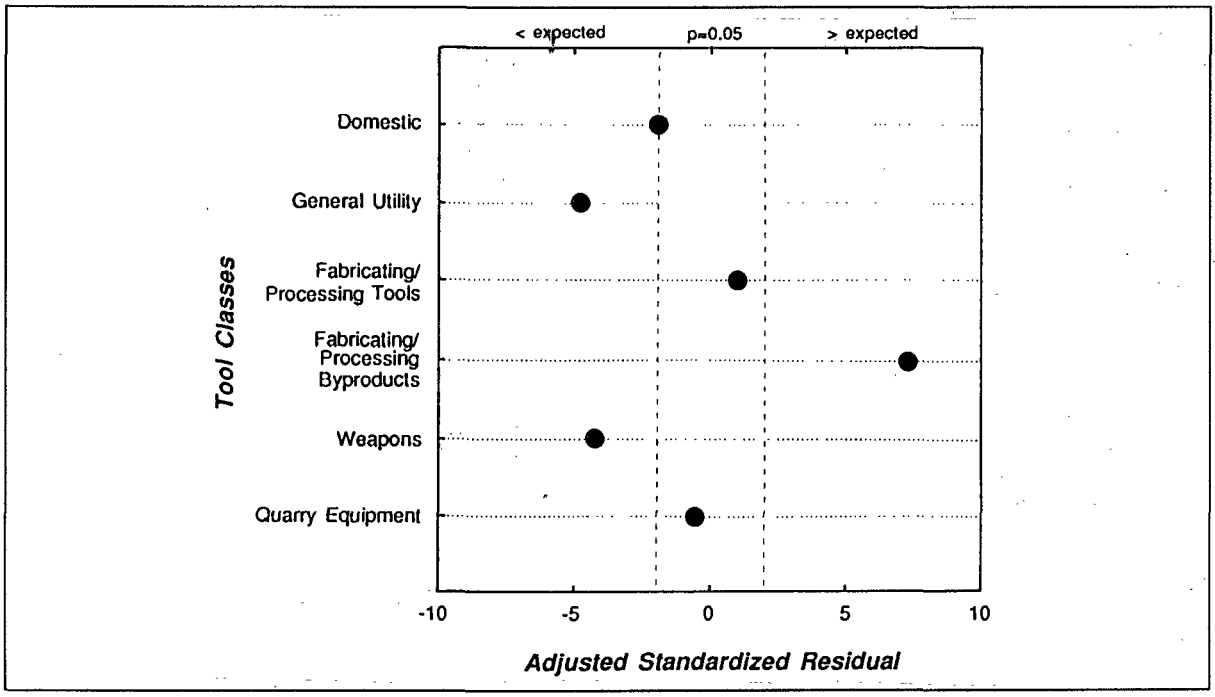


Figure 245. Adjusted standardized residuals for assemblages of tool classes less rich than two standard errors around the mean of simulated richness.

average samples. In sum, the low richness assemblages are consistent in their lack of Weapons and Domestic Equipment. The high richness assemblages (Figure 244b) show a partial reversal of this pattern: high frequencies of Weapons and low frequencies of Fabricating/Processing Byproducts.

Assemblage Composition of Outliers to Type and Class Evenness

Comparison of the thirty-one assemblages less even than the boundaries of simulated evenness values based on types (Figure 241, Table 214) shows that less even assemblages have higher frequencies of General Utility tools and lower frequencies of tools in the Domestic, Fabricating/Processing Byproduct, and Weapon tool classes (chi-square=112.152, p<0.001; *D*max=.113, *D*crit=.042 at $p=0.05$, $n1=4051$; $n2=1422$; Figure 246). The single assemblage lying above the two standard error boundary of type evenness is not significantly different from the average sample group.

The ten assemblages below the simulated tool class evenness boundaries (Figure 242, Table 214) differ significantly from the 76 assemblages in the average sample group (chi-square=124.477, p<0.001; *D*max=.155, *D*crit=.042 at $p=0.05$, $n1=1493$; $n2=3473$). The less even tool class assemblages mirror the composition of the less even tool type assemblages, with the exception that Fabricating/Processing Tools occur in approximately the expected frequency (Figure 247a). The four assemblages with higher than average evenness values (Figure 242, Table 214) relative to the simulated class evenness distribution also differ significantly from the average group (chi-square=86.560, p<0.001; *D*max=.103, *D*crit=.064 at $p=0.05$, $n1=518$; $n2=3473$). Three of the four assemblages (26Ek3149, 26Ek3185, 26Ek3237 Locus C) also are higher than the average group in richness (based on regression limits), so it is not surprising that they mirror this group in composition (cf. Figure 244b and Figure 247b).

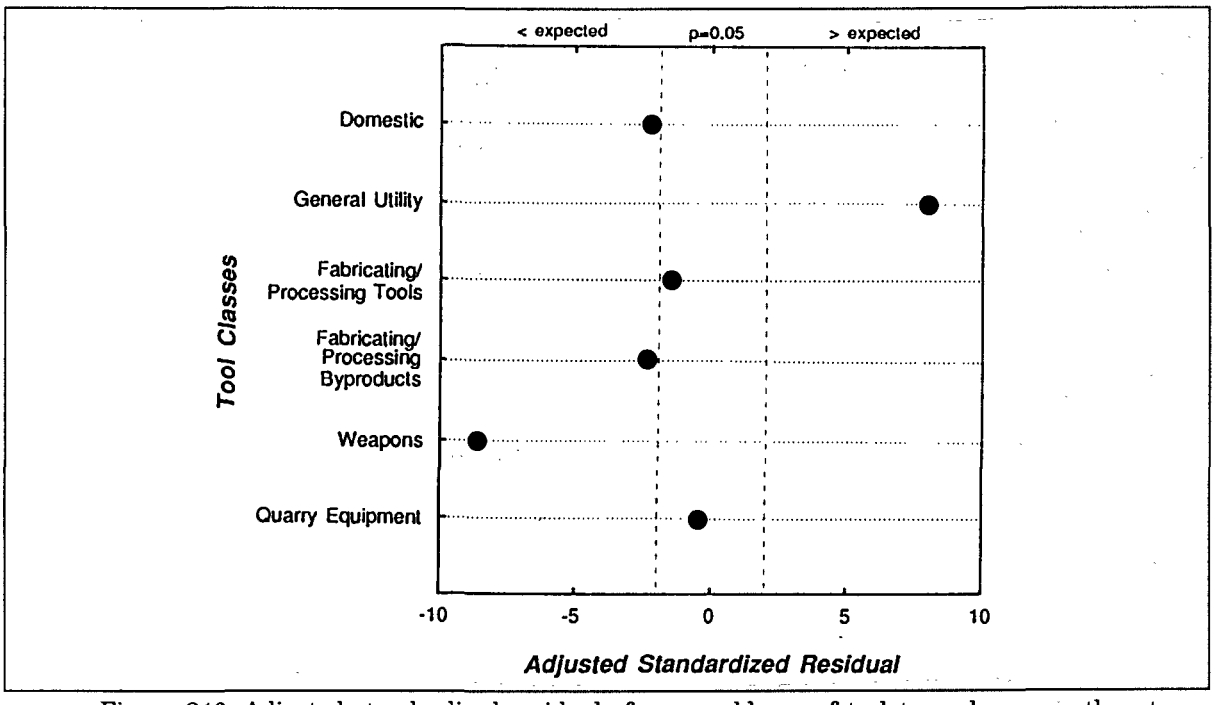


Figure 246. Adjusted standardized residuals for assemblages of tool types less even than two standard errors around the mean of simulated richness.

In fact, many of the same assemblages are recurrent outliers (cf Table 214, 215), so outliers to the richness relationship are also likely outliers to evenness values. There is no reason why evenness of tool classes should be correlated with richness of tool types, since the number of types present is not necessarily related to how they are distributed among classes or how class frequencies are related. However, the same assemblages appear as outliers in different kinds of analyses, indicating that there really must be something different about them in comparison to all other tool assemblages. Hence, differences in composition probably are real, that is, they are not merely artifacts of the analytical techniques employed.

Assemblage Composition of Outliers to the Rank Correlation Relationship

The Spearman's *r* examination undertaken above to assess assemblage evenness provides a starting point for the analysis of assemblage composition. Figure 243 and Table 215 show that some assemblages are not correlated with the pooled tool class proportions of the Tosawihi assemblages. These assemblages have a composition different from the overall Tosawihi sample, since tool classes occur in a different order of frequency. In the pooled Tosawihi tool class assemblage, the order of tool class occurrence is: General Utility implements (47%); Fabricating/Processing Byproducts (36.6%); Weapons (7.1%); Fabricating/Processing tools (6.8%); Domestic Equipment (2.4%); and Quarry Equipment (0.1%). A closer examination of why the ten assemblages with more than ten tools (Table 215) are not correlated with the pooled sample reveals a pattern in seven of the ten assemblages. These seven assemblages (26Ek3178, 26Ek3096, 26Ek3197, 26Ek3185, and 26Ek3032 Localities 21, 23, and 25) all have Fabricating/Processing Byproducts as their most frequent tool class, and General Utility tools rank second. Activities that generated Fabricating/Processing Byproducts appear to have been more common than the norm on these sites. The most frequent tools in this class at Tosawihi are early stage bifaces (earlier than Stage 3.5; cf. Chapter 6), and it is perhaps no surprise that all seven of the assemblages cited above are at most a few hundred meters from toolstone sources; many actually *are* toolstone sources.

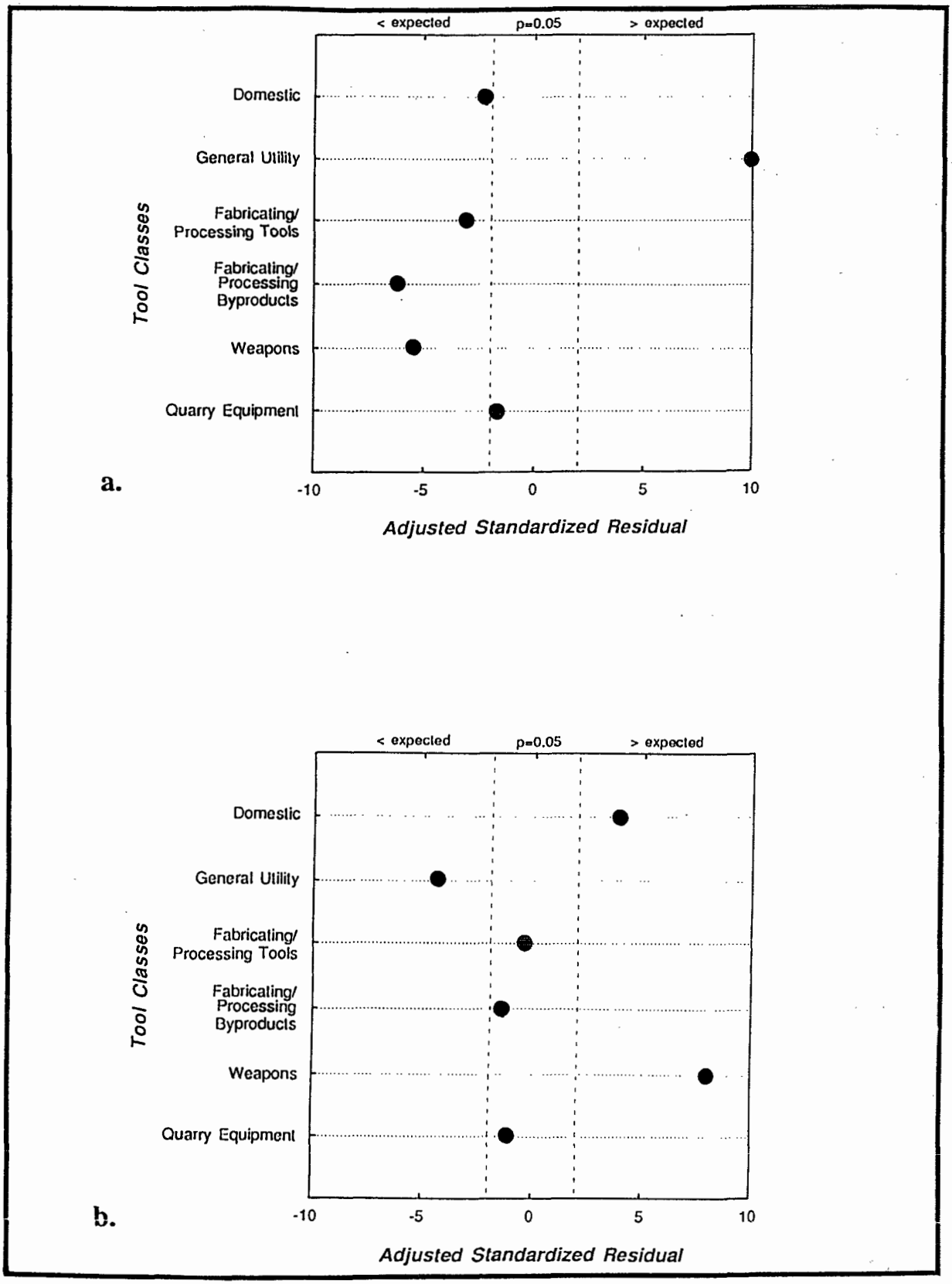


Figure 247. Adjusted standardized residuals for assemblages of tool classes (a) less even than two standard errors around the mean of simulated richness and (b) more even than two times the standard error around the mean.

Assemblage Composition of Outliers to Tool Class Proportional Frequency

The comparisons above are phrased in terms of *groups*: assemblages that shared a particular outcome in the analysis of richness and evenness. The method of contrasts employed can be extended to contrast single assemblages with all other assemblages. No contrast of richness or evenness precedes assemblage selection, although only assemblages with more than ten tools were examined in this analysis. Each assemblage was contrasted with the pooled Tosawihi assemblage sample (subtracting the assemblage of interest) using a Kolmogorov-Smirnov two-sample test (Thomas 1976). Like the Spearman's rank order correlation coefficient study, constructing the contrast in this way compares tool class *proportions* and not frequencies, so it is independent of sample size. Tool class assemblages different at the $p = 0.05$ level and containing more than ten tools are considered outliers to the tool class proportional frequency.

Seventeen assemblages are outliers with regard to tool class proportional frequency (Table 216). Compared to the pooled sample to which they were compared, they fall into three distinct groups: those with high proportions of Fabricating/Processing Byproducts and low proportions of General Utility tools (Group 1 assemblages), those with low proportions of Fabricating/Processing Byproducts and high proportions of General Utility tools (Group 2), and those with high proportions of Weapons (Figure 248). Some minor differences between the three groups and the pooled assemblage class proportions are also evident in Figure 248. For example, Group 3 assemblages have not only proportionally more tools in the Weapons class, but also have fewer General Utility tools and more Domestic Equipment than the pooled assemblage. Group 1 has more Fabricating/Processing Tools as well as more Fabricating/Processing Byproducts. Thus, the comparison of individual assemblages to the pooled sample tool class proportions appears to isolate consistent differences in some assemblages.

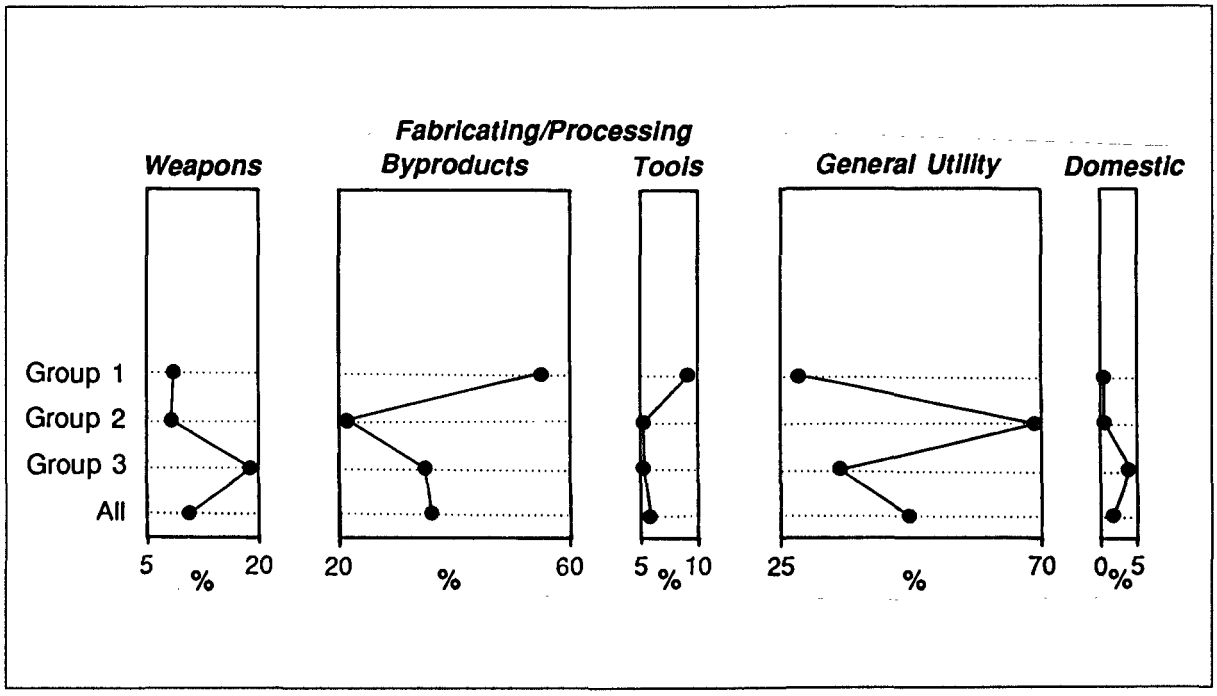


Figure 248. Proportional frequency of tool classes (excluding Quarry Equipment) for pooled Tosawihi assemblages and three Kolmogorov-Smirnov analytical result groups.

Table 216. Kolmogorov-Smirnov Test Outliers ($p<0.05$) to Pooled Tool Class Proportional Frequency.

Figures shown are percentage difference between class proportion in assemblage and class proportion in pooled Tosawihi assemblages without assemblage. *Only assemblages with more than ten tools are shown.*

Site (locus)	Quarry	Weapons	Fabricating/Processing Byproducts	Fabricating/Processing Tools	General Utility	Domestic	Analytical Group
3032/21	-0.11	-7.16	47.93	-1.57	-36.66	-2.42	1
3032/23	0.85	-1.51	17.67	8.42	-22.98	-2.46	1
3032/25	-0.11	-7.28	35.66	-1.14	-24.68	-2.46	1
3170	-0.11	-3.54	15.07	0.67	-10.56	-1.54	1
3185	-0.11	9.61	3.17	12.02	-24.36	-0.33	1
3190	-0.11	4.77	7.07	5.08	-15.70	-1.11	1
3197	-0.11	-7.19	38.08	-4.00	-24.36	-2.43	1
3203	-0.11	-7.15	63.64	-6.84	-47.12	-2.41	1
3204	-0.11	-2.31	19.27	2.99	-18.20	-1.63	1
3232	-0.11	-7.15	63.62	-6.84	-47.12	-2.41	1
3160	-0.12	-2.80	-23.72	-4.97	31.51	0.10	2
3160C	-0.11	-2.35	-12.54	-0.36	16.18	-0.82	2
3181	-0.11	-7.16	-28.17	-6.85	28.00	14.29	2
3184	-0.12	-5.48	-10.15	1.88	15.83	-1.96	2
3198	-0.11	14.45	-3.45	-3.77	-5.46	-1.66	3
3237C	-0.11	11.30	-4.65	-1.20	-6.57	1.24	3
3251	-0.11	10.81	3.24	-0.66	-18.06	4.79	3

Analytical Group:

(1) Fabricating/Processing Byproducts greater than in pooled assemblage. General Utility Tools less than in pooled assemblage.

(2) Fabricating/Processing Byproducts less than in pooled assemblage. General Utility Tools greater than in pooled assemblage.

(3) Weapons greater than pooled assemblage.

Axes of Variation, Analytical Weighting, and Controlling Assemblage Composition

Outliers to the unsurprising relationship between measures of diversity and measures of evenness indicate that the composition of Tosawihi assemblages can be modeled as an arrangement of tool frequency along two compositional dimensions or axes. The clearest axis is defined by Domestic Equipment and Weapons. These tool classes are closely related to each other; when the frequency of one is high, so is the other (cf. Chapter 20). The two are either both higher than expected or both lower than expected in all but one of the six chi-square contrasts in which they are included (Figure 244b).

A second axis of variation is defined by three tool classes. Fabricating/Processing Byproducts and Fabricating/Processing tools share the same outlier status (i.e., significantly higher or lower than expected) in four of the six contrasts presented above. The linkage between these two classes is less strong than that between Weapons and Domestic Equipment. General Utility tools are at the other end of the Fabricating/Processing axis of variation. This tool class is always either more or less frequent than expected in the six contrasts. There is good reason to suspect that many of the General Utility tool types at Tosawihi are more related to chipped stone production (since later stage bifaces and hammerstones are part of this class) than to the performance of multiple tasks. So, frequencies of General Utility tools might be expected to covary positively with the Fabricating/Processing compositional dimension. In fact,

they do not. Fabricating/Processing classes and General Utility tools are residuals in the same direction (both more than expected or both less than expected) in only one of the five contrasts containing significant Fabricating/Processing residuals. Thus, General Utility tools may be the other end of the fabricating/processing compositional dimension. This is clearly seen in the results of the Kolmogorov-Smirnov comparisons of individual assemblages to the pooled Tosawihi sample (Table 216).

The Domestic Equipment-Weapons and Fabricating/Processing-General Utility dimensions are mutually independent. Any given assemblage then, consists of some mixture of these two compositional dimensions (Figure 249). The Tosawihi assemblages are complicated mixtures of both axes, so no clear assemblage patterns emerge (hence no higher order typology of "assemblage types" is generated by this study). Yet, if one axis of this variation is given more analytical weight than the other, compositional differences may become apparent and perhaps even interpretable.

Variation in Assemblages with Domestic Equipment

Domestic Equipment is infrequent, comprising only 2% of the pooled Tosawihi tool assemblage (Table 212). Although several tool types comprise the Domestic Equipment class, many have fairly specific functions related to food processing (cf. Chapters 12, 13, 20). Are other tool classes positively or negatively associated with these (inferred) behavioral indicators (*cf.* Chapter 20)? To evaluate this, assemblages with and without Domestic Equipment were compared to each other, thus giving analytical weight to this particular tool class. Since the previous analyses showed that Weapons covary with Domestic Equipment, Weapons should associate positively with Domestic Equipment.

Tool class composition differences were assessed with chi-square and Kolmogorov-Smirnov tests contrasting the frequencies of the other four tool classes excluding Quarry Equipment. As in

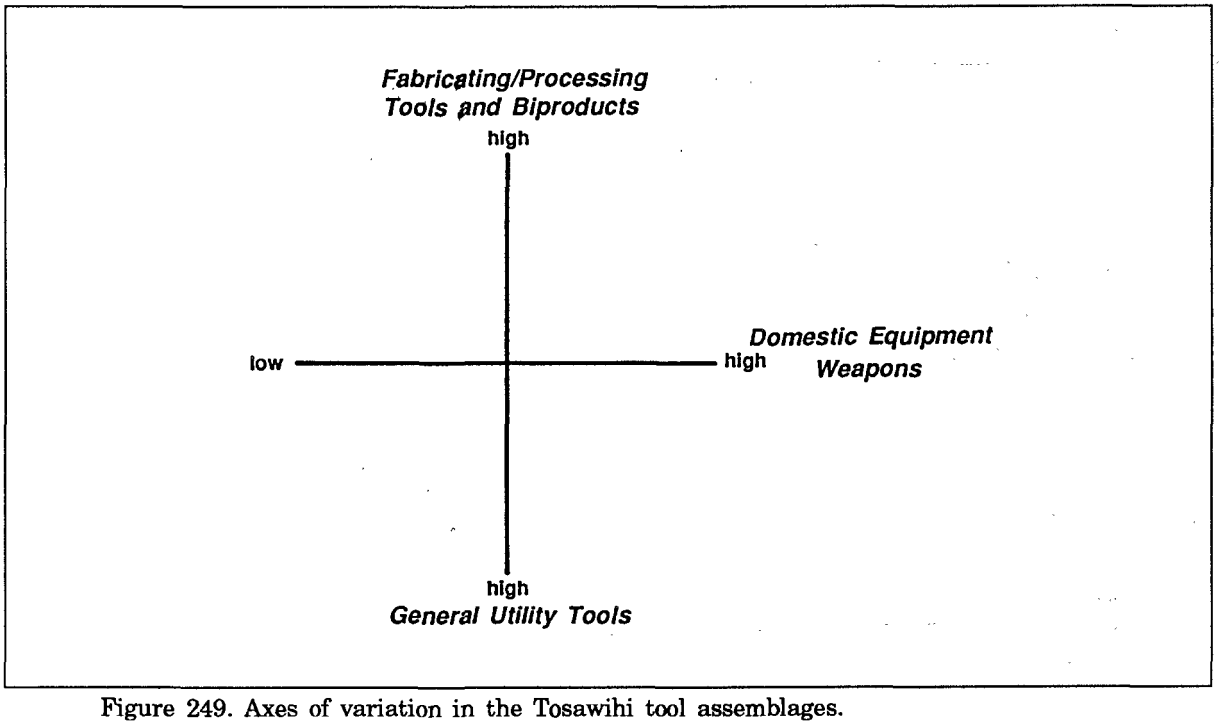


Figure 249. Axes of variation in the Tosawihi tool assemblages.

all previous compositional analyses, only assemblages with more than ten tools were included in the contrast. There are, indeed, differences between assemblages with Domestic Equipment (n=32) and those without (n=17; chi-square=67.86, df=3, $p<0.01$, Dmax=.151, Dcrit=.060 at $p=0.01$). The compositional differences can be examined readily using adjusted standardized residuals (Everitt 1977) shown in Figure 250. Assemblages containing Domestic Equipment tend to have significantly higher frequencies of Weapons (as expected) and General Utility tools. Fabricating/Processing Byproducts are significantly less frequent than expected under a chi-square model of independence between the two groups.

If, as suggested above, we consider assemblages containing Domestic Equipment and Weapons as at least partially reflecting maintenance activities, the "production" axis of assemblage variation is split when presence of Domestic Equipment is given analytical weight (Figure 251a). The results suggest that the discard of food processing equipment was segregated from discard of Fabricating/Processing equipment and byproducts. Whether this represents differences in locations of activities is addressed below.

Variation in Assemblages using Environmental Variables

As shown above, different axes of variation can be separated in the Tosawihi assemblages, and their separation may be useful in interpreting prehistoric activities. The analytical weighting used above is internal, since Domestic Equipment is a part of the assemblages themselves. Analytical weight was therefore given to an *intrinsic* part of the assemblages, by presuming it to be more meaningful than others. Analytical weight also can be given to *extrinsic* factors. Two of the most important at Tosawihi are proximity to toolstone and proximity to water (cf. Chapter 2). How do the Tosawihi assemblages fit along the dimensions of assemblage composition controlling for these factors?

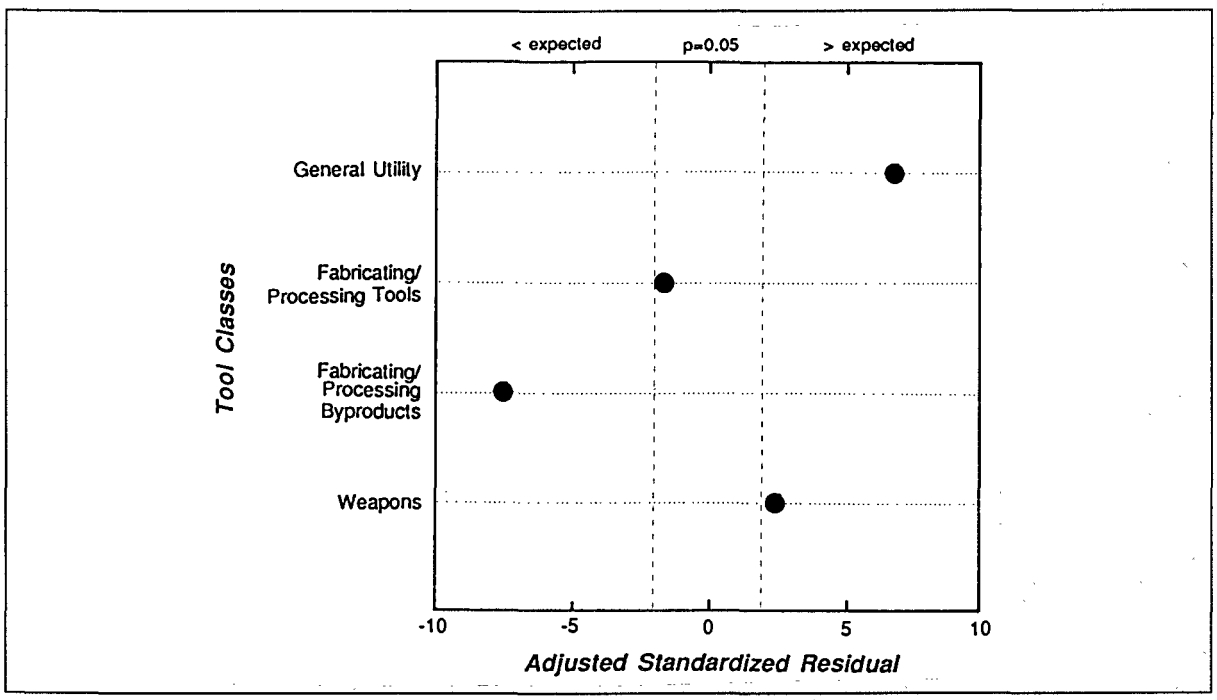


Figure 250. Adjusted standardized residuals for assemblages of tool classes having tools in the Domestic Equipment tool class.

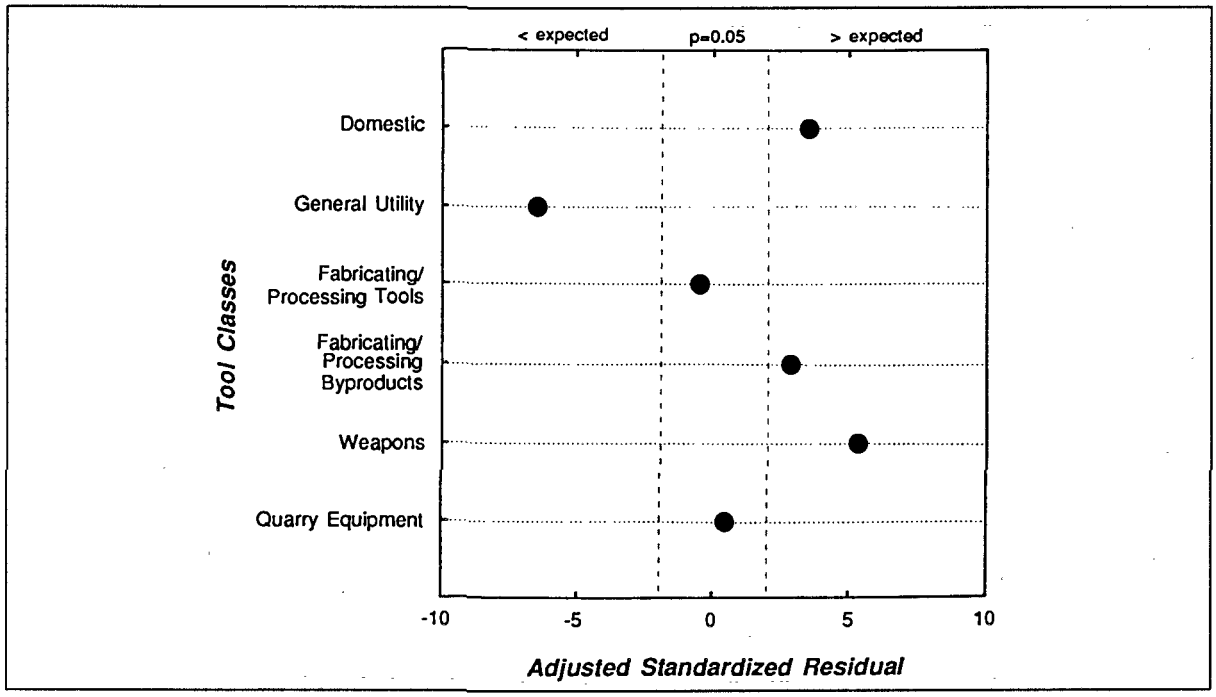


Figure 251. Adjusted standardized residuals for assemblages of tool classes within 250m of water sources.

Using the same techniques described above, assemblages within 250m of water and within 250m of toolstone were segregated from all others, and contrasted with them. Both contrasts (water<250m vs. water>250m; toolstone<250m vs. toolstone>250m) are highly significant. Assemblages near potential water sources differ in composition from those away from water sources (chi-square=66.329, p<0.001; *D*max=.076, *D*crit=.037 at $p=0.05$, $n1=3243$; $n2=2241$) by having lower than expected frequencies of General Utility tools and higher than expected frequencies of Domestic Equipment and Fabricating/Processing Byproducts (Figure 252). Scaling the results along the axes of compositional variation (Figure 251b), the pattern clearly differs from the results of weighting Domestic Equipment assemblages. Assemblages within 250m of toolstone sources also differ from other assemblages (chi-square=123.696, p<0.001; *D*max=.152, *D*crit=.038 at $p=0.05$, $n1=3439$; $n2=2045$). Assemblages close to toolstone (Figure 253) have higher than expected proportions of Fabricating/Processing Tools and Byproducts, and lower than expected General Utility tools and Domestic Equipment. Scaled along the two axes of compositional variation (Figure 251c) the two groups form a pattern similar to that for sites with Domestic Equipment vs. sites without Domestic Equipment. Insofar as activities are indicated by the axes of compositional variation, these analyses jointly show that activities followed a regular pattern in relation to landscape properties.

Discussion

A series of arguments was advanced in Chapter 4, suggesting that variation in the tools discarded in a location should reflect many facets of human behavior. For example, places used for long term visits to Tosawihi are expected to contain discarded tools associated with the maintenance of human groups, especially tools used directly in procurement and processing of food (cf. Chapter 20).

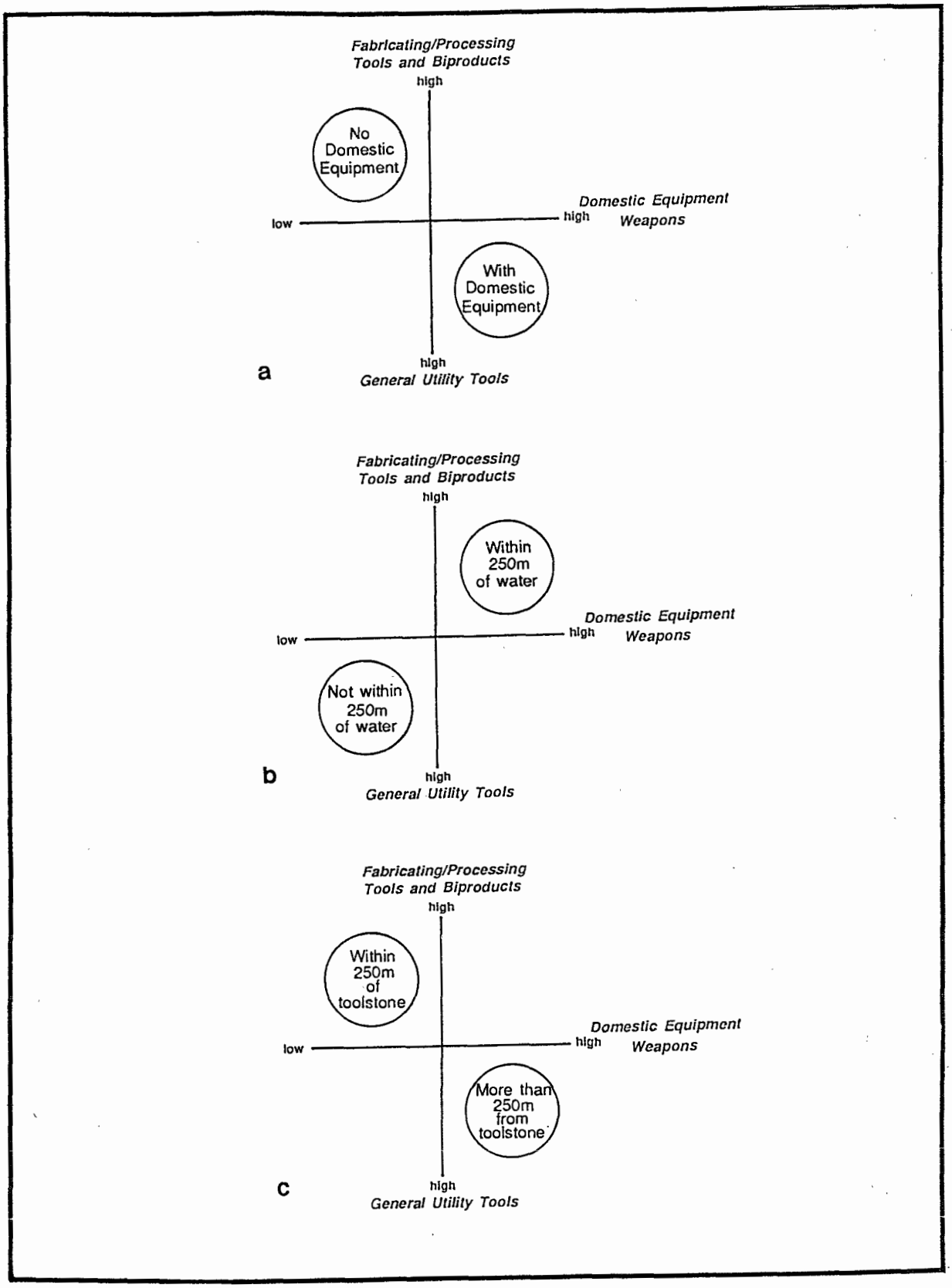


Figure 252. Tool composition patterns scaled along axes of variation in the Tosawihi tool assemblages.

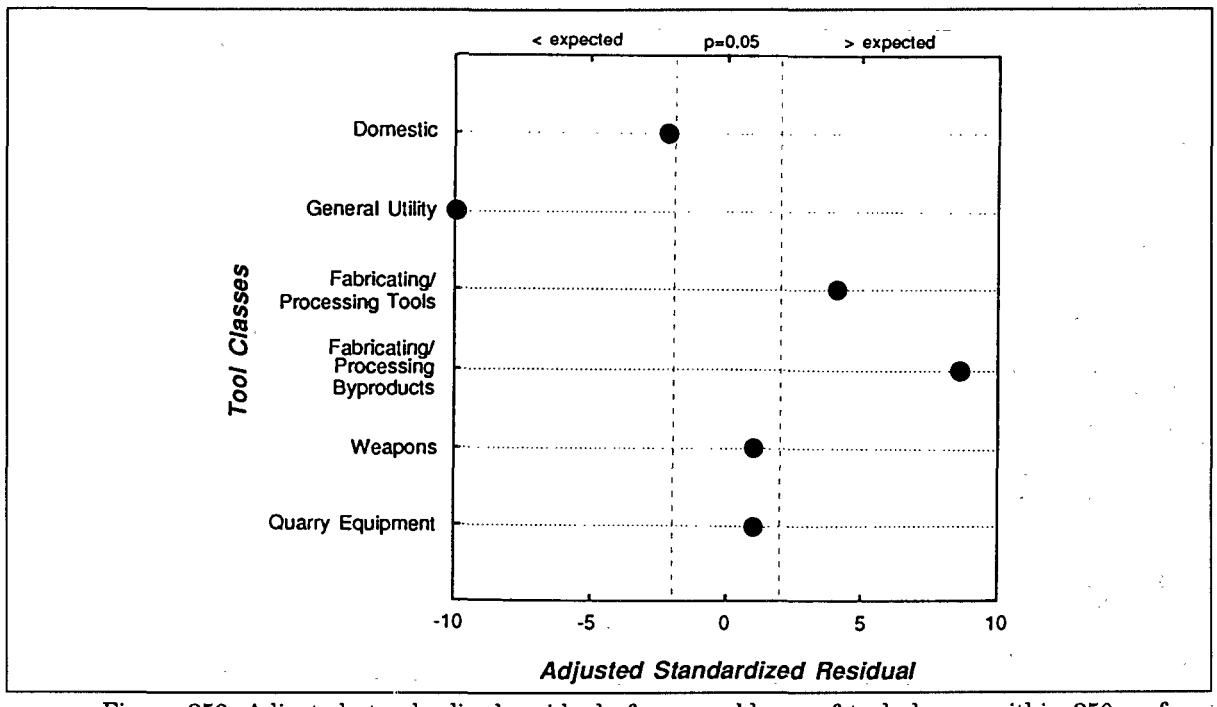


Figure 253. Adjusted standardized residuals for assemblages of tool classes within 250m of toolstone sources.

Assemblages of discarded and lost tools can contain direct testimony to human actions, such as tools discarded at the location(s) of their use. Tool assemblages also can contain tools discarded at locations different from their places of use. Worn projectile points, for example, may be discarded where idle time permits refurbishing of a toolkit. Assemblages also can contain evidence of longer term behavior in support of a particular technological organization: the production (or overproduction) of tools for future (rather than immediate) use. Thus, while assemblages can testify directly to actions undertaken where tools are found, they also can contain tools that are shades of events past, events present, and events in the future.

The strong relationships between assemblage size and various measures of assemblage richness and evenness are artifacts of sampling, and thus are wholly expectable. The strength of these relationships clearly restricts interpretation of the Tosawihi tool assemblages based only on intuitive expectations of greater and lesser diversity.

Assemblages that do not fit the expected relationship between size and diversity measures have consistent differences in composition from their non-outlier counterparts. Because the relationship between sample richness and sample size is so expectable, little could be learned by examining assemblage composition without somehow controlling for the effects of sample size. The technique used here was to examine the composition of outlier assemblages. In effect, the contrasts employing outliers break apart the monolithic relationship between sample size and assemblage richness, allowing more fruitful direct comparisons. The desired goals were not simply numerical contrasts or the creation of assemblage types. As stated at the outset of the chapter, the aim was to define general patterns in assemblage composition to serve as a basis for further studies of particular assemblages or sites (Table 217).

Table 217. Summary of Diversity and Composition Results for Each Assemblage.

Site	A	B	C	D	E	F	G	H	I	J
26Ek3032/004	0	0	0	0	0	0	0	0	<250	<250
26Ek3032/019	-1	-1	-1	-1	0	0	0	1	<500	<250
26Ek3032/020	0	0	0	0	0	0	0	0	<500	<250
26Ek3032/021	0	0	0	-1	-1	1	1	0	<500	<250
26Ek3032/022	0	0	0	0	0	0	0	0	<500	<250
26Ek3032/023	0	0	0	-1	0	1	1	0	<500	<250
26Ek3032/025	-1	-1	-1	-1	-1	1	1	0	<500	<250
26Ek3032/026	0	0	0	0	0	0	0	0	<250	<250
26Ek3032/028	0	0	0	0	0	0	0	0	<250	<250
26Ek3032/040	0	0	0	0	0	0	0	0	500+	<250
26Ek3032/072	0	0	0	0	0	0	0	0	<250	<250
26Ek3032/098	-1	0	0	-1	0	0	0	0	<500	<250
26Ek3032/107	0	0	0	0	0	0	0	0	<500	<250
26Ek3032/138	0	0	0	0	0	0	0	0	<250	<250
26Ek3032/158	0	0	0	0	0	0	0	0	500+	<250
26Ek3084	0	0	0	0	0	0	0	0	<250	<250
26Ek3085	0	0	0	0	0	0	0	0	<250	<250
26Ek3086	0	0	0	0	0	0	0	0	<250	<500
26Ek3087	0	0	0	0	0	0	0	0	<250	<250
26Ek3088	0	0	0	0	0	0	0	0	<250	<250
26Ek3090	0	0	0	0	0	0	0	0	<250	<250
26Ek3091	0	0	0	0	0	0	0	0	<250	<250
26Ek3092	0	0	0	-1	0	0	0	1	<250	<250
26Ek3093	0	0	0	0	-1	0	0	0	<250	<500
26Ek3095	0	0	0	-1	0	0	0	1	<250	<500
26Ek3096	0	0	0	0	0	1	0	1	<250	<500
26Ek3099	0	0	0	0	0	0	0	0	<250	<250
26Ek3100	0	0	0	0	0	0	0	0	500+	<250
26Ek3101	-1	0	0	-1	0	0	0	0	<500	<250
26Ek3101/1	0	0	0	0	0	0	0	0	<500	<250
26Ek3102	-1	0	0	-1	0	0	0	0	<500	<250
26Ek3104	0	0	0	-1	0	0	0	0	500+	<250
26Ek3106	0	0	0	-1	0	0	0	1	500+	<250
26Ek3107	0	0	0	-1	0	0	0	0	<500	<250
26Ek3110	0	0	0	0	0	0	0	0	<500	<500
26Ek3114	0	0	0	0	0	0	0	0	<500	500+
26Ek3115	0	0	0	0	0	0	0	0	<500	<500
26Ek3116	1	0	0	0	0	1	0	0	<500	<500
26Ek3149	1	0	0	0	1	0	0	1	<250	<500
26Ek3160	1	0	0	-1	-1	0	2	1	<500	<500
26Ek3160A	0	0	0	-1	0	0	0	1	<500	<500
26Ek3160B	1	0	0	0	0	0	0	1	<500	500+
26Ek3160C	0	0	0	-1	-1	0	2	1	<500	<500
26Ek3165	-1	-1	0	-1	0	0	0	1	500+	500+
26Ek3165A	-1	0	0	-1	-1	0	0	1	500+	500+
26Ek3170	0	0	0	0	0	0	1	1	<500	<250
26Ek3170A	0	0	0	0	0	0	0	0	<500	<250
26Ek3170B	1	0	0	0	0	0	0	0	<500	<250
26Ek3171	1	0	0	-1	-1	0	0	1	<250	<250
26Ek3172	0	0	0	0	0	0	0	0	<250	<250
26Ek3173	1	0	0	0	0	0	0	0	<250	<500
26Ek3174	0	0	0	0	0	0	0	1	<500	<500
26Ek3177	0	0	0	0	0	0	0	0	<250	<250
26Ek3178	-1	0	0	-1	0	1	0	0	<250	<250
26Ek3179	0	0	0	0	0	0	0	0	<250	<250
26Ek3181	0	0	0	0	0	1	2	1	<500	<250
26Ek3183	0	0	0	0	0	0	0	0	<500	<250
26Ek3184	-1	-1	0	-1	-1	0	2	1	<500	<250
26Ek3185	1	0	0	0	1	1	1	1	<250	<250

Table 217, continued.

Site	A	B	C	D	E	F	G	H	I	J
26Ek3186	0	0	0	0	0	0	0	0	<250	<250
26Ek3189	0	0	0	0	0	0	0	0	<250	<250
26Ek3190	0	0	0	0	0	0	1	1	<250	<250
26Ek3191	0	0	0	0	0	0	0	0	<250	<250
26Ek3192	0	0	0	-1	0	0	0	1	<250	<250
26Ek3193	-1	-1	0	-1	0	0	0	0	<250	<250
26Ek3195	-1	-1	0	-1	0	0	0	0	<250	<250
26Ek3196	-1	-1	0	-1	0	0	0	1	<250	<250
26Ek3197	-1	-1	-1	-1	-1	1	1	0	<250	<250
26Ek3198	1	0	0	0	0	0	3	1	<250	<250
26Ek3200	0	0	0	0	0	0	0	0	<500	<250
26Ek3201	-1	-1	0	0	0	0	0	1	<250	<250
26Ek3202	0	0	0	0	0	0	0	0	<500	<250
26Ek3203	0	0	0	0	0	0	1	0	<500	<250
26Ek3204	0	0	0	-1	0	0	1	1	<500	<250
26Ek3208	1	0	0	1	0	1	0	1	<250	<250
26Ek3228	0	0	0	0	0	0	0	1	<250	<250
26Ek3231	0	0	0	0	0	0	0	0	<250	<250
26Ek3232	0	0	0	0	0	0	1	0	<250	<250
26Ek3234	0	0	0	0	0	0	0	0	<250	<250
26Ek3237	1	0	0	-1	0	0	0	1	<250	<250
26Ek3237A	0	0	0	0	0	0	0	1	<250	<250
26Ek3237B	0	0	0	0	0	0	0	0	<250	<250
26Ek3237C	1	0	0	0	1	0	3	1	<250	<250
26Ek3238	0	0	0	-1	0	0	0	1	<250	<250
26Ek3239	1	0	0	0	0	0	0	1	<250	<250
26Ek3251	0	0	0	0	1	0	3	1	<250	<250
26Ek3271	0	0	0	-1	0	0	0	1	<250	<500
26Ek3271A	0	0	0	-1	0	0	0	0	<250	<500
26Ek3271B	0	0	0	-1	-1	0	0	1	<250	<500
26Ek3271C	1	0	0	0	0	0	0	1	<250	<500

Key:
A. Outlier to regression of type richness on sample size.
B. Outlier to regression of simulated type richness on sample size.
C. Outlier to regression of simulated class richness on sample size.
D. Outlier to simulation of type evenness on sample size.
E. Outlier to simulation of class evenness on sample size.
F. Non-significant Spearman's rho correlation with pooled assemblage sample.
G. Kolmogorov-Smirnov test outlier.
H. Assemblage has Domestic Equipment.
I. Distance to water.
J. Distance to toolstone.

The results of these analyses show that tool assemblages at Tosawihi can be roughly scaled along two orthogonal axes of variation, one defined by Domestic Equipment and Weapons, the other by Fabricating/Processing Tools and Byproducts at one end and General Utility tools at the opposite. These two axes can be linked reasonably to two different dimensions of human action at Tosawihi. Domestic Equipment-Weapons are tool classes used to support or *maintain* people directly by providing food (cf. Chapter 20). The other axis is more closely related to *production*, creating a surplus in excess of local needs through the quarrying and processing of toolstone and the production of bifaces. The inverse relationship of early stage bifaces (which dominate the Fabricating/Processing Byproducts class) and later stage bifaces (which dominate the General Utility class) further suggest that the discard of failures (cf. Chapter 6) in biface production occur in distinct locations, perhaps indicating that the action of biface reduction was similarly segregated. Since biface breakage rates increase in

later stages of reduction (cf. Chapter 6), this pattern probably is even stronger than it appears in these results. Later stage bifaces (i.e., bifaces that fall into the General Utility class) should be more ubiquitous since they break more frequently. If they were commoner in the Tosawihi pooled assemblage sample, then they would not pattern differently from the Fabricating/Processing Byproducts.

At first glance, this outcome seems obvious. People have to feed themselves, and in the process of getting food, processing it, and consuming it, the equipment of human maintenance is discarded. At the same time, only the most profligate stone tool using hunter-gatherers would pass up the toolstone of Tosawihi. So, finding that Tosawihi tool assemblage composition can be interpreted as a mixture of maintenance and production residues is not startling.

What *is* worthy of notice is how closely the two axes are intertwined. Lithic procurement and production (especially on the scale of opalite exploitation at Tosawihi) need not occur in the same places as human maintenance activities. Spatial segregation of the two is easily visualized, for example as a result of exploitation of the quarries solely by logistical forays which leave little trace of human maintenance (cf. Chapter 4). Under this scenario, Tosawihi sites should exhibit assemblages dominated by fabricating and processing, little domestic equipment, and few weapons and general utility tools. If, on the other hand, the Tosawihi uplands were exploited chiefly as a foraging patch, assemblage composition should exhibit more residues of maintenance and relatively few by-products of lithic production. The assemblages expected from these alternate poses can be represented graphically in nearly diametric opposition (Figure 254).

No clear segregation of compositional axes is apparent in the Tosawihi assemblages. When different assemblage attributes are given unequal analytical weights, patterns emerge which indicate how these two dimensions of behavior were integrated. The next logical step is to examine how they cooccur. This involves analysis of site function to discover which activities went together and how frequently they did so (cf. Chapter 24). How these prehistoric actions were integrated with broader strictures on behavior imposed by the distribution of resources and the limitations of human energy then can be examined through looking at where prehistoric actions happened on the landscape (cf. Chapter 25).

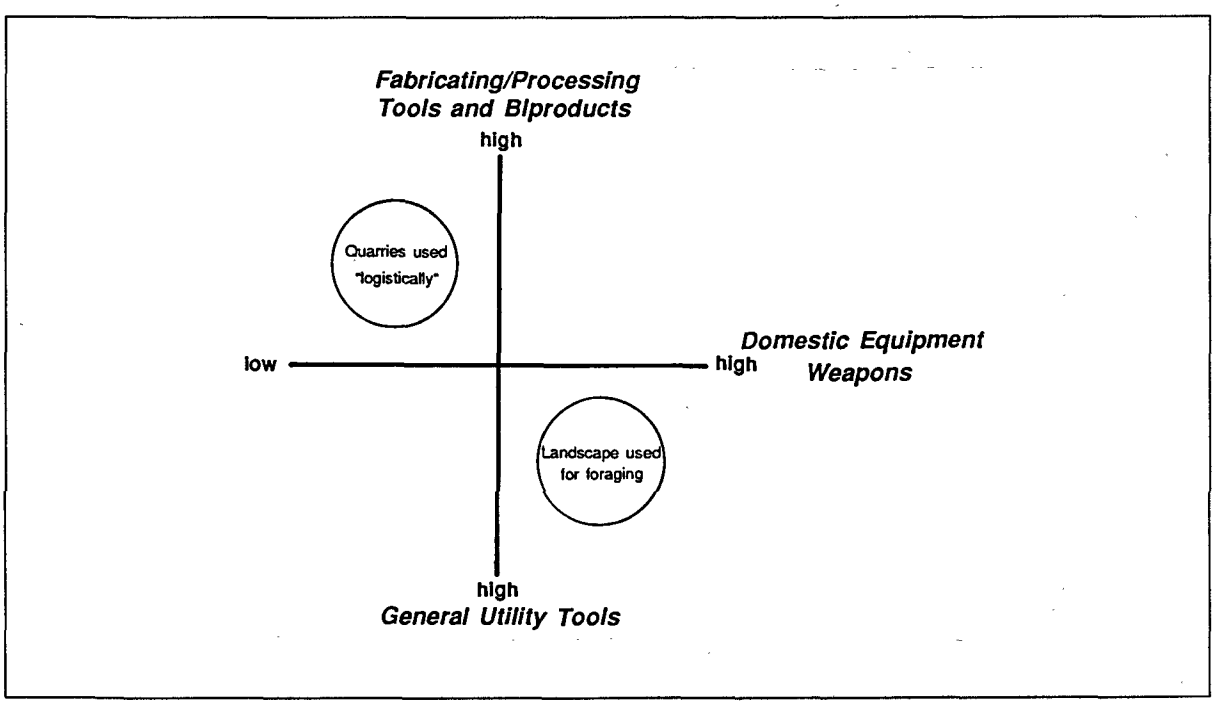


Figure 254. Hypothetical assemblage coordinates on the axes of variations in Tosawihi tool assemblages.

Chapter 24

SITE FUNCTION AND RESIDENTIALITY

Melinda Leach

We have suggested in Chapters 3 and 4 that alternative lithic procurement strategies employed by prehistoric Great Basin hunter-gatherers were conditioned by attributes of the lithic terrane, seasonal scheduling constraints, labor availability, regional toolstone demand, and other factors. The mix of strategies used was tied closely to settlement and subsistence, often involving shifts in mobility and residential patterns as means to alleviate transport, extraction, and opportunity costs of toolstone.

Herein, we examine variability in archaeological patterning as a function of cost-minimizing economic behavior. One way in which toolstone acquisition costs can be minimized is to alter the locations of activities on the landscape, and consequent variations in site structure, assemblage composition, and site function should be apparent. Variability is *presumed*, then, and the goal of this chapter is not to investigate whether or not functionally different kinds of sites occur, but to examine how variation is distributed among several apparent site classes. Special attention is given variability in the nature and location of domestic behavior (residentiality), since residential sites can inform about the structure and organization of groups using the quarries.

Several methods for examining differences in assemblage composition across predetermined site classes are employed to advance arguments about functional variability and to assess whether various residential modes appear to correspond with different modes of lithic procurement.

Organizational and Archaeological Attributes of Alternative Residential/Mobility Strategies

Chapter 3 proposed that alternative toolstone procurement techniques (encounter procurement, surface collection, quarrying, and retrieval) were accompanied by both variable return rates and variable opportunity costs, and that certain organizational strategies might be employed to affect these favorably. Such strategies include shifting mobility and residential options and altering labor organization. Several mobility and procurement options are available to toolstone collectors (cf. Chapter 4, especially Figure 19). They may gather toolstone during regular foraging activities (an encounter pattern); they may collect toolstone from within the diurnal range of an existing residential base (a diurnal pattern); they may move the residence to the toolstone source for a short-term toolstone collecting foray (a short-term residential pattern); they may move the residence to the vicinity of toolstone, convenient to other non-toolstone resources, for an extended stay (a longer-term residential pattern); or they may dispatch special-task groups to toolstone sources some distance from the residence (a logistical pattern). Quarriers may, in fact, integrate several of these options when conditions warrant.

These procurement strategies suggest specific archaeological expectations about the nature and locations of residences or of associated residential activity (cf. Chapter 4). These alternative scenarios are depicted in Figure 255 and are reviewed in Table 218.

Recognizing and ascribing such hypothetically differentiated site assemblages to any one of these scenarios is problematic. Given the time depth of the archaeological record at Tosawihi, these strategies may not appear distinct, but we expect that traces of at least the more visible scenarios (logistical, short-term, and longer-term residential use) may be detected. *Observed* variability is examined below.

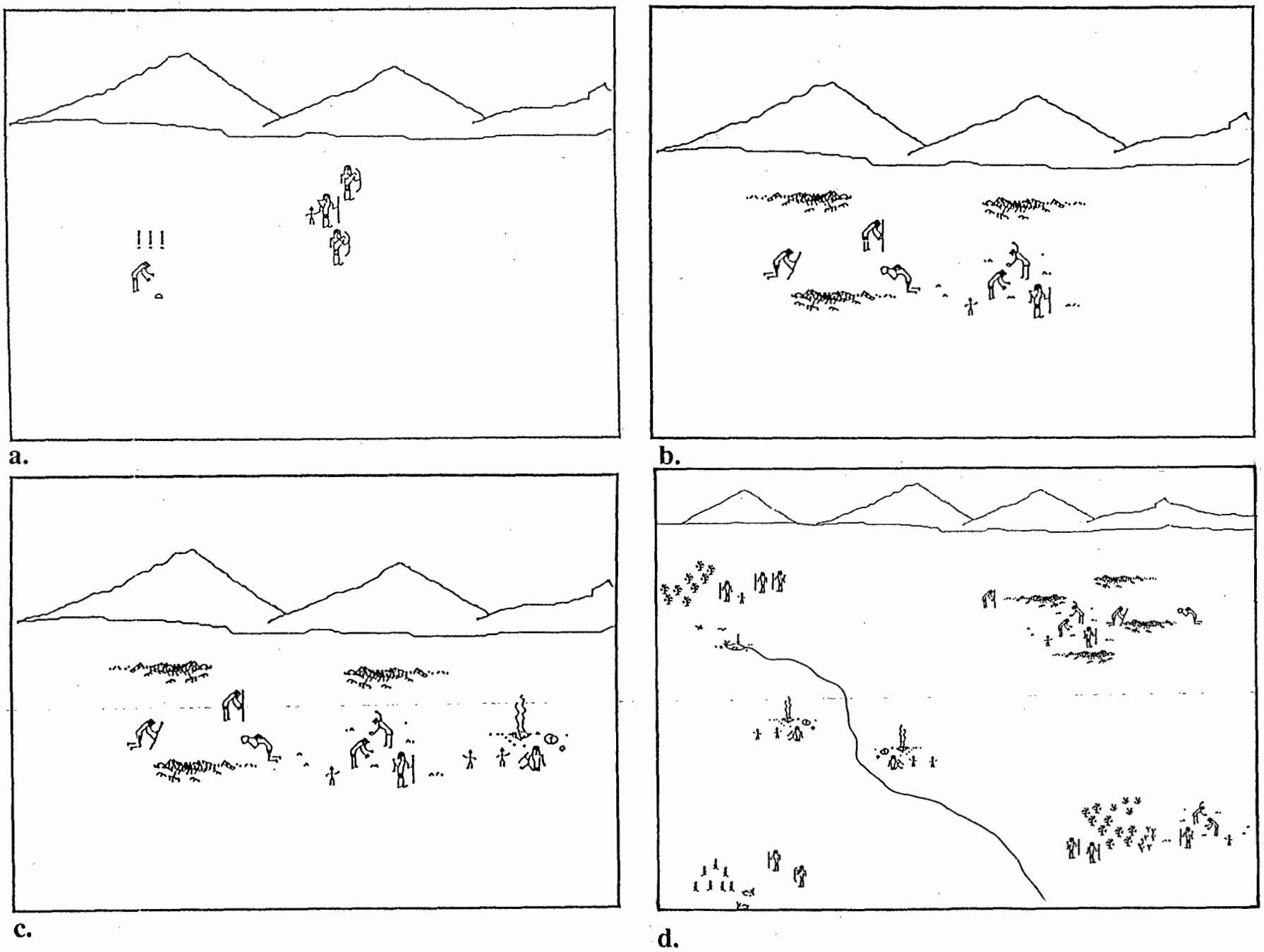


Figure 255. a. Encounter procurement of raw materials during the course of foraging; b. diurnal quarrying from off-quarry residence; c. short-term residential or logistical use of a quarry locale; d. long-term residential use of the quarries—quarrying activities and resource procurement are segregated from residence location. (Cartoons courtesy of R.G. Elston).

Table 218. Alternative Tosawihi Lithic Procurement Strategies and Hypothesized Organizational Attributes.

Lithic Procurement Strategy	Relative Opportunity Costs	Relative Mobility Level	Group Size/Composition	Location of Domestic Activities	Intensity of Domestic Behavior	Relative Assemblage Diversity Expected
Encounter	low	high	small family foraging group	off-quarry	--	low
Diurnal	moderate	moderate	small family or task groups	off-quarry	--	low
Short-term Residential	low	moderate-high	small family foraging group	at or very near quarry	ephemeral	low
Long-term Residential	low-high depending on season of residential move	low-moderate	single or multiple families and small task groups	near quarry: primarily convenient to water and a mix of food patches; secondarily to toolstone	moderate-high	moderate-high
Logistical	low-high depending on season	low-moderate	small task groups	at or very near quarry	ephemeral	low

Site Typology

In the previous chapter, differences in site assemblage variety were evaluated relative to sample size, and a pervasive relationship between the two variables was demonstrated. Still, there remained unexplained that variability ascribable to functional differences in the way humans behaved on the landscape. To review, two axes of assemblage variation were defined relating to domestic maintenance and lithic extraction and production (cf. Chapter 23, especially Figure 252). This framework requires closer examination; it will be used here to evaluate differences in sites and how they are integrated into a system of maintenance and quarrying/tool production.

The seventy-six sites (excluding 26Ek3032, Locality 93, an isolated millingstone) investigated by testing and data recovery are segregated by a simple typology that discriminates sites and assemblages containing on-site lithic sources and quarrying features, reduction debris or features, and domestic equipment (this and other tool classes are defined in Chapter 23). The resulting site classes include quarrying locales, reduction locales, and residential locales (reduction or quarrying complexes that also contain domestic equipment, designated domestic reduction sites and domestic quarries, respectively; cf. Table 219).

Table 219. Definition of Principal Site Classes.

Site Classes	Reduction Debris	Quarrying Features/ Lithic Source	Plant Processing Equipment
Reduction Locales	+		
Quarrying Locales	+	+	
Residential Locales			
Domestic Reduction Sites	+		+
Domestic Quarries	+	+	+

+ Indicates presence of assemblage item or feature

The distribution of site classes across Tosawihi subareas is conditioned largely by toolstone availability, topography (particularly broad, flat places suitable for extended stays), and reliable water sources. The Eastern Periphery contains almost twice as many outcrop quarries and four times as many quarry pit sites as the Western Periphery, and encompasses all rockshelters and isolated milling stations. Lithic reduction scatters and reduction complexes are nearly evenly split between the Eastern and the Western Peripheries, and *only* such scatters and complexes are found in the Northern Corridor.

The East, with its broadly distributed toolstone sources, contains 56% of the quarrying locales and 100% of the domestic quarries (Table 220; Figure 256). Forty-two percent of the domestic reduction sites lie in the West, compared to 32% in the East and 26% in the Northern Corridor. In addition to being more abundant in the West, domestic reduction sites are considerably more extensive there, revealing complex site structures that signal repeated, long-term occupations.

Table 220. Distribution of Site Classes Across Tosawihi Subareas.

	Northern Corridor (row %)	Eastern Periphery (row %)	Western Periphery (row %)	Total
Domestic Quarries	-	7 (100%)	-	7
Domestic Reduction Sites	5 (25%)	6 (32%)	8 (42%)	19
Quarrying Locales	-	9 (56%)	7 (44%)	16
Reduction Locales	3 (9%)	16 (47%)	15 (44%)	34
Total	8	38	30	76

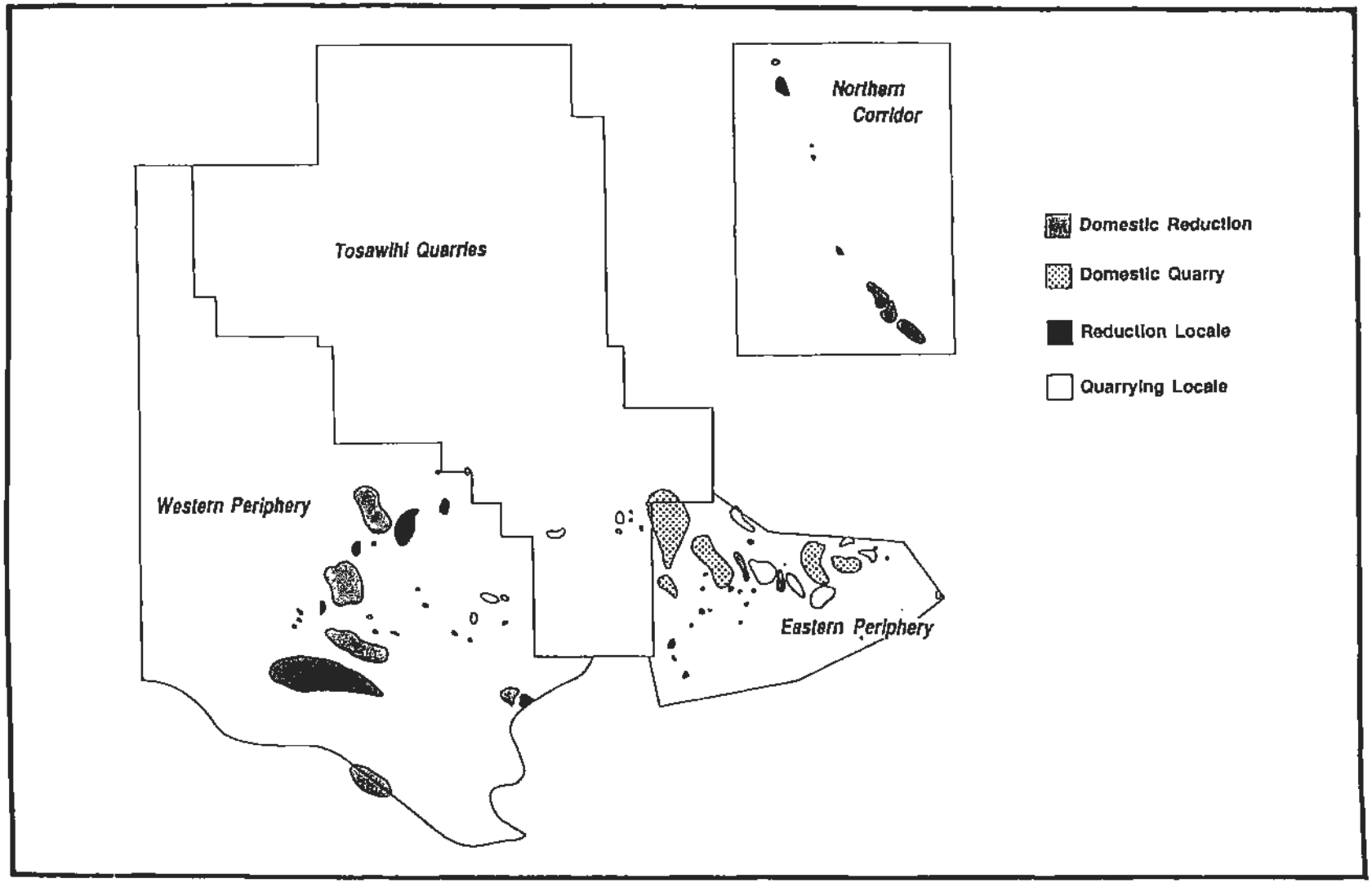


Figure 256. Distribution of principal site classes across Tosawihi Subareas.

Quarrying Locales (n=16)

Locations of natural toolstone deposits and lithic extraction—including cobble deposits, outcrop quarries (Figure 257), and quarry pits—range in scale from the massive, 4-meter deep deposits of opalite quarrying debris at 26Ek3208 (Figure 258a) to shallow depressions found elsewhere. These sites contain quarrying tools such as boulder-sized hammerstones and, where preservation is excellent, perishable quarrying implements like bone or antler wedges and scapula scoops (Figure 258b). Ash and charcoal lenses from bedrock fires are common, as are primary fabricating/processing by-products (e.g., cores, modified chunks, and early stage bifaces) from blocks, slabs, and flake blanks. Most debitage at quarrying locales consists of early stage reduction, since blanks, cores, and bifaces usually are reduced in bulk at the quarries for transport to other locales. The distribution of functional tool classes across quarrying locales is shown in Table 221.

Table 221. Assemblage Composition of Quarrying Locales.

Site No.	Site Type	Area (m^2)	Features (n)	Quarrying Equipment	Weapons	Fabricating/ Processing By-products	Fabricating/ Processing Tools	General Utility Tools	Domestic Equipment	Volume Excav. (m^3)
Subarea: East										
26Ek3032/23	QP	30	1	1	6	57	16	26	-	0.060
26Ek3032/25	OQ	2,250	7	-	-	75	6	24	-	0.240
26Ek3032/98	OQ	900	1	-	-	6	1	3	-	0.200
26Ek3191	OQ	6,600	1	-	1	3	1	5	-	0.080
26Ek3193	OQ	3,610	7	-	-	10	1	11	-	0.140
26Ek3195	QP	9,425	8	2	-	23	3	17	-	0.023
26Ek3197	QP	4,556	11	-	-	26	1	8	-	0.665
26Ek3200	QP	242	1	1	-	7	1	4	-	0.015
26Ek3203	OQ	8,230	-	-	-	7	-	-	-	0.075
Subarea: West										
26Ek3082	OQ	300	3	-	-	-	-	-	-	0.000
26Ek3083	OQ	2,000	-	-	-	-	-	-	-	0.000
26Ek3084	OQ	4,250	2	1	-	2	1	6	-	0.010
26Ek3085	QP	1,178	8	-	-	-	-	2	-	0.000
26Ek3104	OQ	600	-	-	-	5	-	7	-	0.025
26Ek3207	OQ	1,200	-	-	-	-	-	-	-	0.000
26Ek3208	QP	10,367	10	-	1	-	3	6	1[a]	0.000[b]

QP = Quarry Pit
OQ = Outcrop Quarry

[a]Ornamental bone beads only
[b]Backhoe Trenches only



Figure 257. Opalite outcrop used as toolstone source.



Figure 258. a. Backhoe trench at 26Ek3208, revealing deep deposit of opalite quarrying debris; b. bison scapula scoop, located under photo (scale) in deposit of quarry debris.

Reduction Locales (n=34)

Reduction locales are the archaeological remains of lithic (usually biface) reduction episodes. They range from small, discrete, shallow scatters of debitage (Figure 259) representing single reduction events to large, multi-feature complexes (Table 222). Two such locales (26Ek3177 and 26Ek3202) lie within Eastern Periphery rockshelters. Reduction assemblages tend to be dominated by the by-products of fabricating and lithic processing (especially debitage and shatter), with bifaces and cores predominating. The occurrence, however, of weapons (projectile points) and certain general utility tools (particularly various flake tool forms) suggests a broader diversity of processing activities at some reduction stations (cf. discussion below). Analyses presented elsewhere in this volume have demonstrated that when these locales fall relatively near the heart of the quarries, early stages of toolstone reduction and biface forms are typical; farther from the quarries, late stage bifaces and debris are more common (cf. Chapters 6, 10, and 25).

Table 222. Assemblage Composition of Reduction Locales.

Site No.	Area (m^2)	Features (n)	Hearths	Weapons	Fabricating/ Processing By-products	Fabricating/ Processing Tools	General Utility Tools	Volume Excav. (m^3)
Subarea: East								
26Ek3032/20	200	3	-	1	12	2	15	0.140
26Ek3032/21	100	1	-	-	16	1	2	0.270
26Ek3032/22	5	1	-	-	8	-	1	0.300
26Ek3172	2420	6	-	-	1	-	5	0.160
26Ek3173	530	4	-	2	4	2	7	0.865
26Ek3175	90	1	-	-	-	-	-	0.000
26Ek3177	70	1	-	2	2	-	2	0.100
26Ek3178	910	4	-	3	7	-	4	0.100
26Ek3179	110	2	-	-	-	2	3	0.260
26Ek3180	12	1	-	-	-	-	-	0.000
26Ek3183	90	1	-	-	-	-	3	0.300
26Ek3186	185	2	-	-	-	-	1	0.000
26Ek3187	40	1	-	-	-	-	-	0.000
26Ek3188	95	1	-	-	-	-	-	0.000
26Ek3189	1,320	4	-	-	2	-	-	0.000
26Ek3202	8	1	-	-	2	-	1	0.250
Subarea: West								
26Ek3086	1,100	-	-	-	4	2	-	0.000
26Ek3087	300	-	-	-	4	-	-	0.000
26Ek3088	650	-	-	-	2	1	-	0.000
26Ek3090	150	-	-	-	2	1	2	0.450
26Ek3091	400	-	-	-	3	-	1	0.000
26Ek3093	1,875	6	+	2	15	1	25	1.070
26Ek3097	500	-	-	-	-	-	-	0.000
26Ek3099	750	4	-	1	2	-	7	0.000
26Ek3100	5,850	2	-	-	1	-	-	0.040
26Ek3101	11,250	-	-	1	6	2	15	0.740
26Ek3102	2,400	5	-	1	7	-	6	0.160
26Ek3107	6,750	5	-	1	3	-	2	0.092
26Ek3114	100	1	-	1	4	2	3	0.200
26Ek3115	100	1	-	-	3	2	5	0.200
26Ek3116	200	1	-	6	4	5	8	0.240
Subarea: North								
26Ek3231	2,100	1	-	1	1	-	1	0.080
26Ek3232	1,590	1	-	-	6	-	-	0.080
26Ek3234	4,200	-	-	-	2	-	-	0.040

+Hearth present



Figure 259. Shallow reduction scatter. Lower left quadrant has been scraped to two cm.

Residential Locales (n=26)

In hunter-gatherer settlement systems, "residences" typically are the places where a variety of economic and domestic pursuits come together, and where a variety of by-products reflect the residues of multiple maintenance and processing activities (Binford 1980:9; Thomas 1988:381). The assemblages at Tosawihi residential locales are distinguished by the residues of tool production, tool maintenance, and food processing (Table 223), discarded in varying degrees of intensity. And there is often a high incidence of lithic heat-treatment, a relatively time-intensive process that can be engineered easily during down-time in camp (cf. Chapters 6 and 10).

The presence of millingstones in any quantity guarantees membership in this site category. At Tosawihi, millingstones occur overwhelmingly in the context of other things—in clusters of multi-purpose features and tools reflecting functions beyond field food processing. In such contexts, then, plant processing signifies a commitment to time and place, a convening of equipment at a particular location, task differentiation, and very probably a relatively extended stay. The convergence of these phenomena defines "residentiality" in the Tosawihi environment.

Residential locales may exhibit the structured use of domestic space. 26Ek3092, for example, hosts a central boulder (cf. Figure 114a) that served as a long-term focal point for various activities, resulting in some 24 overlapping features, and 26Ek3095 contains multiple, functionally-differentiated surface features (cf. Chapter 16). Too, sites reoccupied over many episodes may exhibit complex aggregates of seemingly unrelated debris, as camp maintenance activities and the displacement of work areas over time contributed to vertical and horizontal reorganization of debris.

Biface caches are most common in, though not exclusive to, residential sites, which also often contain hearths (Figure 260) or ashy concentrations, multiple tool maintenance and reduction features, preserved subsistence remains, occasional evidence of ceramic vessel use, and sometimes relatively large numbers of millingstones.

Table 223. Assemblage Composition of Residential Locales.

Site No.	Area (m^2)	Features (n)	Hearths	Biface Caches	Quarrying Equipment	Weapons	Fabricating/ Processing By-products	Fabricating/ Processing Tools	General Utility Tools	Domestic Equipment	Volume Excav. (m^3)
Subarea: East											
26Ek3032/19	10	1	-	-	-	-	33	12	39	1	0.160
26Ek3170	31,000	14	-	+	-	11	119	23	96	2	8.500
26Ek3171	7,540	8	-	-	-	2	52	7	64	2	7.560
26Ek3174	590	2	-	-	-	-	-	-	1	1	0.000
26Ek3181	235	1	-	-	-	-	1	-	9	2	0.520
26Ek3184	11,309	26	-	+	-	7	94	30	216	2	4.880
26Ek3185	910	7	-	-	-	8	19	9	11	1	0.440
26Ek3190	4,241	11	-	-	-	9	33	9	24	1	0.865
26Ek3192	3190	5	-	+	-	16	98	32	132	9	15.840
26Ek3196	11,800	7	-	-	-	-	21	2	11	1	0.400
26Ek3198	12,724	26	+	-	-	27	42	4	53	1	7.010
26Ek3201	2,474	4	-	-	-	-	19	2	12	2	0.310
26Ek3204	60	1	-	-	-	6	68	12	36	1	0.900
Subarea: West											
26Ek3092	4,800	24	+	-	-	37	245	48	286	14	26.560
26Ek3095	15,000	25	-	+	1	36	190	26	260	27	12.396
26Ek3096	14,250	7	-	-	-	-	11	-	4	1	0.080
26Ek3106	5,175	7	+	-	-	2	31	4	17	1	1.100
26Ek3149	2,500	3	-	-	-	3	5	1	7	2	0.330
26Ek3160	46,000	25	+	-	-	58	175	35	578	20	15.130
26Ek3165	4,500	2	-	-	-	3	25	3	54	4	5.550
26Ek3271	19,500	22	-	-	-	23	160	24	193	6	1.940
Subarea: North											
26Ek3228	4,750	2	-	-	-	-	2	-	5	1	0.250
26Ek3237	42,000	5	+	-	-	45	88	14	118	9	18.250
26Ek3238	22,500	2	-	-	-	5	14	1	17	1	0.850
26Ek3239	12,800	1	-	-	-	2	10	3	23	1	0.210
26Ek3251	15,000	6	-	-	-	45	102	16	77	18	11.075

+Hearth or biface cache present

Residential assemblages are more likely to contain exotic raw materials: 92% manifest multiple raw materials (including obsidian, basalt, and other materials), compared to only 36% of the non-residential assemblages. Even more striking is the distribution of obsidian across residential and non-residential locales (Table 224). Imported to the quarries from substantial distances, obsidian arrived from a broad territory well beyond the boundaries of the Tosawihi vicinity (cf. Chapter 19). Residential sites yield obsidian assemblages in far greater proportions than non-residential locales (Figure 261), and contain, as well, a wider representation of distant obsidian sources in their reduction debris (cf. Appendix N).

Table 224. Obsidian Sources Represented in Tosawihi Assemblages.

Residential Locales	Non-Residential Locales
•Bordwell Spring, Nevada	•Brown's Bench, Nevada
•Brown's Bench, Nevada	•Paradise Valley, Nevada
•Double H Mtns., Nevada	•Pinto Peak, Nevada
•Fox Mtn., Nevada	•Unknown Source A
•Majuba Mtn., Nevada	
•Pinto Peak, Nevada	
•Paradise Valley, Nevada	
•Malad, Idaho	
•Timber Butte, Idaho	
•Unrecognized Source	
•Unknown Source A	
•Unknown Source B	
•Unknown Source C	
•Unknown Source D	
•Unknown Source E	
•Unknown Source F	



Figure 260. Hearth at 26Ek3092.

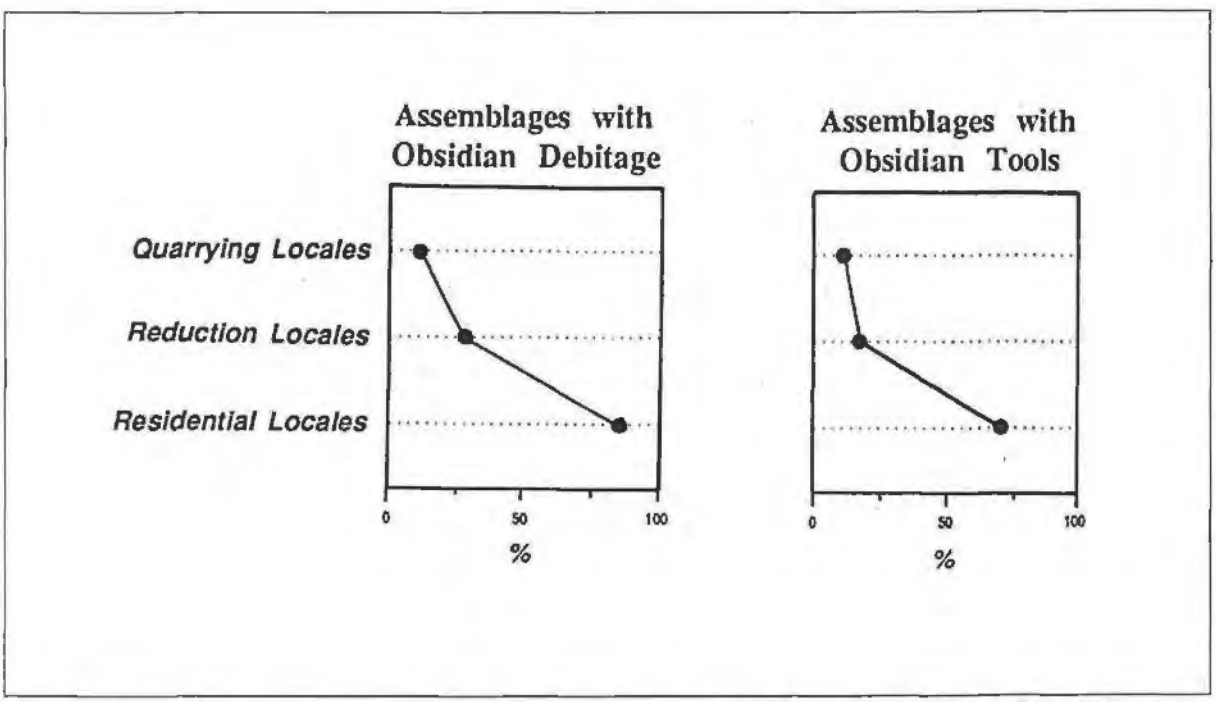


Figure 261. Proportions of sites, within site classes, with obsidian debitage and obsidian tools.

Domestic Reduction Sites and Domestic Quarries as Residential Subclasses

Turning now to how residentiality intersects with quarrying behavior, the chief economic pursuit at Tosawihi, some of the internal variability witnessed among residential localities must be highlighted. Recall that sites with domestic equipment were segregated further on the basis of quarrying features; those with quarrying debris were designated domestic quarries, those without, domestic reduction sites. Domestic reduction sites exhibit the most overt signs of residentiality (chiefly, relatively large numbers of millingstones, ceramics, and functionally-diverse features; cf. Table 225). Domestic quarries maintain high tool diversity and density reflecting a variety of activities, yet they reveal far more ephemeral domestic use; domestic equipment, such as groundstone and ceramics, appears only in isolated occurrences, in only one or two features, or in non-feature contexts.

Table 225. Assemblage Composition of Residential Locales, by Subclass.

Type	Site No.	Subarea	Domestic Equipment	General Utility Tools	Fabricating/ Processing Tools	Fabricating/ Processing By-products	Weapons	Quarrying Equipment
Domestic Reduction Sites								
	26Ek3092	West	14	286	48	245	37	-
	26Ek3095	West	27	260	26	190	36	1
	26Ek3096	West	1	4	-	11	-	-
	26Ek3106	West	1	17	4	31	2	-
	26Ek3149	West	2	7	1	5	3	-
	26Ek3160	West	20	578	35	175	58	-
	26Ek3165	West	4	54	3	25	3	-
	26Ek3174	East	1	1	-	-	-	-
	26Ek3181	East	2	9	-	1	-	-
	26Ek3185	East	1	11	9	19	8	-
	26Ek3190	East	1	24	9	33	9	-
	26Ek3192	East	9	132	32	98	16	-
	26Ek3204	East	1	36	12	68	6	-
	26Ek3228	North	1	5	-	2	-	-
	26Ek3237	North	9	118	14	88	45	-
	26Ek3238	North	1	17	1	14	5	-
	26Ek3239	North	1	23	3	10	2	-
	26Ek3251	North	18	77	16	102	45	-
	26Ek3271	West	6	193	24	160	23	-
Domestic Quarries								
	26Ek3032/19	East	1	39	12	33	-	-
	26Ek3170	East	2	96	23	119	11	-
	26Ek3171	East	2	64	7	52	2	-
	26Ek3184	East	2	216	30	94	7	-
	26Ek3196	East	1	11	2	21	-	-
	26Ek3198	East	1	53	4	42	27	-
	26Ek3201	East	2	12	2	19	-	-

The marked visibility of domestic equipment at domestic reduction sites (compared to its relatively low densities at domestic quarry sites) is accounted for largely by multiple and prolonged reoccupations of favorable locations (cf. Conclusions, below). These sites are usually close to a significant water source, and this feature in a relatively dry upland was, no doubt, a seductive attractor for the location of sustained residential activities. As well, several economic advantages often converge in these locations—comfortable resting spots for toolstone reduction, reliable sources of hammerstones, predictable root crops, access to game watering areas—so the repeated use of these locations is expected (cf. Binford 1980:9; Thomas 1983b:427).

Evaluation of Site Class Variability

The basic typology of sites for the Tosawihi system has been defined; below, we explore how well the principal site classes hold up under scrutiny, and investigate some of the variability within and among them. In the previous chapter, the effects of sample size on assemblage variety were explored in some detail. The relationship between tool type richness and assemblage size bears brief reiteration here, as the recognition of assemblage diversity is critical to discussions of site function. Typically, small assemblages with low richness are interpreted as diurnal use locales; moderately sized and moderately diverse assemblages as short-term, logistical field camps; and larger, more diverse assemblages as residential bases (Thomas 1988:381).

When we examine the relationship between tool type and tool class richness (cf. Chapter 23), several patterns emerge (Figure 262). First, the four principal site classes (reduction locales, quarry locales, domestic quarries, and domestic reduction sites) are segregated cleanly by mean assemblage sizes. Thus, it appears that they are distinct from each other, at least in terms of size. However, this pattern is a function both of the intensity with which tools were discarded across site types (a behavioral phenomenon) and of our own collection strategies; we excavated significantly more volume, and thus retrieved more rare items, on residential sites than on other kinds of sites.

Second, the power of assemblage size to predict richness is revealed; as assemblage size increases, so do tool type and class richness. Assemblages of reduction and specialized quarry locales are considerably smaller and contain fewer classes of tools. Standard deviations around mean assemblage size for these sites are rather large, indicating considerable internal variability in the numbers of tool classes they contain; this also suggests some internal functional differentiation, explored below. Assemblages of domestic quarries and domestic reduction sites reveal higher mean tool type and class richness, restricted variability in the number of tool classes, and considerably more internal variability in tool types. That is, though individual tool types are variable, they are merely repetitive members of a few functional tool classes.

The linear relationship between tool type and tool class richness across site classes confirmed by Figure 262 suggests that absolute assemblage variety is not a particularly good measure of site complexity. Analyses that investigate *relative* assemblage variety and assemblage *composition* are more informative of site class variability. Thomas (1988:381) and others have posited that the relative degree of variety revealed between site classes within a single settlement system may inform importantly about site function. Different functional uses of the landscape may produce groups of assemblages with variable slopes (slope coefficients of the richness:size regression (cf. Chapter 23 and Figure 235).

We can use these relationships to model expectations about Tosawihi. Diurnal use areas (equivalent to Tosawihi quarrying and reduction locales) typically were targeted at limited tasks, and should produce relatively homogeneous assemblages resulting from a limited number of tool types being discarded repetitively. Such assemblages will be depicted by a low richness:size slope coefficient. Logistical base camps, though short-term, encompass more diverse activities and therefore more diverse discard patterns, and should reveal a steeper richness:size slope. The steepest slope coefficient should characterize those places used longest and witnessing the widest variety of activities and tool discard patterns (residential sites; cf. Chapters 4 and 23; Thomas 1988:381). Tosawihi assemblages might be expected to follow similar patterns, given specific expectations about assemblage composition and breadth of tool classes (Table 226).

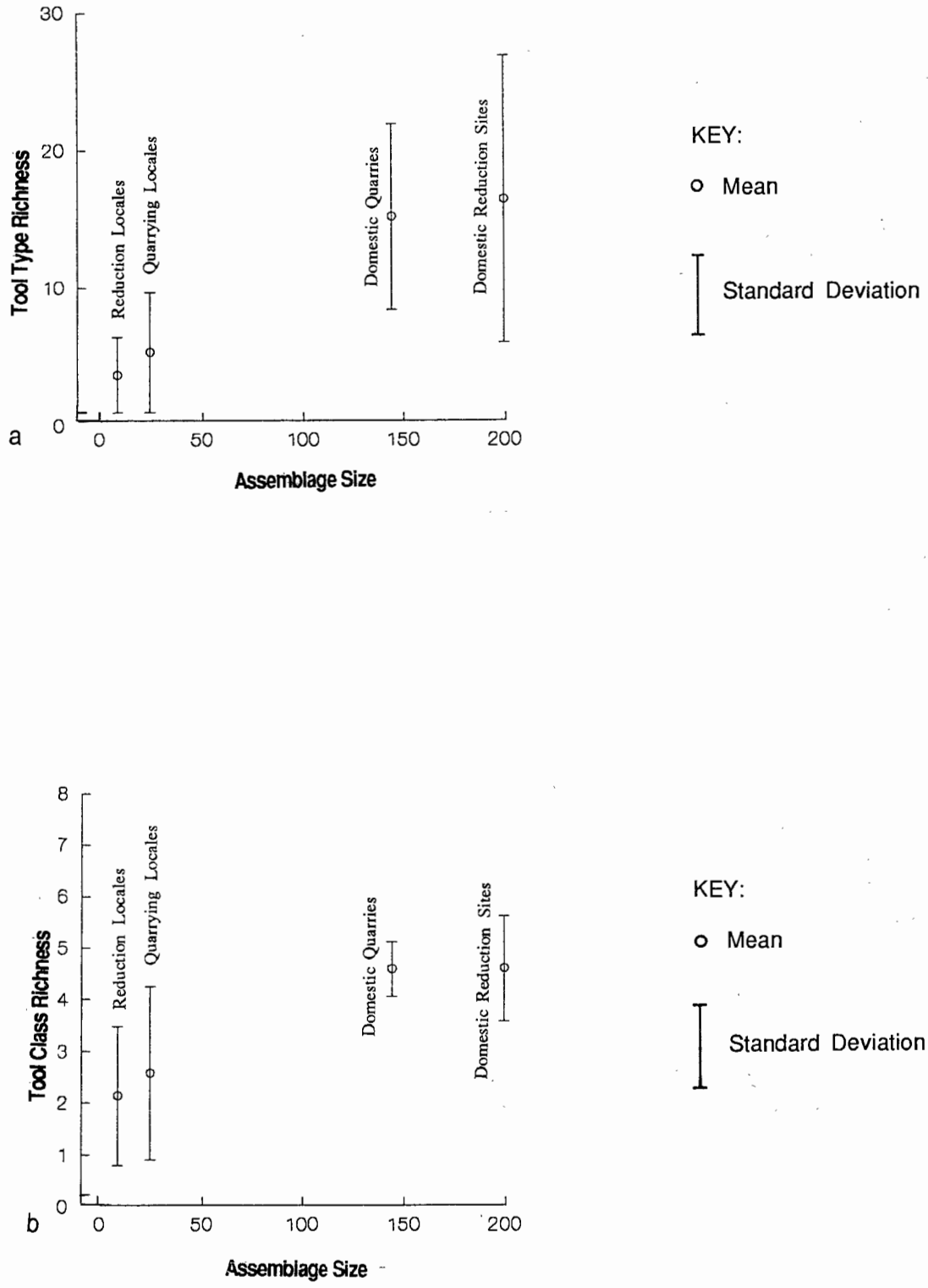


Figure 262. Mean tool type richness:assemblage size; b. mean tool class richness:assemblage size.

Table 226. Expected Site Class Assemblage Components.

	Domestic Equipment	Weapons	General Utility Tools	Quarrying Equipment	Fabricating/ Processing Tools	Fabricating/ Processing By-products
Domestic Quarries	+	+	+	+	+	+
Domestic Reduction Sites	+	+	+		+	+
Quarrying Locales				+	+	+
Reduction Locales			+		+	+

Domestic quarries should reveal the steepest slope (and the highest regression coefficient) since they are expected to contain the broadest number of tool classes, comprised of debris of disparate residential activities (domestic equipment) as well as reduction tools and debris and quarrying equipment. Domestic reduction sites should be somewhat less diverse (since they lack quarrying activities), reflecting a somewhat flatter, yet still quite steep slope. Reduction stations should reveal a significantly flatter slope still, and finally, quarry locales should have the flattest of all (they should contain the least diverse assemblages, reflecting redundant extraction and processing activities).

The Tosawihi regression slope lines for log tool type richness:log assemblage size (Figure 263) reveal a substantial (and expected) disparity in assemblage variability across site classes, but show a surprising lack of congruence with the expected pattern detailed above (Table 227 provides regression coefficients for principal Tosawihi site classes).

Table 227. Regression Coefficients for Tosawihi Site Class Assemblages (log Tool Type Richness: log Assemblage Size).

Site Class Assemblage (n)[a]	Slope *b*	Correlation *r*
Domestic Quarries (n=7)	.56	.98[b]
Domestic Reduction (n=19)	.47	.99[b]
Reduction Locales (n=29)	.66	.89[b]
Quarry Locales (n=13)	.42	.78[c]

[a] some cases excluded due to missing data
[b] significantly different from zero (at p<.001)
[c] significantly different from zero (at p<.01)

The steepest slope is represented by reduction locale assemblages, indicating the greatest relative variety of all site classes. Domestic quarries and domestic reduction sites are intermediate in slope, and, as predicted, quarrying locales are the least diverse. Reduction stations, rather than representing single-purpose, homogeneous assemblages, are characterized by considerable assemblage variability. As their assemblages increase in size, assemblage variety increases more rapidly than for all other site classes.

This reduction locale pattern has several behavioral implications: (1) multiple, functionally-differentiated uses of single locations may have increased the average (overall) mean tool type richness, (2) multiple reoccupations of single loci, though each may have consisted of special-purpose activity sets, appear diverse in the aggregate, (3) resources exploited, group composition, or artifact byproduct histories may have been highly variable over

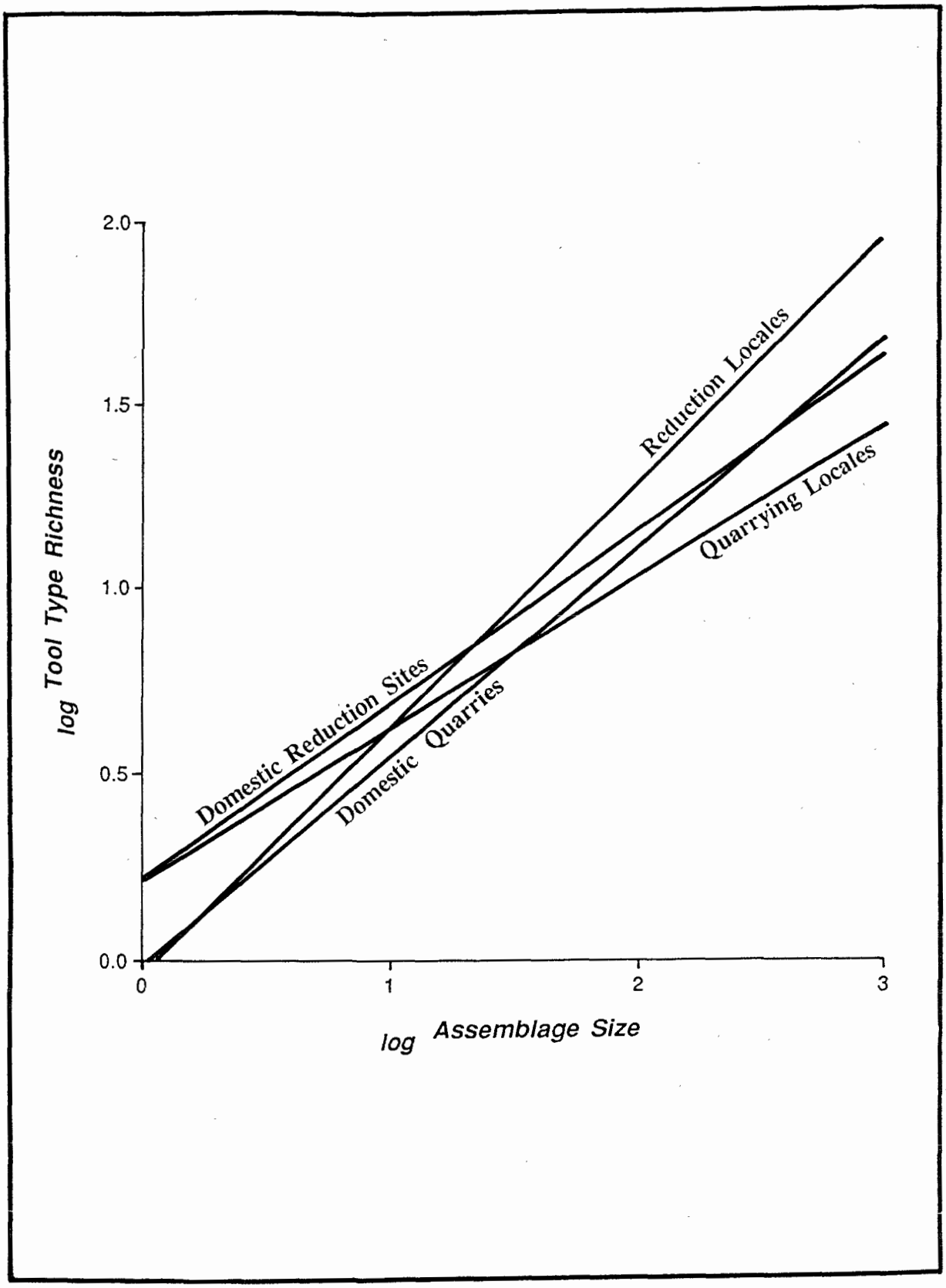


Figure 263. Regression of log tool type richness to log assemblage size, all site classes.

time (Thomas 1988), producing a class of highly differentiated sites, and (4) some reduction sites actually may represent scenes of short-term domestic activities, not recognized archaeologically because they lack groundstone. Without intensive analysis of feature-level data and good internal chronological control, the first three possibilities are impossible to address. However, the potential of some reduction sites to represent unrecognized domestic sites is a testable proposition.

Two aspects of assemblage composition within reduction locales (functional tool class frequencies and biface stage frequencies across subareas) were examined more closely for spatial/functional variability. The intent was to discover whether proximity to quarries (sites falling in the Eastern Periphery) or proximity to large domestic sites (sites falling in the Western Periphery and the Northern Corridor) affect assemblage characteristics.

In the first analysis, summed frequencies of weapons, fabricating/processing by-products (cores, preforms, and early stages of bifaces), fabricating/processing tools, and general utility tools (tools used in a wide variety of activities, including varieties of flake tools, late stage bifaces, and bone tools) were cross-tabulated by subarea (Figure 264). Low expected frequencies of tools in the Northern Corridor reduction locale assemblages (33% of the cells contained expected frequencies of fewer than 5) made application of the chi-square test inappropriate. We then combined frequencies of tools into groups shown in Chapter 23 to co-vary commonly (i.e., weapons were combined with general utility tools and fabricating/processing by-products with fabricating/processing tools). A chi-square result of 5.83 (with 2 degrees of freedom) did not exceed the critical chi-square value of 5.99 (at .05), thus no significant association could be demonstrated between tool groupings and geographical subareas. Analysis of adjusted standardized residuals (Everitt 1977; cf. Chapter 10) is not strictly appropriate given this chi-square result, but the analysis suggested a pattern of unexpectedly low weapon/general utility tool frequencies and unexpectedly high fabricating/processing tool and byproduct frequencies in the Northern Corridor.

This suggestive pattern was born out by a Kolmogorov-Smirnov Two-Sample Test conducted between pairs of subarea assemblage aggregates (Figure 265). Only one pair of

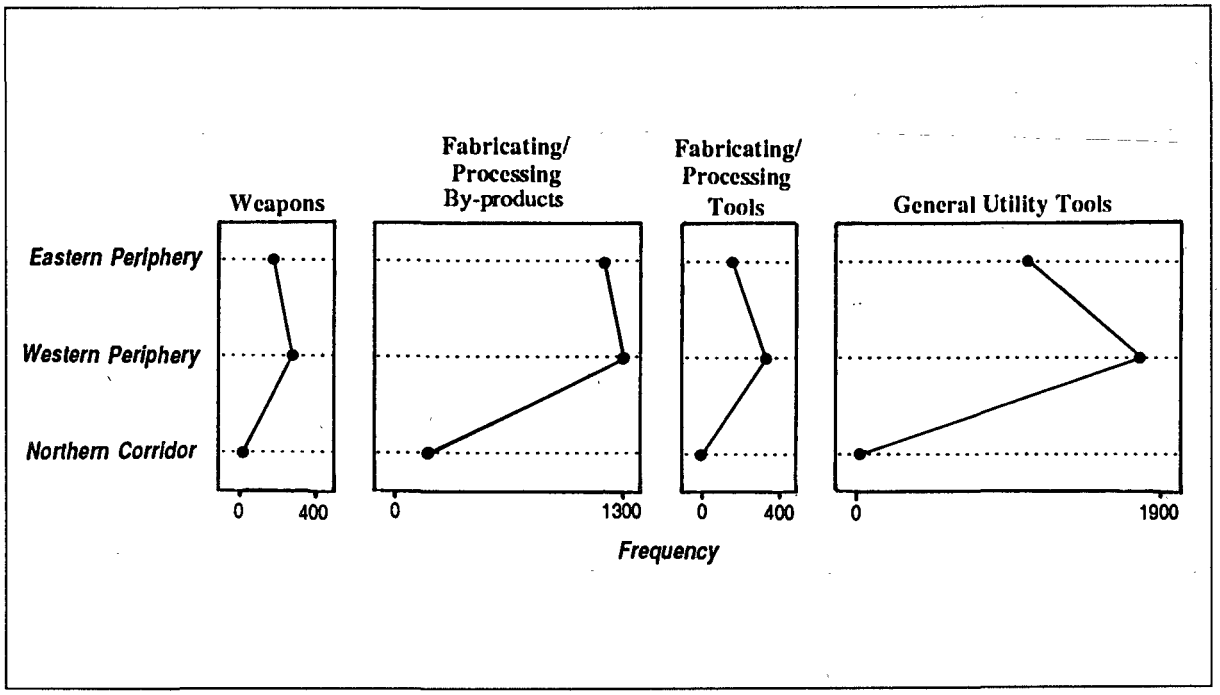


Figure 264. Frequencies of functional tool classes, across Tosawihi Subareas, reduction locale assemblages (n=34).

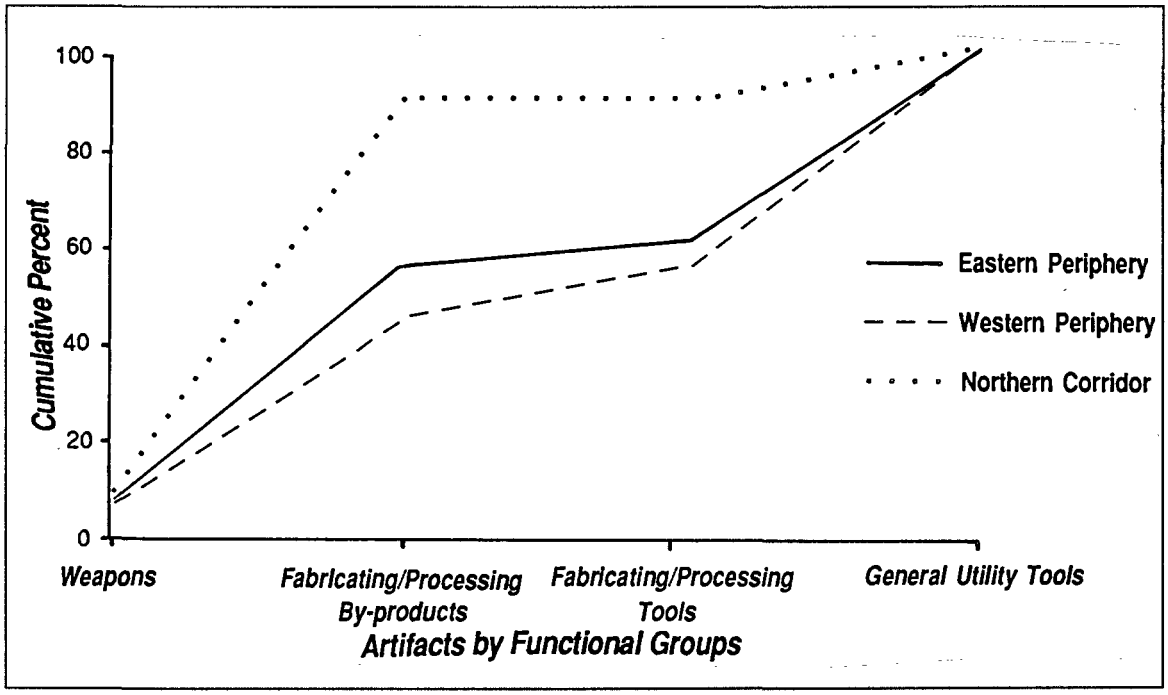
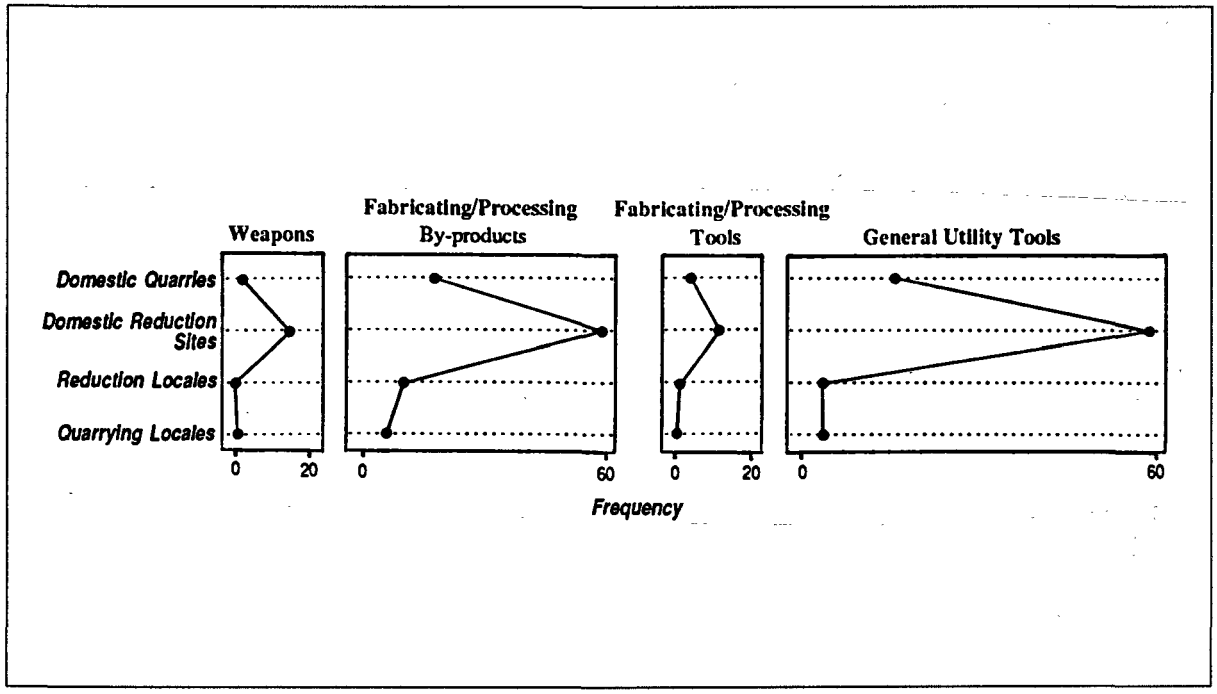


Figure 265. Cumulative proportions of functional tool classes, across Tosawihi Subareas, reduction locale assemblages (n=34).

combined assemblages, the Northern Corridor and Western Periphery residential locales, revealed a significant (*D*max=.46, *D*crit=.43, at p=0.05, n1=11, n2=163) difference in the proportions of functional tool classes. This result at first is surprising, since domestic reduction sites lie close to reduction locales in both these areas. Yet Northern reduction locales have relatively more fabricating/processing by-products and relatively fewer general utility tools and appear to be somewhat more specialized, with less evidence of other processing/maintenance activities. Reduction activities in the Northern Corridor may be integrated with other activities (as when they are components of multi-function domestic sites) *or* they may be spatially segregated, with reduction occurring away from multi-function sites. The Eastern and Western reduction locale assemblages look very similar, reflecting comparable trajectories of lithic production (substantial quantities of processing by-products), as well as maintenance activities (revealed by significant proportions of general utility tools and weapons) *co-occurring* with reduction episodes. The comparison of fabricating/processing bifaces (Stage 3.4 and earlier) and general utility bifaces (Stage 3.5 and later) from reduction locales failed to reveal significant patterning across subareas (chi-square = 5.923, $.05 < p < .10$).

A cluster analysis performed on *non-reduction* locales incorporating major tool types and flake tool sub-types failed to reveal any striking *within*-class site clusters. This suggests that there is more variation across site classes than within them, and that our pre-defined site classes segregate well and are relatively consistent internally.

An analysis of differences in functional tool class composition among principal site classes was undertaken next (Figure 266). Excluding domestic equipment (primarily millingstones, the most obvious domestic signal) and quarrying equipment (our rarest tool class) enabled us to evaluate how different the remaining assemblages really are. A chi-square test result of 113.93 (with 9 degrees of freedom; $p < .001$) revealed a significant association between tool classes and site classes. That is, they are not independent phenomena. Analysis of adjusted standardized residuals (Everitt 1977; results shown in parentheses) showed several classes of data to co-occur more frequently than expected under conditions of random association: weapons



Figue 266. Frequencies of functional tool classes across site classes (n=76).

(4.65) and general utility tools (4.62) at domestic reduction sites, and fabricating/processing by-products (8.51) at quarrying locales. These results are entirely expected; domestic reduction sites (arguably occupied longer than specialize quarrying locales) are an appropriate functional context for the deposition of tools used in a variety of food processing and maintenance tasks (cf. Chapters 20 and 23). Quarrying locales, on the other hand, the scenes of primary toolstone extraction, are likely repositories for the debris from early stage stone tool production. Other tool classes are less common than expected within site classes: weapons at domestic quarries (-3.19) and quarrying locales (-3.92), fabricating/processing tools (-2.32) and by-products (-6.0) at domestic reduction sites, and general utility tools at quarrying (-7.1) and reduction locales (-2.42).

All possible pairs of site classes were evaluated by K-S test for significant differences in proportions of tool classes (weapons, fabricating/processing by-products, fabricating/ processing tools, and general utility tools) (Figure 267). Significant differences in the proportions of tool classes within summed assemblages were revealed between domestic quarries and quarrying locales (Dmax=.18, Dcrit=.08, at p=0.05, n1=998, n2=382), domestic reduction sites and quarrying locales (Dmax=.19, Dcrit=.07, at p=0.05, n1=3664, n2=382), and domestic reduction sites and reduction locales (Dmax=.09, Dcrit=.08, at p=0.05, n1=3664, n2=287).

This analysis allows the important observation that a differential (probably residential) "effect" is pervasive in other tool classes, *even when millingstones are removed from the assemblages*. Domestic reduction sites differ from reduction locales and domestic quarries differ from quarrying locales not just because they contain milling equipment, but because the suites of activities producing the assemblages were distinctive.

It is interesting, as well, that the proportions of remaining functional tool classes are not significantly different between the two kinds of residential sites. Though these site classes occur in quite different settings (cf. Figure 256; Chapter 25), and generally offer quite different facilities and resources, apparently the variety of production and maintenance activities that took place upon them varied only slightly.

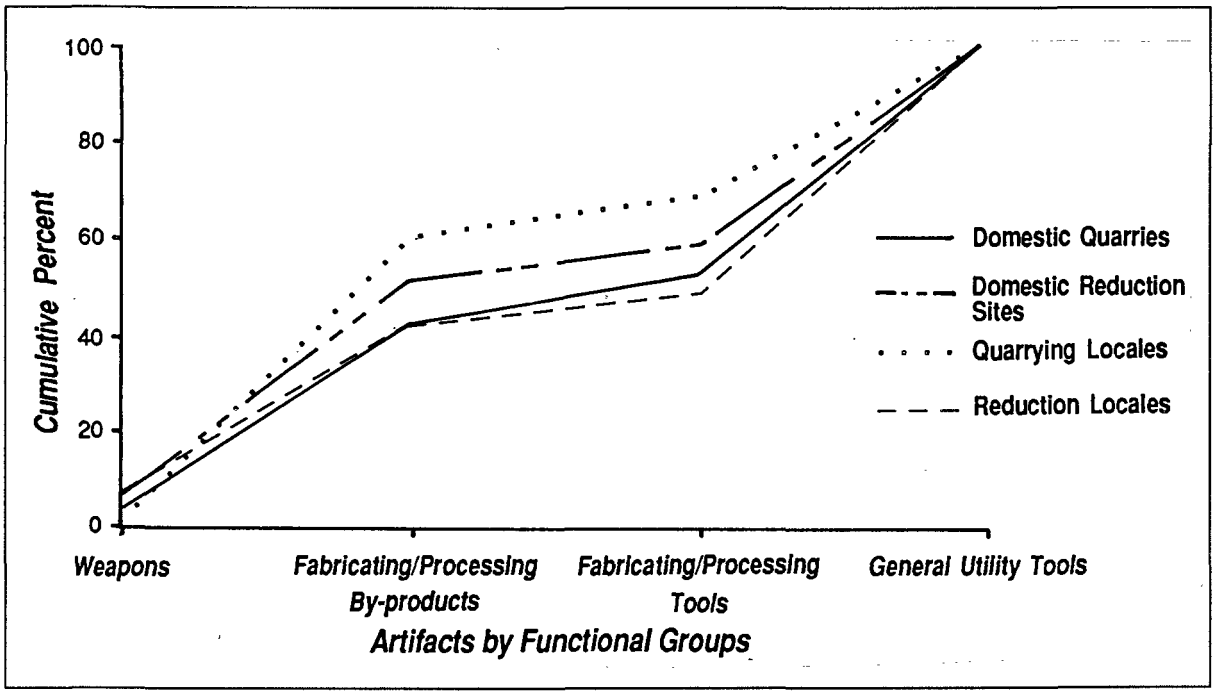


Figure 267. Cumulative proportions of functional tool classes across site classes (n=76).

Confirming the results of the standardized adjusted residuals analysis presented above, residential sites were shown to contain somewhat more general utility tools, more weapons, and slightly fewer fabricating/processing by-products than do quarry and reduction locales. The lower frequencies of these by-products at residences indicate emphasis on later stages of toolstone reduction. A closer examination of biface assemblages confirms this pattern (Figure 268). There is a significant difference in the proportions of fabricating (early stage) bifaces (Stages 1 to 3.4) and general utility (late stage) bifaces (Stages 3.5 to 5) across several site categories (domestic quarries and quarrying locales--*D*max=.31, *D*crit=.10, at p=0.05, n1=663, n2=251; domestic reduction sites and quarrying locales--*D*max=.35, *D*crit=.09, at p=0.05, n1=2421, n2=251; quarrying locales and reduction locales--*D*max=.29, *D*crit=.13, at p=0.05, n1=251, n2=177). Residential sites contain more late stage bifaces than early ones, while quarrying locales, where fabrication and initial lithic reduction are primary activities, reveal substantially more early stage bifaces. In the aggregate (across the entire study area), reduction locales contain almost equivalent proportions of early and late stage bifaces. It has been shown elsewhere in this volume, however, that when analyzed in smaller subsets (e.g., across Tosawihi subareas) reduction locales contain internal biface stage variability accounted for by distance from the central quarries (cf. Chapters 4, 6, and 25).

Additional exercises were undertaken to evaluate the validity of the primary site typology and to identify between-class differences, including a stepwise discriminant analysis to investigate both how well our site typology was replicated by multivariate analysis and to discover if any tool types are particularly powerful discriminators among site classes. For the discriminant analysis, artifact frequencies were converted to presence/absence data to ameliorate the persistent problem of differential sampling and large assemblage size variation. Several patterns were particularly informative:

(1) When millingstones and ceramics, our chief domestic indicators, were removed from the analysis and flake tool subtypes substituted as discriminating variables, sites still were correctly identified more than 76% of the time. Sixty-three percent of the domestic reduction sites and 86% of the domestic quarries were identified correctly, suggesting that, with the addition

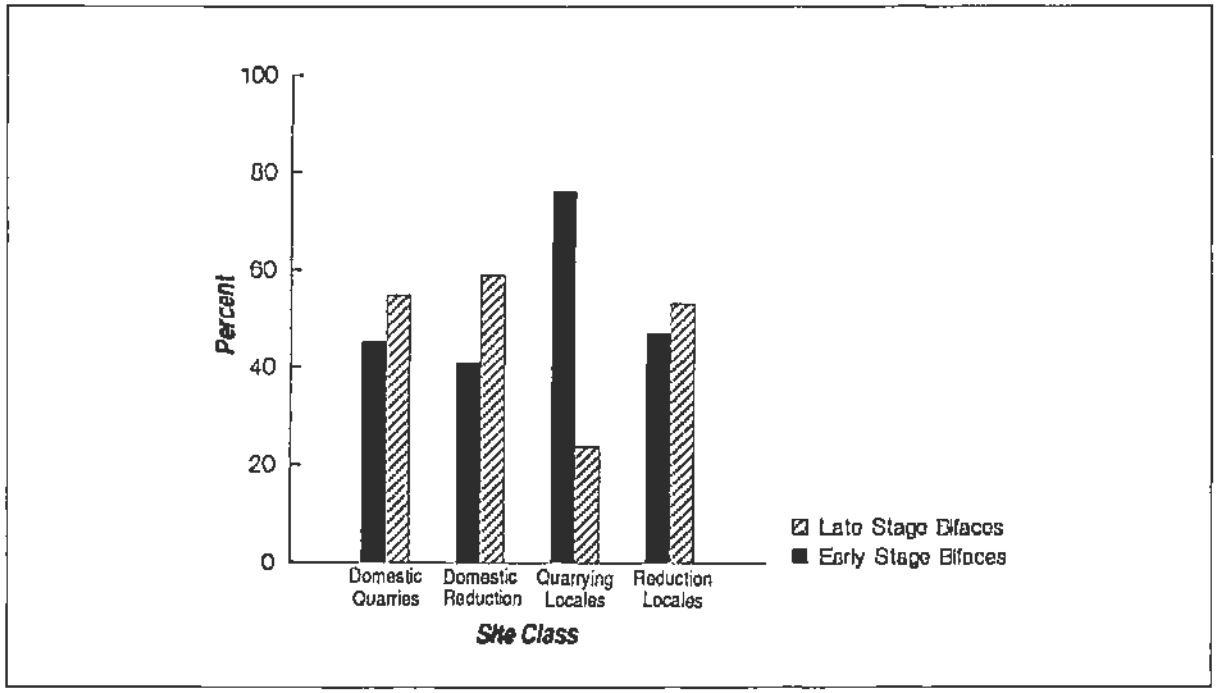


Figure 268. Relative proportions of fabricating (early stage) bifaces and general utility (late stage) bifaces across site classes.

of flake tool subtypes, discriminating power is substantial. Ninety-one percent of the reduction locales were classified correctly, signalling a higher internal consistency than previous analyses have indicated, and confirming the functional distinction between domestic reduction sites and reduction locales. Quarries, however, were segregated poorly.

(2) Removing flake tool subtypes caused classificatory accuracy to plunge for domestic reduction sites (to 36.8%) and quarrying locales (to 25%). Relatively rare flake tool subtypes, then, are very sensitive indicators of domestic site variability. However, 100% of all domestic quarries were correctly assigned to class, emphasizing the differentiation between domestic quarries and quarrying locales.

(3) Particularly powerful discriminators include percussion/cobble tools, preforms, points, crudely retouched flakes, microdenticulates, bone tools, notched denticulates, general utility bifaces, and miscellaneous retouched flakes. To explore this result further, we undertook a K-S test of the proportional contribution of these selected tool types to site classes, ordered by their entry into the discriminant functions. Domestic quarries are significantly different from domestic reduction sites (Dmax=.08, Dcrit=.06, at p=0.05, n1=552, n2=2292), chiefly in the higher relative proportion of projectile points on the latter. Domestic quarries and quarrying locales (Dmax=.21, Dcrit=.13, at p=0.05, n1=552, n2=139), domestic reduction sites and quarrying locales (Dmax=.21, Dcrit=.12, at p=0.05, n1=2292, n2=139), and quarrying locales and reduction locales (Dmax=.21, Dcrit=.16, at p=0.05, n1=139, n2=149) also vary significantly in their tool type proportions.

The graphed relative proportions of these tool types, compared across site classes, provide singular profiles (Figure 269). Quarrying locales are particularly distinctive, with higher proportions of bone tools (though these are still quite rare), notched denticulates, percussion/cobble tools, and miscellaneous retouched flakes, suggesting a suite of tools functionally related to toolstone extraction. Also notable is the lack of preforms, projectile points, and general utility (later stage) bifaces; domestic quarries and domestic reduction sites,

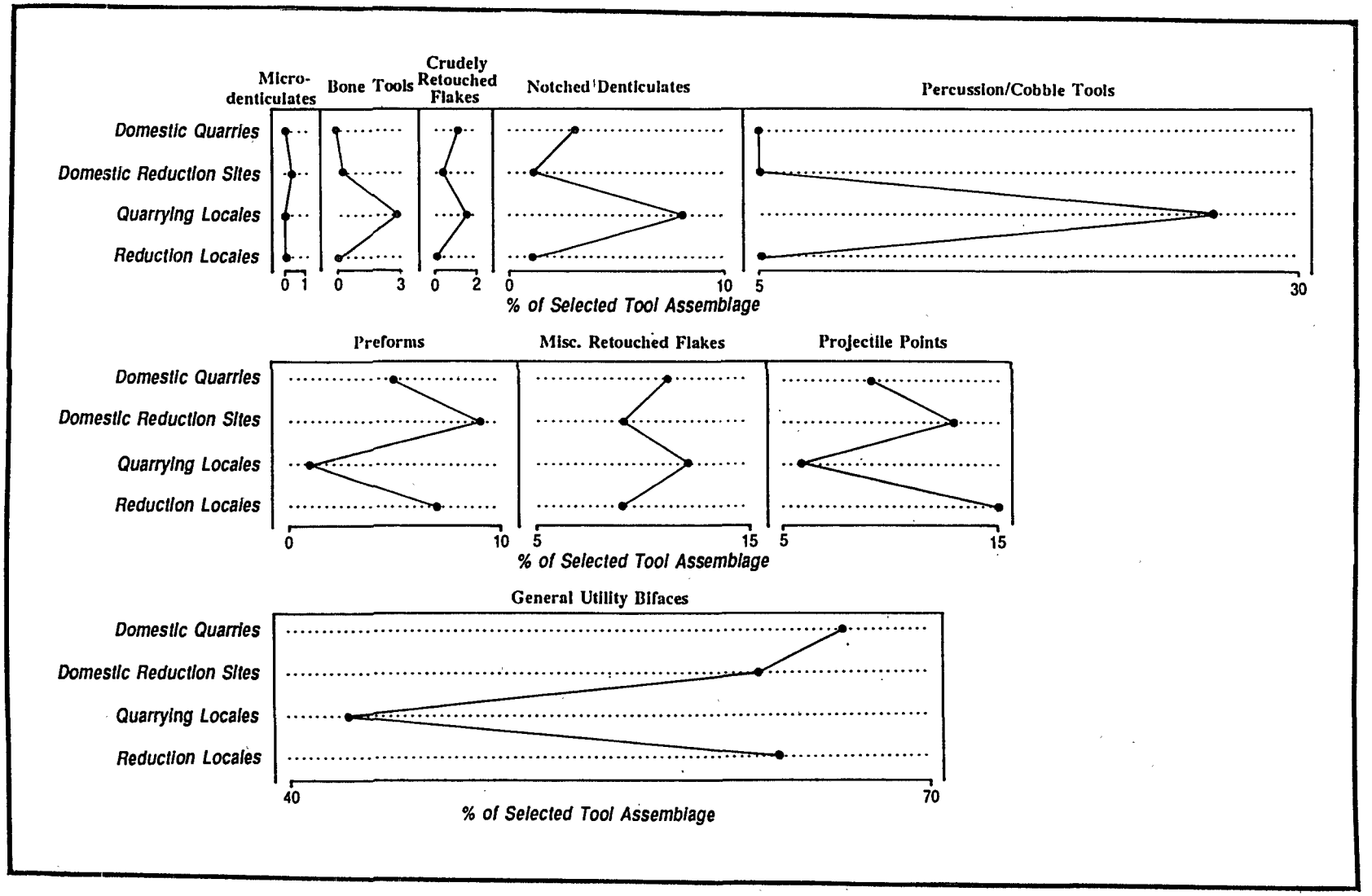


Figure 269. Relative proportions of discriminating tool types across site classes.

on the other hand, are repositories for these tool types. Weapons and late stage bifaces, then, were not discarded commonly where people conducted relatively narrow activities (e.g., at quarrying locales). However, as domestic exercises (indicated by millingstones and ceramics) were added to the repertoire of other activities, and as more time was spent, several classes of tool types such as preforms, projectile points, and general utility bifaces were added.

As presented in Chapter 7, flake tool variety and sample size are related linearly. Because we invested considerably more time in the excavation of potential residential sites than in special-purpose locales, and retrieved comparatively larger assemblages, it is not surprising that we recovered a higher diversity of flake tools from them. Nonetheless, when we examine the relative proportions of flake tools *within* assemblages, and compare these *across* site types, we see a marked, sample-size independent, difference in assemblage components. In particular, comparatively high proportions of flake tools make up assemblages at domestic locales. Figure 270 plots the graphic proportional contributions of flake tools to the total assemblages of each site class.

Figure 271 depicts the contribution of specific flake tool types to entire flake tool assemblages. Specifically, domestic sites have a higher mean proportion of pointed tools and retouched flakes in their assemblages than do reduction and quarrying locales. Because such tools are used for a wide range of perforating, boring, drilling, grooving, cutting and scraping functions (cf. Chapter 7), it is not surprising that these activities should be carried out more often in the context of multiple domestic routines.

Discussion and Conclusions

An understanding of site function is critical for understanding regional settlement study patterns. Variability in the archaeological record implies variability in behavior, and if we are attempting to define organizational strategies and long-term changes in them, we must be able to sort out variable poses on the landscape that resulted from these organizational modes.

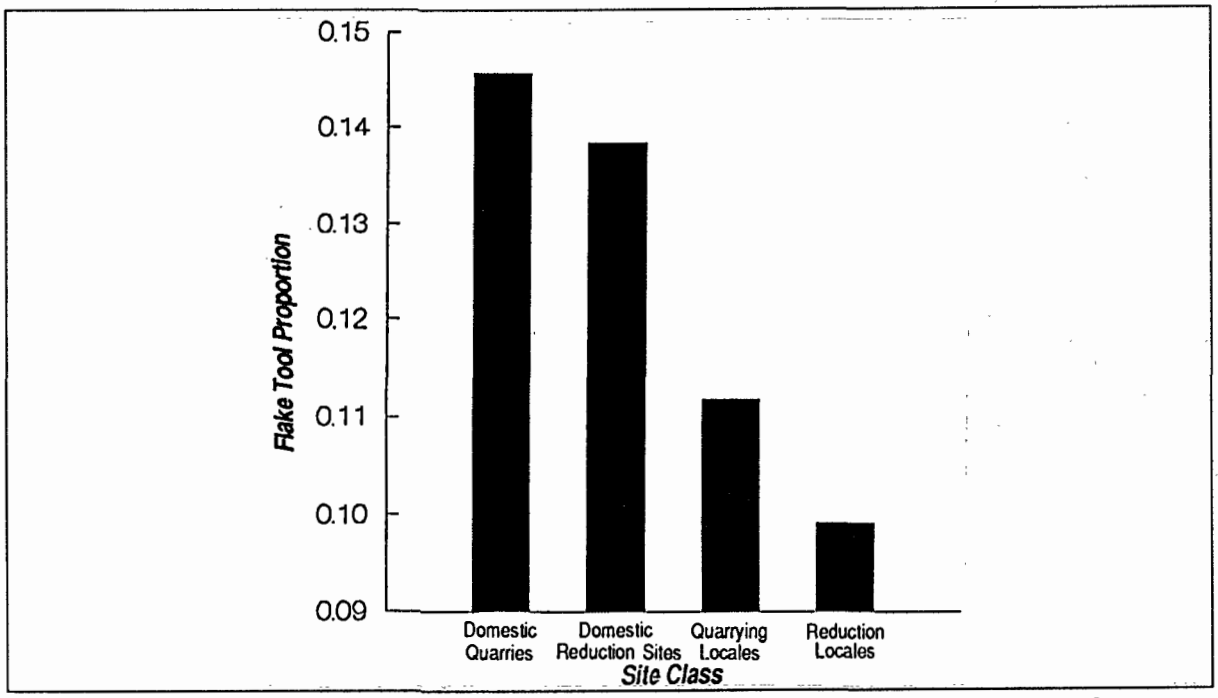


Figure 270. Proportional contribution of flake tools to total assemblages across site classes.

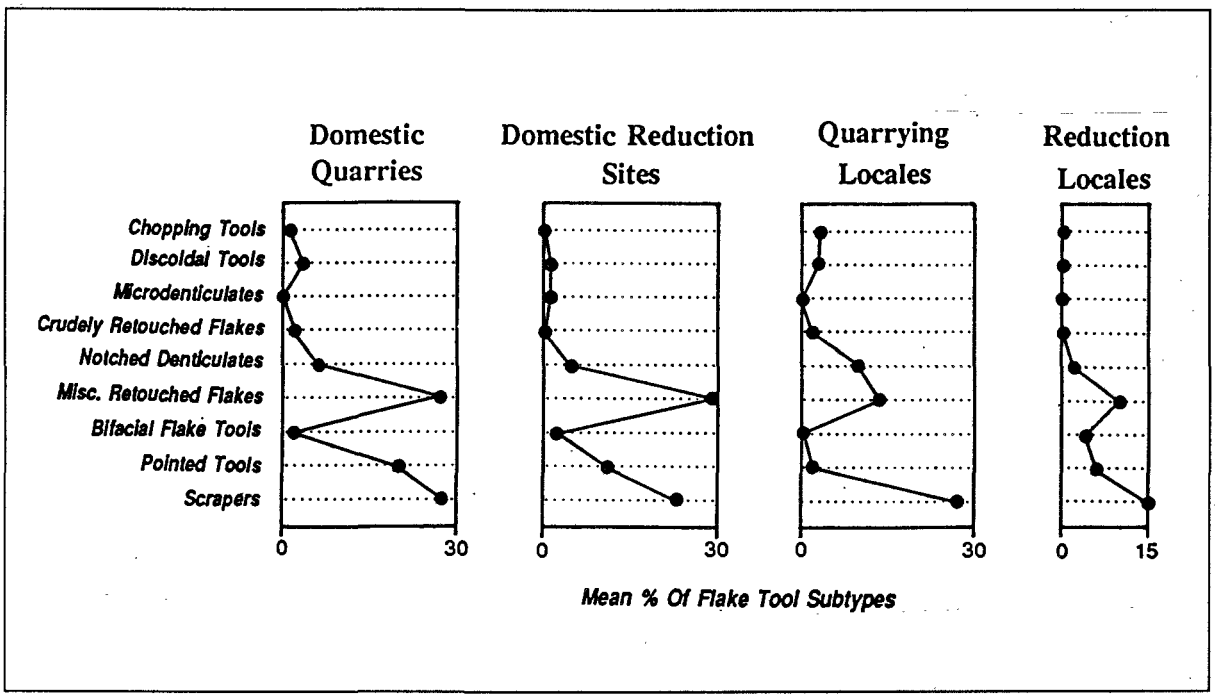


Figure 271. Mean proportions of flake tool types comprising flake tool assemblages across site classes.

In Chapter 4, we argued that opportunity costs incurred during toolstone procurement can be reduced in several ways, including positioning activities so that travel costs are minimized, and segmenting the organization of labor, so that only a few individuals or task groups are removed from foraging opportunities. How were these alternative strategies realized at Tosawihi? We have recognized two dimensions of residentiality at Tosawihi, the ephemeral domestic behavior at or near toolstone sources (domestic quarries) and the more visible reoccupations of off-quarry locales favorably located near water and food resource patches (domestic reduction sites). Each pose represents efforts to accommodate cost-minimizing strategies.

In the case of domestic quarries, transport costs are minimized (the camp is established directly on the toolstone source) and bifaces are prepared for transport. Placing a short-term residence or a logistical camp on a toolstone source represents a highly efficient spatial strategy when time spent at the quarries can be minimized. Food resources at Tosawihi are poor enough, even in the most productive seasons, that if group size and time at Tosawihi *can* be limited, they *should* be. Because time at the quarries is short, it is not necessary to place residences convenient to any particular food resources; small food supplies can be packed in and groups need not invest substantial time maintaining themselves while there. Activities are located near toolstone sources, and little time or energy is expended in travel or transport.

For longer-term stays at the quarries, however, such a strategy is exceedingly risky and costly, given the spatial structure of food resources. Opportunity costs while camping on a toolstone source increase significantly the longer the stay, since one may be isolated from other life-supporting resources.

When energy and time spent at Tosawihi are extended, then, possibly by high toolstone demand, decreased access to other toolstone sources, or constrained territorial movements, it pays to adopt a different residential strategy, involving residential groups moving into the vicinity of the quarries during food-rich seasons and establishing longer-term residential bases

off-quarry. A relocated residential group engages in intensive toolstone extraction as one activity among numerous other domestic routines (cf. Figure 255d). Quarrying is undertaken diurnally by part of the residential group, while others are foraging for food to support an extended stay. Concerns for propinquity to water and food resources, as well as to toolstone sources, dictate the placement of the residence. Diurnal collecting trips requiring no encampment at the quarries would, of course, leave no significant domestic signature on toolstone sources.

Representing this strategy, most domestic reduction sites are relatively far from toolstone sources, their location being conditioned more by the distribution of water and food resources. Lithic cores and bifaces are transported to them where they subsequently are prepared for further transport.

To summarize, where residential assemblages co-occur with toolstone sources, we suggest we are seeing evidence either of logistically-organized task-group or short-term residential group exploitation of the quarries (these alternative modes are indistinguishable in the archaeological record). The second residential strategy (heavily represented in the Western Periphery and Northern Corridor) is illustrated by domestic reduction sites, which reveal very different locations and organization. An extended residential stay in the Tosawihi vicinity and the disjunct nature of support resources required strategic positioning of residence and task groups with regard to *both* food and toolstone patches.

Thus, the enactment of longer-term residential use (with bases located convenient to multiple resources) vs. logistical or short-term residential use (with bases located only to ease toolstone access) is conditioned by external phenomena which may have dictated the need to acquire other resources concurrently with toolstone procurement.

Adoption of a longer-term residential lithic procurement strategy may have been an appropriate response to various external conditions, including an increased need to intensify toolstone collection (e.g., because of trade demands or regional constraints on movements to other toolstone sources). Evidence for the intensification of quarrying activity at Tosawihi has been presented in Chapter 19, and some confirmation of the phenomenon can be provided here (Figure 272). Although the attractive locations of domestic reduction sites have been favored from Pre-

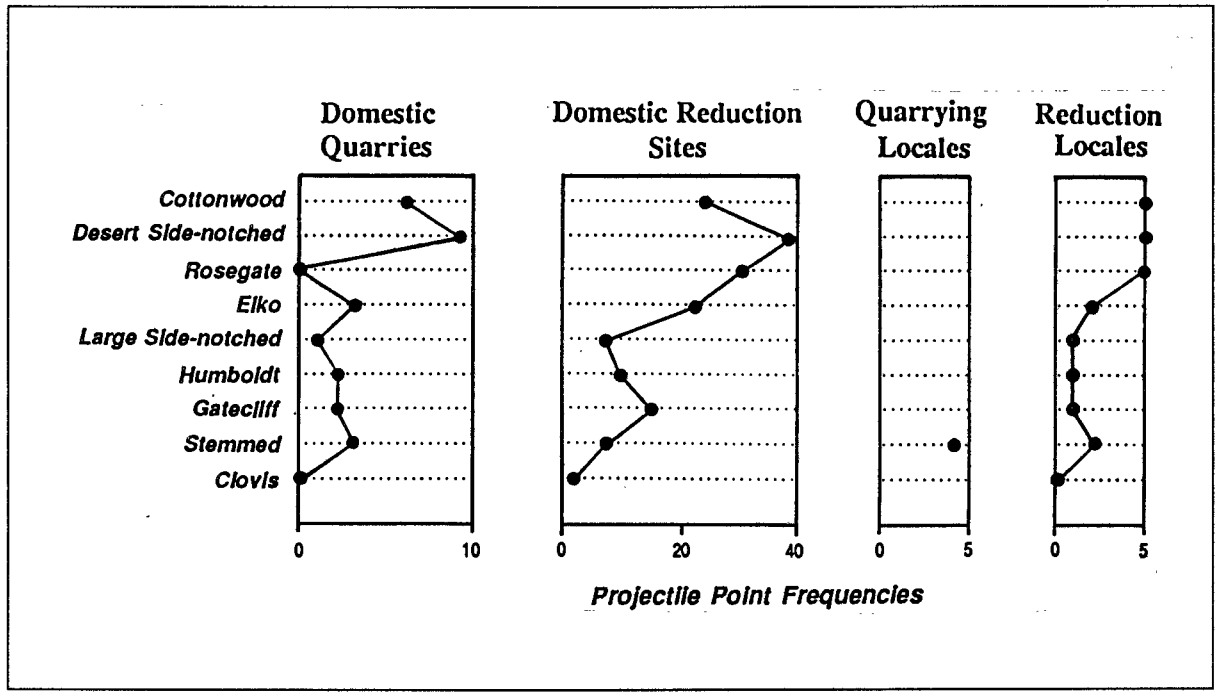


Figure 272. Frequencies of projectile points by site class.

Archaic times through the Late Archaic, over 70% of the time-markers at these "sweet spots" began to be deposited about 3250 BP, suggesting intensified use of the locations of domestic reduction sites after Elko series points were introduced.

Intensification of activity at the quarries has important implications for residential and mobility strategies. Once intensification began, cost-minimization concerns motivated quarriers to establish more centrally-located residential camps, enabling convenient access to plants and game in support of longer forays. The availability of water, game, and root crops on the West and in the North may account for the frequently reoccupied, aggregate sites we see in several of the later domestic reduction sites.

Chapter 25

SPATIAL RELATIONSHIPS

Christopher Raven

I placed a jar in Tennessee,
And round it was, upon a hill.
It made the slovenly wilderness
Surround that hill.
—Wallace Stevens

We assume that spatial structures observable in the archaeological record bear patterned relationships to the behavior that produced them. This assumption has fostered a burgeoning literature, largely ethnoarchaeological, of investigations of "site structure" (Binford 1978a, 1978b, 1982, 1983a; Gould 1980; Kent 1984; O'Connell 1987; O'Connell, Hawkes, and Blurton Jones 1991; Simms 1988; Yellen 1977a). The message of much of this literature has been cautionary, adumbrating *why* most such inquiry is conducted in ethnoarchaeological contexts; quite simply, it is vastly easier to understand spatial patterns of which the causal behavior has been witnessed than to infer causality from a sometimes taciturn archaeological record. The interpretive hazards conferred by the repeated use of places, by the mounting of multiple and often unrelated activities from a single hearth, by activities that intentionally reorganize spatial distributions (such as scavenging and the cleaning of living surfaces), and by the storm of taphonomic processes that begins to descend the moment after deposition all inhibit simple linear inferences about why things lie where they do.

At Tosawihi we have seen all these hazards at play, but we believe there remains an important residue of patterning within aggregations of things that can inform us usefully about the spatial organization of prehistoric behavior at the quarries. We are concerned here particularly with patterns discernible in *sites*, since those are the principal spatial frames of reference within which virtually all our data were collected, and with some of the behavioral events that contributed to their placement on the landscape.

Assumptions and Analytical Conventions

Events are constituted always, and only, of interplays of matter, energy, space, and time (Raven 1985); observation of these properties suffices to describe any event, and no event transpires absent the coincidence of all of them. *Behavior*, consisting of patterned sequences of events, is measurable with reference to each. Archaeology reconstructs events that transpired in time past, during which some quantity of energy acted on some circumstance of matter in some context of space. And because often we are more concerned with behavior than with the events of which it is composed, we ask the archaeological record to disclose recurrences in the ways that matter, energy, space, and time came into play.

But archaeological data consist chiefly of packages of matter deposited in spatial contexts, from the study of which we infer the temporal and energetic histories effecting their conditions and locations. In the present report we dwell at length on circumstances of *matter* (the physical data classes of the archaeological record) in Part II, on circumstances of *space* (the distributions and locations of pieces of the record) in Part III, and on inferences of the systematics of *time* and *energy* (how and when things got to be where they are, in the conditions they exhibit) in Part IV; in the chapter at hand, we are concerned particularly with synthesizing our archaeological observations on regularities of spatial patterning at Tosawihi, and with relating our observations to what we believe to have been some of the circumstances causing them to occur.

The various models discussed in Chapter 3 take as their common point of departure the economic assumption that successful expenditures of effort tend to be organized in ways that yield favorable ratios of benefit to cost. In the abstract, this can be accomplished severally; productivity can be enhanced by efficient strategies of procurement, processing, and redistribution of resources, while costs can be reduced by adjusting how time and energy are expended, how matter is manipulated, and how space is occupied. In real world situations, the possibilities are likely to be vastly more diverse, owing to the interplay of numerous subtly weighted variables. Too, we assume that in any system of work several strategies of economizing are likely to operate concurrently.

To approach the problem of understanding how effort may have been organized at Tosawihi, particularly with reference to the procurement, production, and transport of useful (beneficial) packages of toolstone, we formalized in Chapter 4 some expectations about how the archaeological record should look if various imaginable behavioral scenarios were played out. Among these are several explicit expectations about spatial relationships, all based on the principal of distance minimization as one among many viable economic strategies for reducing costs or enhancing productivity. Below, we examine our archaeological observations to test the reliability of these expectations, adopting for purposes of discussion some simple analytical conventions and definitions.

Location and Distribution

Spatial patterns are either intrinsic or non-intrinsic, i.e., they do or they do not have anything to do with variables of the field or environment in which they occur. Non-intrinsic patterns are independent of landscape attributes, and usually are defined by spatial relationships among members of a single class of phenomenon (e.g., bifaces, reduction stations, residential complexes) or among phenomena witnessed at the same scale of observation (e.g., artifacts, features, sites); we refer to such patterns as *distributions*. Distributions can be described with reference to distance and direction between equivalent members of the class, relative densities of members by area, and tendencies toward patterning in the arrangement of members. *Interpretation* of distributions, however, may require that we also invoke observations of dimension and make inferences about their hierarchical organization.

Intrinsic spatial patterns, on the other hand, are conditioned by various qualities of their environment, and their description requires identification of the environmental attributes on which they depend; we refer to them as patterns of *location*. Locational patterns come about when some aspect of the environment attracts or repels the placement of an activity; the occurrence of toolstone, water, and economically useful plants and animals are all likely to have served at Tosawihi as locational attractors of certain classes of activity, while various limiting factors (steepness of slope, barrenness of resources) may have repelled use of certain tracts. Additionally, however, other classes of cultural place-making (e.g., the placement of campsites, caches, permanent facilities, or prior episodes of quarrying) may have affected later locational decisions, and the explanation of observed patterns may require consideration of both natural and cultural attributes of the immediate environment.

Units of Analysis

We looked at spatial patterns in the Tosawihi record on two principal levels of abstraction. In the first place, we inquired how *sites* are distributed relative to one another and how the locations of various functional categories of site may have been influenced by intrinsic attributes of the cultural and natural landscape. We were concerned especially with

trying to determine the degree to which the geographies of various categories of work may have interdepended. In the second place, we wanted to look at the internal structure of those clusters we identified as "sites" in order to evaluate the degree to which activities within them were patterned discriminately, so we paid particular attention to the distribution and location of *features*; an intentional by-product of this inquiry was to test the utility of site boundaries for segregating meaningful aggregates in the archaeological record.

In all these inquiries we have adopted the geographer's convention of representing our data classes as spatially discrete points within a field, a concession to the utility of point pattern analysis for signalling patterned spatial relationships (Boots and Getis 1988). In certain cases (for instance, in treating hierarchical arrangements of sites and features) we have considered factors such as dimension (e.g., area) as well, but these have served to *qualify* points in our array rather than to modify their position or relationship to other points.

Distributions and Locations of Aggregates

From Tosawihi we collected some 1,337,000 cultural items, recording the provenience of each within .1 m^3 of archaeological deposit. In the preponderance of cases, these items occurred in visually discernible clusters that we designated "sites" or, where we observed clustering of clusters, or other patterns of apparent interrelationship, as "features" of sites. During testing and data recovery we investigated 363 features at 67 sites (cf. Chapters 16, 17, and 18), and from study of their form and content have drawn inferences about their function (cf. Chapter 24). In the following discussion we address some salient spatial relationships among the principal functional classes (residences, quarries, reduction stations) to which they can be assigned. We concentrate particularly on patterns observed in the Eastern and Western Peripheries, since only there do we control sufficiently detailed *areal* data to confront most issues of spatial patterning; the *linear* data available relative to distributions and locations in the Northern Corridor will be examined, but they cannot lead to comparable conclusions. (n.b.: In the ensuing analyses we have regularized somewhat the boundaries of the Eastern and Western Peripheries to eliminate narrow projections that would compromise calculations of distribution and areal density; the same conventions have been adopted for all maps and computations involving surface area throughout the chapter).

Residences

Five sites in the Eastern Periphery (26Ek3170, 26Ek3171, 26Ek3184, 26Ek3192, and 26Ek3198), five in the Western Periphery (26Ek3092, 26Ek3095, 26Ek3160, 26Ek3165, and 26Ek3271), and two along the Northern Corridor (26Ek3237 and 26Ek3251) exhibit attributes suggesting that at various times and to varying degrees of intensity they functioned as residences (cf. Chapter 24). Details of their distribution indicate the operation of similar criteria of site placement for all but the two northernmost sites, and they allow us to examine some of the expectations regarding residential location advanced in Chapter 4.

Residences in the Western Periphery are strongly clustered in the central southern portion of the subarea; the smallest polygon enclosing all of them occupies no more than 14% (314,036 m^2) of the entire subarea (Figure 273). The four northern sites of the group (26Ek3092, 26Ek3095, 26Ek3160, and 26Ek3271), in fact, cluster so tightly that their average size is larger than the distances separating any adjacent pair. This argues that their evident discreteness (suggested by discontinuities in the scatter of cultural materials between them) may owe more to intrinsic qualities of the landscape than to actual segmentation of residence; we note, for instance, that they occupy the *only* flat ground in their immediate vicinity (26Ek3092 on a terrace at the base

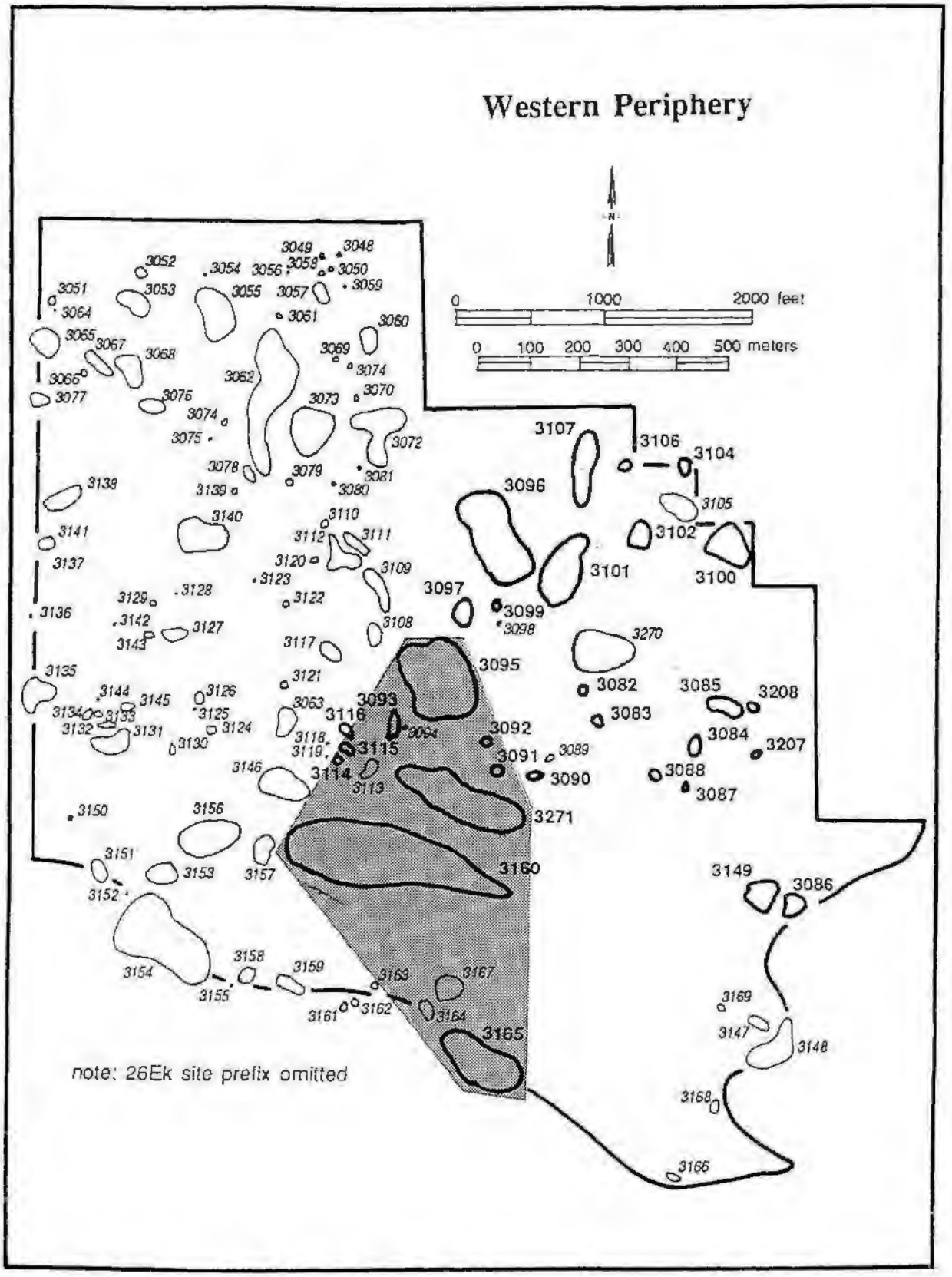


Figure 273. Residential zone of the Western Periphery.

of Basalt Canyon, 26Ek3095 on a broad bench above it, and 26Ek3160 and 26Ek3271 on wide ridgecrests to the south), with much steeper slopes intervening. They thus may reflect related, functionally overlapping, task-specific work and habitation areas exploited sometimes even by the same population, the selection of specific work and living areas dictated by microtopographic variation. 26Ek3165 occupies a saddle of the next ridgecrest south from the group; although something of an outlier, it lies barely more than 400 m from its nearest residential neighbor in the larger aggregation, suggesting that its location was selected on largely similar criteria.

If the five clustered sites discussed here truly define the "residential zone" of the Western Periphery, we are struck by how relatively little diverse is the habitat in which they occur, and how relatively uniform the suite of resources to which they gave access. In light of the expectations regarding environmental correlates of residential locations discussed in Chapter 4, the placement of this zone is remarkably favorable. The only surface water presently available within the entire subarea, for instance, lies just downslope from 26Ek3095 and only about 200 m up-drainage from 26Ek3092. Runoff from this source (a minor seep) is channeled, when flowing, along the Basalt Canyon drainage through the northern reach of the residential zone, passing no more than 50 m from the margin of 26Ek3271 and less than 150 m from 26Ek3160. The flow has been seasonal in recent years, but we note that subsurface waters can be tapped fairly easily along its course; in late June of 1989 (the third year of a drought beginning in 1987), when no flow remained and the up-drainage seeps were declining, channel-bank excavation units at 26Ek3092 had to be terminated when water was encountered at a depth of ca. 1 m. 26Ek3165, the most remote site within the residential zone, is more problematic; it lies nearly 600 m from the nearest approach of the Basalt Canyon drainage, and under the current climatic regime appears high and far from water. A major channel passes some 250 m north of the ridge on which it rests, however, and it may be that, as in Basalt Canyon, subsurface waters could be tapped easily along its course.

The sites lie at an average distance of 470 m from the nearest major sources of toolstone (26Ek3084 and 26Ek3270); 26Ek3092 and 26Ek3095 are the closest (335 m), while 26Ek3165, the most remote, is about twice as far. Since only three major opalite sources occur within the Western Periphery, and since only the very steep slopes of Red Hill intervene between them and the residential zone, it would appear that residences were placed largely to optimize proximity to water (as first priority) and toolstone, constrained only by the requirement for flat ground.

Biotic factors doubtless reinforced this site selection, however, and lent added attractiveness to the residential zone. Bitterroot (the most favorable plant food available in the entire Tosawihi vicinity) achieves its densest stands within and immediately adjacent the subject sites, helping explain the relatively high frequency of ground stone artifacts in their assemblages. Too, the transit of Basalt Canyon (one of the few relatively favorable deer habitats in the subarea) and the adjacency of Rodent Valley (an extremely favorable small mammal habitat) render the residential zone and its immediate hinterlands the richest foraging patch in the Western Periphery; sites within it, then, enjoyed superior access to virtually all the resources we expect to have influenced residential location at Tosawihi, and the zone constitutes a convincing example of the central place solution to managing resource propinquity (cf. Chapter 4).

Sites with residential attributes in the Eastern Periphery pattern somewhat differently from those in the west. An eastern residential zone can be defined (Figure 274) within which most residential sites cluster more tightly than their western counterparts (they can be enclosed by a polygon bounding ca. 198,300 m^2), but the zone is more diffuse relative to the entire surface area of the eastern tract (the polygon encloses 31% of the subarea). Since subarea boundaries were defined arbitrarily, however, we tentatively accept that residences are more nucleated in the Eastern Periphery than in the west, although for the most part they appear to have been inhabited less intensively. Only the sites along Ramadan Ridge (26Ek3170 and 26Ek3171) and 26Ek3192, along Undine Gorge, exhibit a complexity and depth of deposit

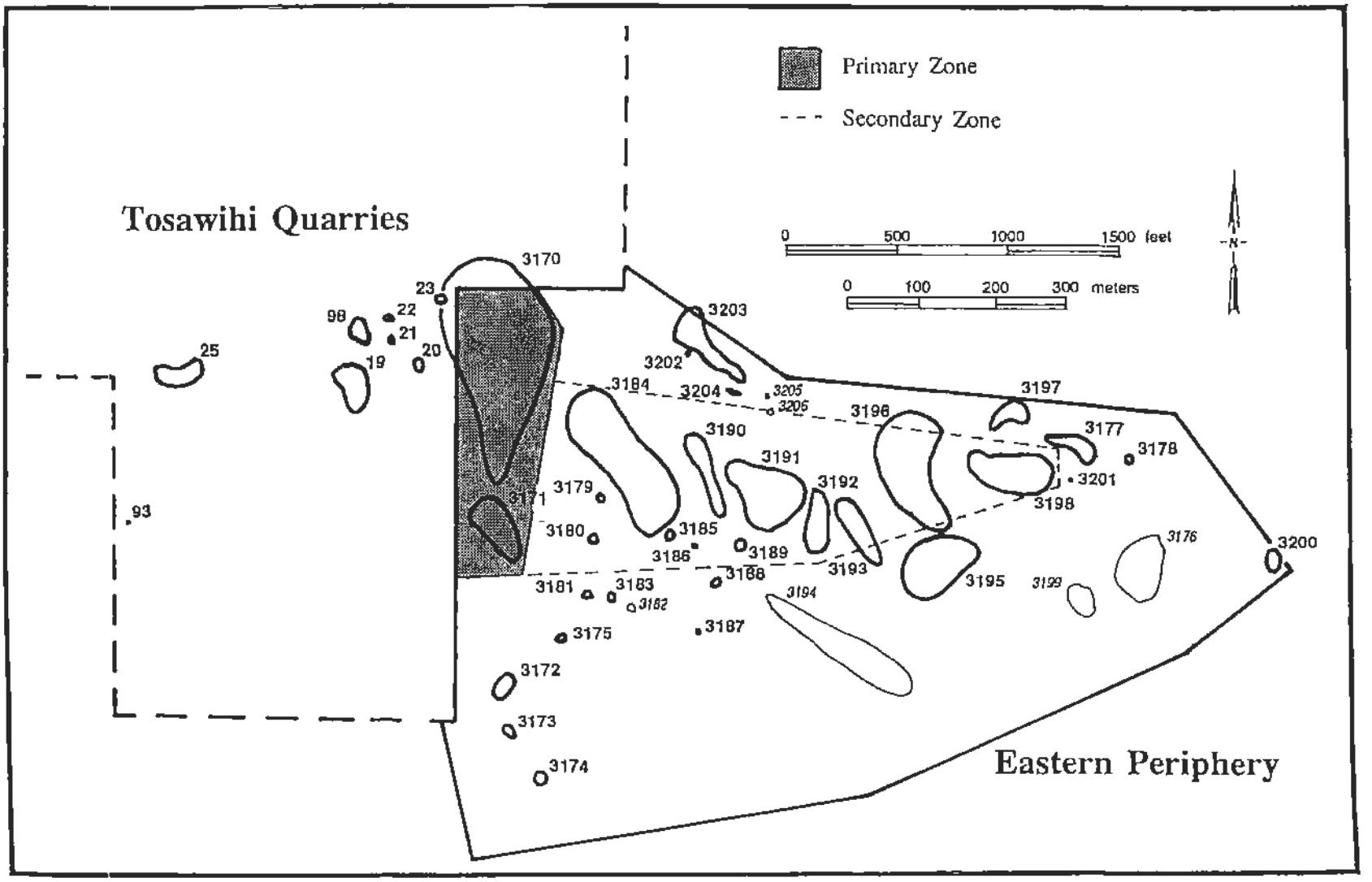


Figure 274. Residential zone of the Eastern Periphery.

suggesting continued revisits, while most of the more easterly places are sparser, shallower, and probably reflect much shorter-term or less frequent occupations. We note that the Ramadan Ridge/Undine Gorge residential zone is continuous with a linear, rather uniformly-spaced array of habitations extending north into 26Ek3032 (Localities 27 and 28, not considered in the present report).

As in the Western Periphery, the discontinuity between adjacent residential sites on Ramadan Ridge probably is a function of a minor break in slope between their precincts. Likewise, slope and a minor drainage channel may account for the apparent separateness of 26Ek3170 and 26Ek3184, the latter a large complex of reduction stations the assemblages of some of which exhibit various residential attributes (cf. Chapter 24). In this view, Ramadan Ridge, rather than the sites lying along and adjacent it, constitutes the residential center of the subarea, and issues of both propinquity and convenience resulted in a somewhat discontinuous distribution of artifacts and features that are components of essentially a single habitation sphere.

Locationally, the heart of the principal residential zone of the Eastern Periphery lies within a 200 m radius of a small but reliable seep at the confluence of Velvet Canyon and Little Antelope Creek, the only relatively permanent water source in the subarea. Other, lesser residences lie along the southern margin of Undine Gorge, now a seasonal drainage in the channel of which ponds collect after early summer rains.

All eastern residences suggest placement largely influenced by the incidence of toolstone sources. Major quarry features occur within the precincts of the larger residences (26Ek3170 and 26Ek3171), while minor sources occur within more diffuse or smaller ones (e.g., 26Ek3184 and 26Ek3198). No residence, however, lies more than 180 m from a major, intensely exploited source of opalite, and we assume that the somewhat diffuse distribution of lesser residences owes in part to the widespread distribution of high quality opalite throughout the subarea.

We have few bases from which to infer that foraging values played a very great role in conditioning residential locations in the Eastern Periphery. Virtually no favorable plant resources grow in the area today, and certainly not in densities likely to constitute profitable foraging patches. Small mammals are relatively abundant in meadows at the northern toe of Ramadan Ridge and on the soft, gradually undulating soils south of Undine Gorge, and the depths of the gorge probably are visited sometimes by deer, although we have observed none over four seasons of fieldwork. The location of 26Ek3198, however, atop a knoll allowing monitoring of a considerable stretch (nearly 1 km) of the deepest part of the gorge, should constitute a favorable hunting stand; the site's assemblage suggests a short-term hunter's camp, and deer passing along the gorge may well have been the attraction.

Major residential locations in the Northern Corridor (26Ek3237 and 26Ek3251) appear to have been conditioned chiefly by reliable water (both lie at major drainage confluences) and chances of game (riparian zones and bifurcating corridors invite both small mammals and deer). We have not observed abundances of particularly valuable plant foods, but both vicinities are grazed heavily under the current regime and are likely to have been more productive before the introduction of domestic livestock. Both sites are far from the nearest known sources of toolstone (although we control no areal survey data in their vicinities), and we assume that their placement had nothing directly to do with the distribution of opalite. Their assemblages, however, indicate that the *use* of opalite, and perhaps its transport, came importantly into play at both places.

Quarries

The location and distribution of quarrying sites are, of course, constrained absolutely by the distribution of toolstone sources, but it is not the case that all potential sources are

likely to have been exploited; quality of material and favorability of location (e.g., proximity to water and residential bases) also must have contributed to the initial selection of a source and to the intensity of its subsequent exploitation (cf. Chapter 4). In fact, however, the distribution of suitable opalite is not homogeneous throughout the Tosawihi vicinity, and its relative abundance affected significantly the volume, content, and location of the resulting archaeological record; much of the character of the various subareas under consideration here was induced by their geographic relationship to available toolstone.

The eastern and western subareas are designated "peripheral" precisely because the intensity of quarrying activity there so evidently was secondary to that conducted within 26Ek3032 (the Tosawihi Quarries proper). Within 26Ek3032, quarry pit localities occur at the density of .21/10,000 m^2, implying that, on average, no place within the quarry lies more than about 300 m from an exploited source of stone. Moreover, two-thirds of the quarry pit localities recorded during initial survey consist of quarry pit *complexes* composed of from two to as many as 55 individual pits (Elston, Raven, and Budy 1987), swelling by a considerable degree the actual intensity of toolstone extraction reflected. This contrasts strikingly with the pattern in the Eastern Periphery, in which quarry pit localities occur at a density of only .079/10,000 m^2, or at an average distance of slightly more than 500 m from any point on the landscape. The distribution is even sparser in the Western Periphery; quarry pit localities occur at a density of .013/10,000 m^2, meaning that any point within the subarea is likely to lie on average somewhat more than 1200 m from the nearest exploited stone source. In neither subarea do quarry pit complexes contain more than a half-dozen pits, further emphasizing that toolstone procurement within them was marginal compared to the intensity of effort expended in 26Ek3032. No quarry pit localities occur along the Northern Corridor, the nearest such site (26Ek3250) lying some 4100 m southeast of the southernmost site (26Ek3237).

Within the eastern and western subareas the incidence of toolstone tends to be clustered. Opalite occurs in the Eastern Periphery only on lower Ramadan Ridge, along the cliffs above Undine Gorge, and in an isolated pocket at the far eastern extreme of the subarea (26Ek3200), with the result that a contiguous block comprising ca. 75% of the surface offers no toolstone whatsoever. In the Western Periphery, virtually all exposed or near-surface opalite (and *all* intensively exploited sources) falls on the crest and slopes of Red Hill; in effect, almost all toolstone extracted within the subarea came from a single zone occupying less than 10% of the surface.

As will be detailed in subsequent discussions, different patterns of exploitation and transport are likely to have characterized the two subareas; in the East, owing to the greater dispersal of principal sources, most opalite is likely to have been extracted locally (i.e., within the subarea), while in the West, owing to its more tightly nucleated exposures, opalite is likely either to have been obtained from sources outside the subarea (sources within 26Ek3032) or transported over considerably greater distances than in the East. The locational relationships of reduction stations to quarries help clarify the archaeological implications of these probable patterns.

Reduction Stations

Reduction stations constitute the most populous class of archaeological place encountered in our investigations of the Tosawihi peripheries, and we expect them to be our most informative source about how space was organized around the quarries (cf. Chapter 4). Their distributions and locations test several of our assumptions about the role of propinquity in conditioning where activities are likely to be carried out (especially in relation to toolstone sources and residential loci), and their compositions define the degree to which convenience governed the reorganization of things in space. We looked at some of the critical spatial relationships of 333 reduction stations (135 in the Eastern Periphery and 198 in the Western

Periphery), limiting our inquiry to those areas in which we control detailed areal data on surface patterns and assemblage compositions.

Based on the principal of distance minimization as a strategy for diminishing the expenditure of effort, we advanced in Chapter 4 a general model of how reduction stations should be located relative to toolstone sources and residences. The model is represented graphically in Figure 275 where, reduced to its simplest elements, we see that the frequency of reduction stations should be high in the immediate vicinity of their parent quarry and in the vicinity of the residence from which the work force was dispatched; between those poles, frequency should decline. Moreover, reduction stations near quarries should be characterized by a high incidence of early stage reduction debitage, while the incidence of later stage debitage should increase as the residence is approached. Deviations from the ideal model are anticipated, of course, as a consequence of numerous real-world contingencies (e.g., multiplicity of quarries, variations in toolstone quality, intervening opportunities or hazards), but we expect observed patterns to *trend* toward the ideal. Deferring for the moment issues of their content, we consider our population of reduction stations only as points in a field in order to inquire how their locations are related spatially to the locations of quarries and residences.

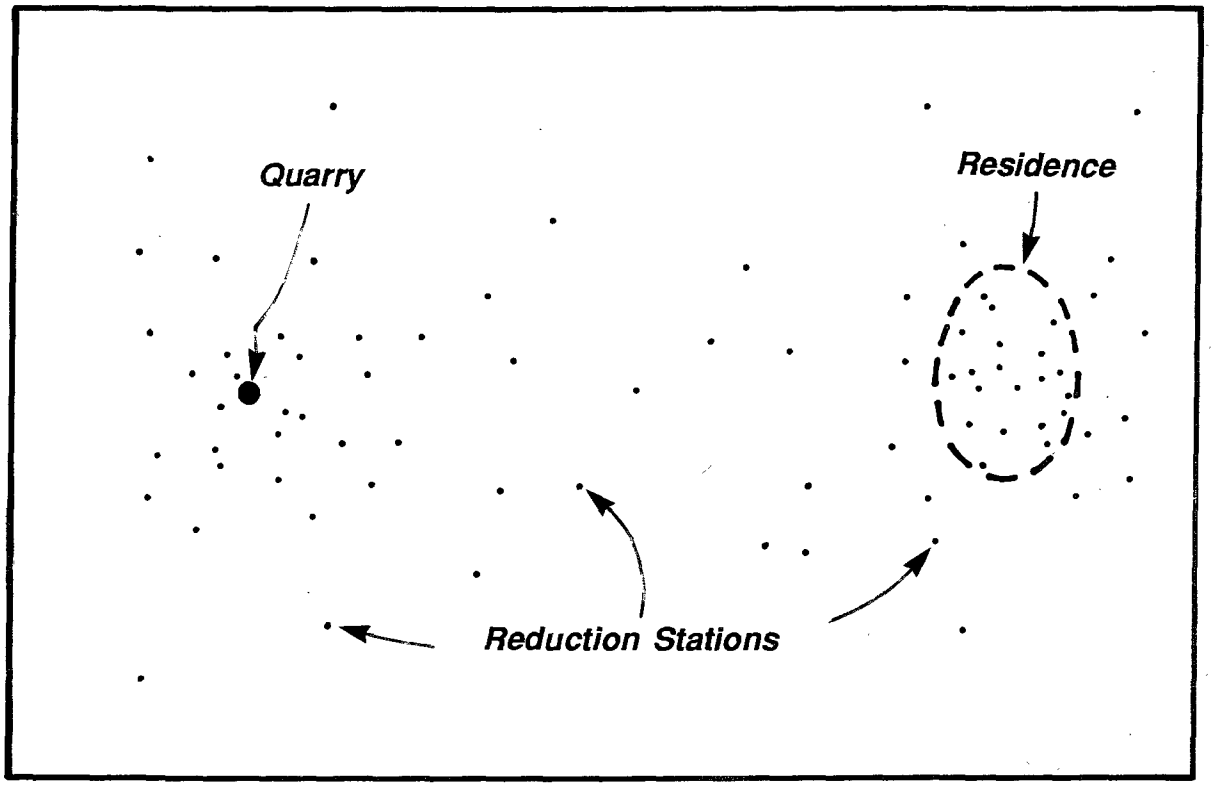
Reduction Stations and Quarries

In the Eastern Periphery we have identified five locations (26Ek3032/23, 26Ek3171, 26Ek3195, 26Ek3197, and 26Ek3200) at which major efforts of toolstone extraction were undertaken. Several other locations occur within the subarea at which very minor procurement efforts have left sparse traces; these consist chiefly of little-used cobble quarries and occasionally battered outcrops. In no instance, however, do we have reason to believe that the volumes of toolstone removed from such places approached by an order of magnitude that taken from our five principal quarries, and they are dismissed from the present analysis.

Major quarries in the Western Periphery are limited to three sites on Red Hill (26Ek3084, 26Ek3208, and 26Ek3270). Numerous localities within 26Ek3032, however, lie close to the northern margin of the subarea and doubtless contributed opalite to the local archaeological record; we have included, therefore, the locations of Localities 36, 39, 42, 43, 182, 193, 199, 201, and 204 in our spatial analysis of toolstone accessibility in the west, even though we have not examined their contents beyond initial reconnaissance.

The 333 reduction stations of our sample lie at an average distance of 373 m from the nearest quarry, although the two subareas differ notably; the average distance from reduction station to nearest quarry is 525 m in the Western Periphery, in the Eastern Periphery, only 152 m. Figure 276 graphs the actual frequency by distance in both areas, from which it is evident not only that absolute distances are considerably greater in the West, but that all articulations within the distance/frequency profile are pitched much higher there. For instance, the highest incidence of reduction stations occurs in the East between 100 - 200 m from the nearest quarry, while in the West it lies between 400 - 500 m. This would appear to contradict our expectation that a high frequency of reduction stations should lie in the immediate vicinity of quarries, but we note that the steep slopes of Red Hill probably constrained much use of the surface. In this case, it may have been considered an acceptable trade-off either to reduce raw material directly within the quarry precinct or to transport it to the nearest level ground for reduction rather than to risk rolling down hill.

In order to relate these general, area-wide frequencies to zones probably served by individual toolstone sources, we subdivided both subareas on the basis of proximity to specific quarries. In Figures 277 and 278 the Eastern and Western Peripheries have been segmented into Thiessen polygons (or Dirichlet domains; cf. Boots and Getis 1988:71), space-exhaustive zones that enclose all the space within a field closer to a single point than to any other (Hodder



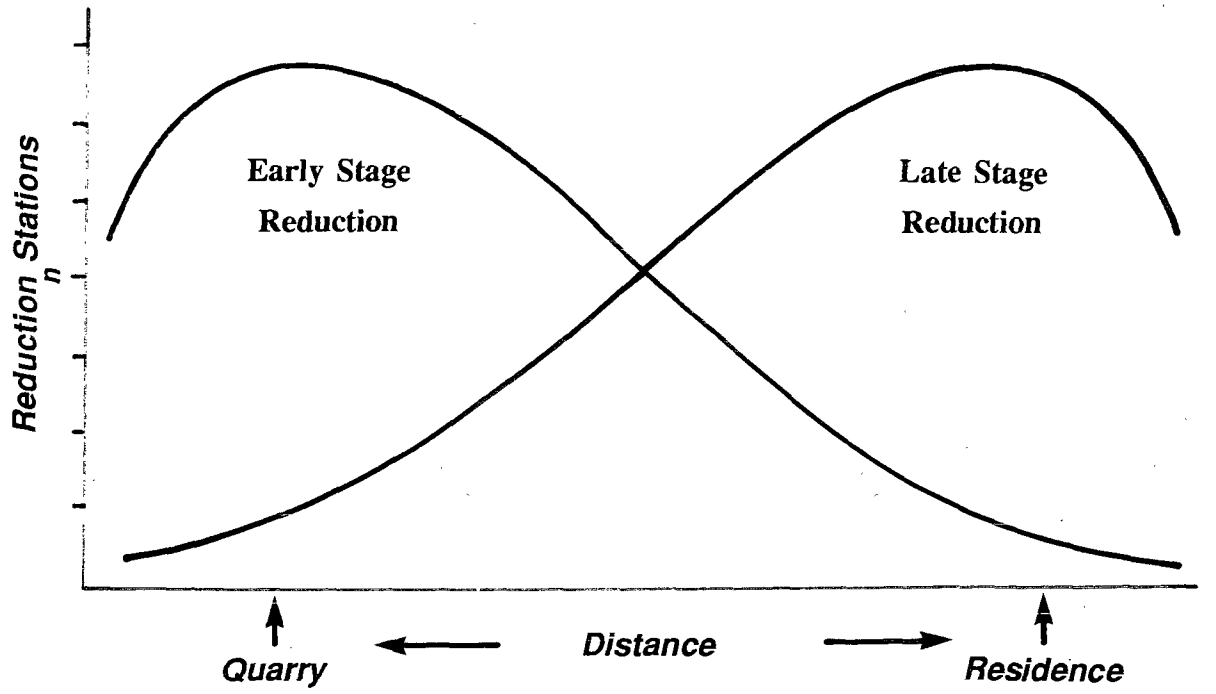


Figure 275. Expected distribution of Reduction Stations as a function of distance from Quarry and Residence.

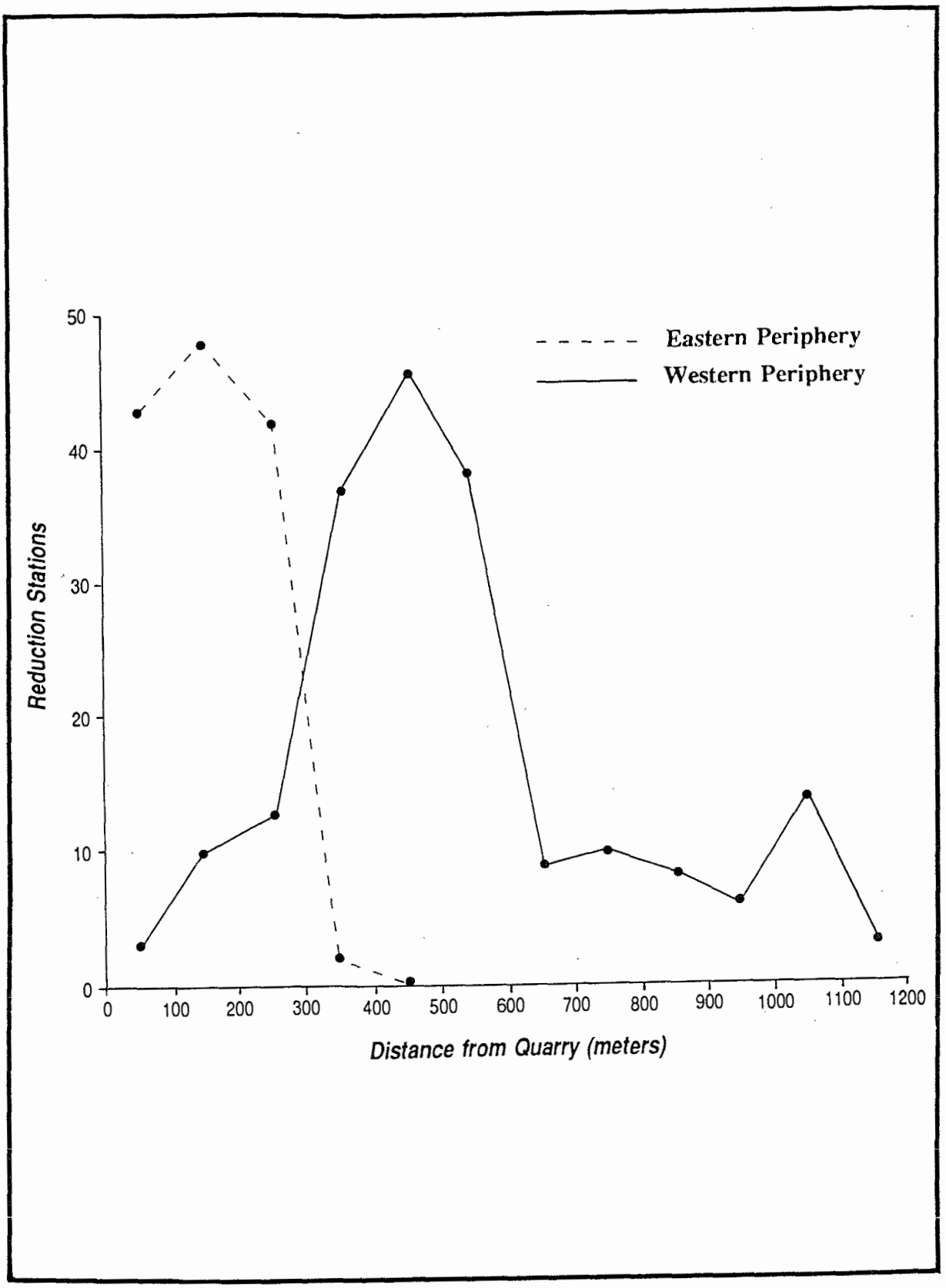


Figure 276. Distance of 333 Reduction Stations from nearest quarry, Eastern and Western Peripheries.

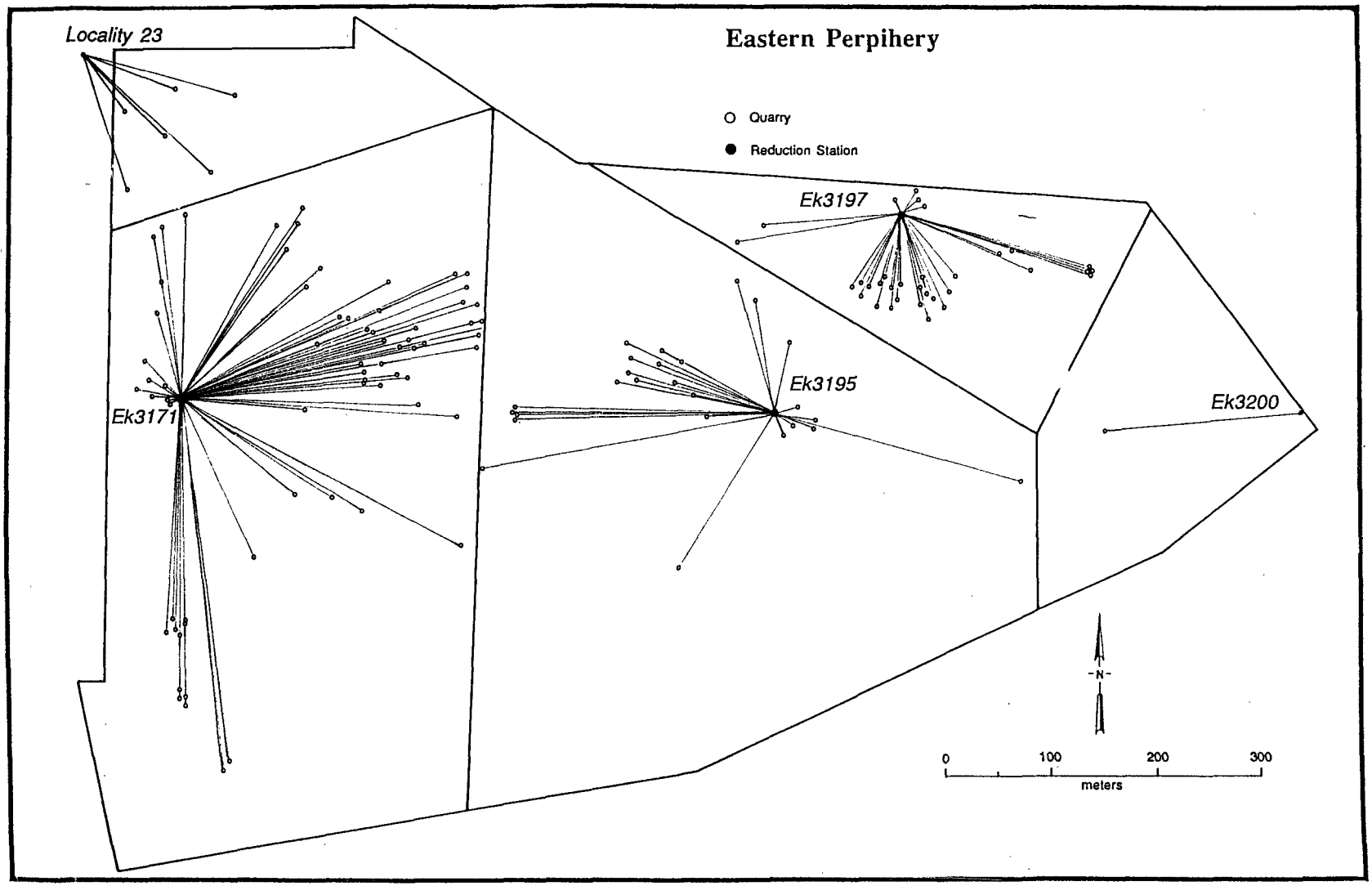


Figure 277. Quarry zones defined by Thiessen Polygons around major quarries, Eastern Periphery; Reduction Stations linked to nearest quarry.

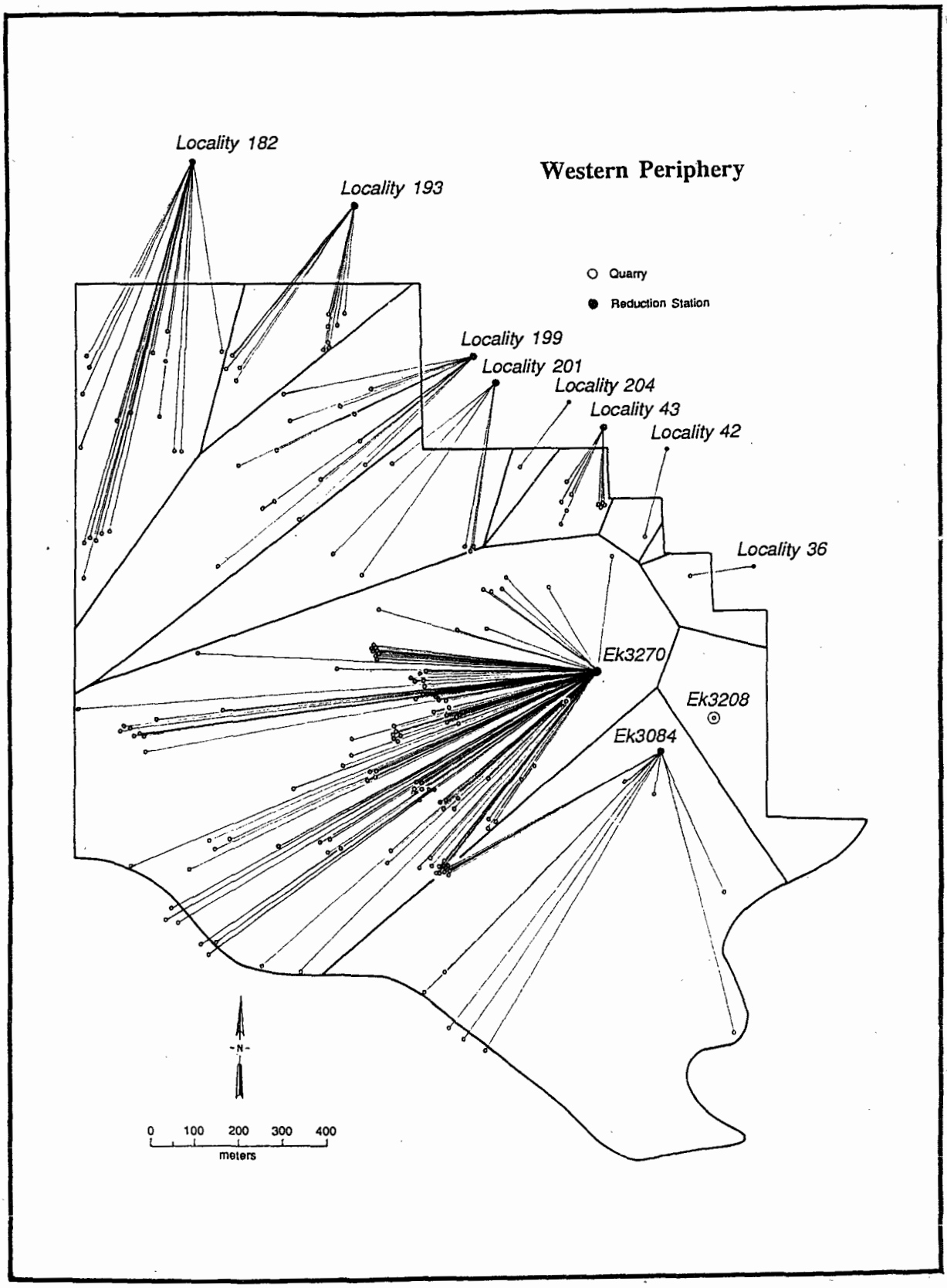


Figure 278. Quarry zones defined by Thiessen Polygons around major quarries, Western Periphery; Reduction Stations linked to nearest quarry.

and Orton 1976:59-60; Taylor 1977:306-307); we centered our polygons on the five major quarries in the East and the three in the West. In the ensuing discussions, we refer to the areas enclosed by these polygons as "quarry zones," designated by the principal toolstone source within each. They segregate populations of reduction stations lying nearer one major quarry than any other (indicated by fine-line radials on Figures 277 and 278), and are purely theoretical constructs for organizing the array of quarries and reduction stations by distance minimization.

Immediately evident in comparison of the two patterns is how the location of reduction stations relates to the distribution of quarries. In the Eastern Periphery, all quarries save 26Ek3032/23 are internal to the subarea, and most capture multidimensional reduction station targets within their proximal zones. In the Western Periphery, only two quarries (26Ek3084 and 26Ek3270) within the subarea lie closer to any reduction stations there than do the various localities of 26Ek3032 external to it on the north, with the result that nine of the twelve quarry zones are attenuated.

The quarry zones clearly group reduction stations on a principal very different from that which groups them into sites, and the resulting groups exhibit both absolute and relative differences among them. One way of looking at these differences is expressed in Table 228, in which overall densities of reduction stations are calculated for each quarry zone.

Table 228. Areal Frequency of Reduction Stations by Quarry Zone, Eastern and Western Peripheries.

Quarry Zone	Area (m^2)	Reduction Stations n	Reduction Stations/ 10,000 m^2
Eastern Periphery			
26Ek3197	64,375	32	4.97
26Ek3195	238,750	26	1.09
26Ek3032/23	40,000	6	1.50
26Ek3171	231,875	70	3.02
26Ek3200	55,000	1	.18
Total	630,000	135	2.14
Western Periphery			
26Ek3032/182	192,500	19	.99
26Ek3032/193	67,500	11	1.63
26Ek3032/199	240,000	14	.58
26Ek3032/201	165,000	6	.36
26Ek3032/204	15,000	1	.67
26Ek3032/43	35,000	10	2.86
26Ek3032/42	17,500	1	.57
26Ek3032/36	30,000	1	.33
26Ek3032/39	2,500	0	-
26Ek3208	82,500	1	.12
26Ek3270	840,000	121	1.44
26Ek3084	560,000	13	.23
Total	2,247,500	198	.88

We note particularly that average densities are very much higher in the Eastern Periphery, suggesting that in that subarea quarries tend to be related spatially to more reduction stations within a smaller area. This does not mean, however, that we should expect eastern quarries to have been exploited more intensively than those in the West, since western

quarry zones in some cases are very much larger (e.g., the zone surrounding 26Ek3270 is larger than the entire Eastern Periphery, and subsumes nearly as many reduction stations). Too, some very high densities in the west (e.g., Localities 43, 182, and 193 of 26Ek3032), as well as some very low ones (Localities 36, 39, and 201) are products of zones attenuated by the northern study area boundary and are of questionable comparability.

More informative than comparison of simple *densities* of quarry zones is comparison of the *distance structures* they display, since these allow more direct inquiry into the degree to which distance from quarry actually may have contributed to the location of reduction stations around it. Table 229, for instance, assigns numbers of reduction stations in terms of hundred meter increments of distance from the quarry in each zone, and calculates reduction station density for each distance domain.

Table 229. Areal Frequency of Reduction Stations by Distance from Nearest Quarry, Eastern Periphery.

Quarry Zone	Radial Distance from Quarry (m)	Area (m^2)	Reduction Stations n	Reduction Stations/ 10,000 m^2
26Ek3171	0 - 100	30,000	8	2.67
	100 - 200	58,750	24	4.08
	200 - 300	68,125	36	5.28
	300 - 400	50,625	2	.39
	400 - 500	24,375	0	-
26Ek3197	0 - 100	22,500	23	10.22
	100 - 200	33,750	9	2.67
	200 - 300	8,125	0	-
26Ek3195	0 - 100	31,875	10	3.14
	100 - 200	73,125	10	1.37
	200 - 300	91,250	6	.66
	300 - 400	42,500	0	-
26Ek3032/23	0 - 100	5,625	2	3.55
	100 - 200	18,125	4	2.21
	200 - 300	16,250	0	-
26Ek3200	0 - 100	10,625	0	-
	100 - 200	26,250	1	.38
	200 - 300	18,125	0	-

With the exception of the quarry zone around 26Ek3171, there is a general fall-off in density as a function of distance from the quarry. The relationship is depicted graphically in Figure 279, in which actual similarities and anomalies become especially evident. 26Ek3197, 26Ek3032/23, and 26Ek3195 all exhibit the trend anticipated by the model. The quarry at 26Ek3200 constitutes a minor anomaly owing to the uniquely sparse use made of its quarry zone. This perhaps is a function of its remoteness from the principal residential zone, since exploitation of its toolstone necessarily would have been somewhat more expensive in terms of travel and transport costs than any other quarry in the Eastern Periphery. Relative to this, we note that it appears to have been the least exploited of the major quarries of the East in terms of probable volume of material removed.

The quarry at 26Ek3171 is anomalous in a different respect; it exhibits a high degree of exploitation, and its quarry zone encloses the highest numbers of reduction stations in the subarea. While reduction stations occur in substantial densities within distances of 100 and 200

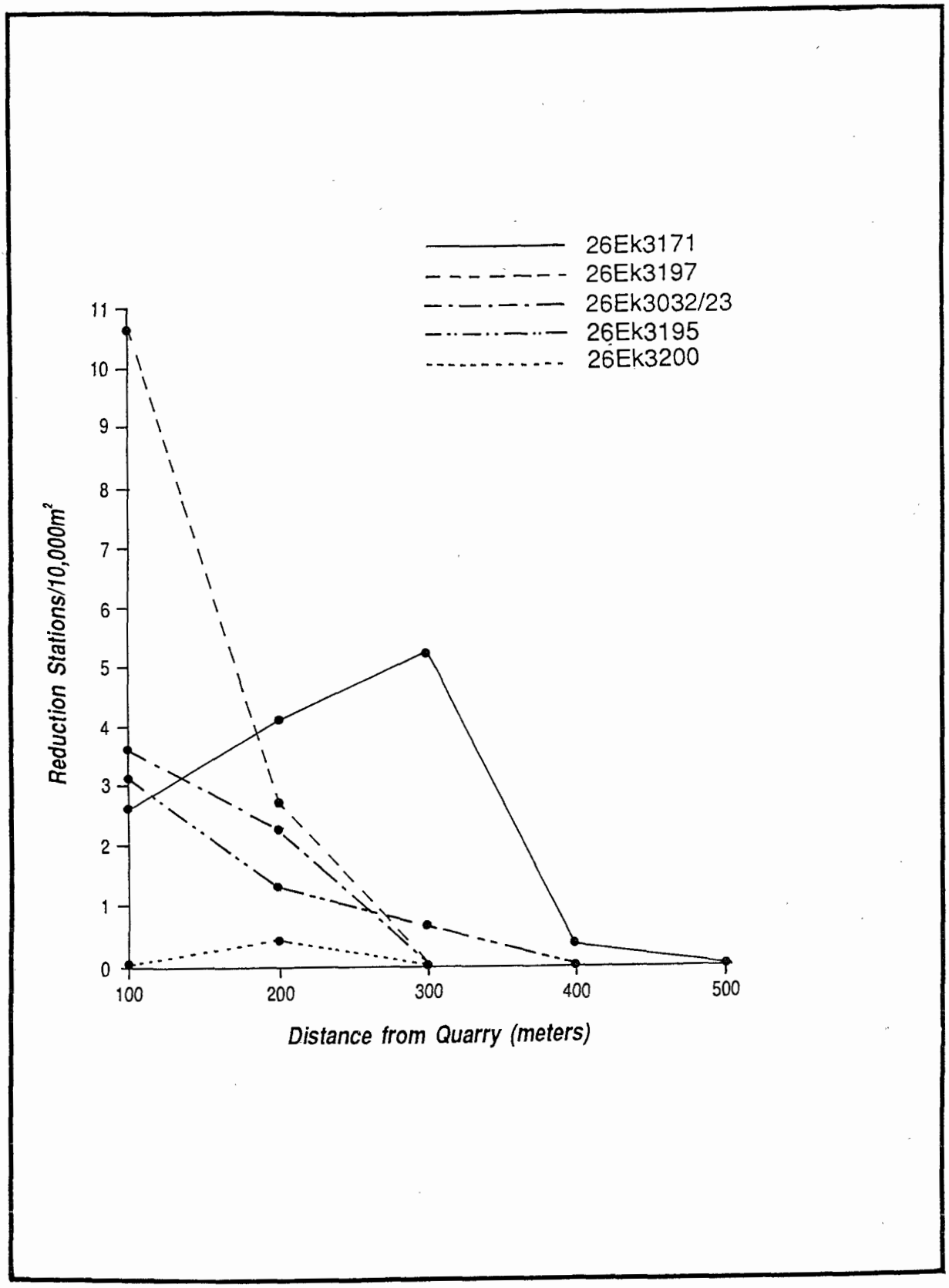


Figure 279. Areal frequency of Reduction Stations by distance from nearest quarry, Eastern Periphery.

m from the quarry, density peaks between 200 and 300 m distance, beyond which it falls off abruptly. Several factors may have contributed to this result. In the first place, 26Ek3171 occurs directly within the principal residential zone of the Eastern Periphery. While both 26Ek3170 and 26Ek3171 exhibit discrete reduction stations within their precincts, both also are characterized by large, amorphous expanses of scattered debitage and tools that probably represent blurred palimpsests of numerous originally discrete depositional components (cf. Chapter 17). In several instances, in fact, discrete reduction stations can be discerned in surface contexts *superimposed upon* the churned and apparently disorganized deposits. This suggests that the incidence of reduction *episodes* actually may have been quite high in areas 100 and 200 m distant from the quarry, but that their archaeological visibility (in the form of reduction stations) has been impinged by disaggregation owing to concentrated use and trampling of the surface. Only reduction stations representing the latest such episodes remain to be counted.

In the second place, over 70% of the reduction stations lying between 200 and 300 m from 26Ek3171 occupy the cluster designated 26Ek3184. We have discussed above the possibility that this site may constitute a related outlier of the Ramadan Ridge residential zone, separated from it chiefly by landform anomalies. If this is the case, the apparently high density of reduction stations at this distance may reflect a workshop of the residential zone that actually received *less* use than the heart of the Ramadan Ridge sites despite its greater frequency of visible reduction stations; excavation found deposits at 26Ek3184 generally not to exceed 10 cm in depth, while those of 26Ek3170 and 3171 frequently attain depths of 40 - 50 cm.

Density patterns in quarry zones of the Western Periphery are more variable, in part as a function of the attenuation of nine of them by the northern study area boundary. Table 230 arrays numbers of reduction stations by distance from quarry in each quarry zone and presents density as a function of distance.

Table 230. Areal Frequency of Reduction Stations by Distance from Nearest Quarry, Western Periphery.

Quarry Zone	Radial Distance from Quarry (m)	Area (m^2)	Reduction Stations n	Reduction Stations/ 10,000 m^2
26Ek3032/182	300 - 400	32,500	1	.31
	400 - 500	37,500	3	.80
	500 - 600	32,500	5	1.54
	600 - 700	32,500	4	1.23
	700 - 800	25,000	0	-
	800 - 900	17,500	5	2.86
	900 - 1000	10,000	1	1.00
	1000 - 1100	5,000	0	-
26Ek3032/193	200 - 300	22,500	4	1.78
	300 - 400	20,000	3	1.50
	400 - 500	15,000	4	2.67
	500 - 600	10,000	0	-
26Ek3032/199	100 - 200	25,000	0	-
	200 - 300	30,000	1	.33
	300 - 400	25,000	4	1.60
	400 - 500	25,000	4	1.60
	500 - 600	27,500	4	1.45
	600 - 700	25,000	0	-
	700 - 800	25,000	1	.40
	800 - 900	20,000	0	-
	900 - 1000	17,500	0	-
	1000 - 1100	15,000	0	-
	1100 - 1200	5,000	0	-

Table 230, continued.

Quarry Zone	Radial Distance from Quarry (m)	Area (m^2)	Reduction Stations n	Reduction Stations/ 10,000 m^2
26Ek3032/201	100 - 200	7,500	0	-
	200 - 300	25,000	0	-
	300 - 400	35,000	4	1.14
	400 - 500	22,500	0	-
	500 - 600	20,000	2	1.00
	600 - 700	17,500	0	-
	700 - 800	15,000	0	-
	800 - 900	10,000	0	-
	900 - 1000	7,500	0	-
	1000 - 1100	5,000	0	-
26Ek3032/204	100 - 200	7,500	1	1.33
	200 - 300	7,500	0	-
26Ek3032/43	0 - 100	2,500	0	-
	100 - 200	15,000	8	5.33
	200 - 300	15,000	2	1.33
	300 - 400	2,500	0	-
26Ek3032/42	100 - 200	12,500	1	.80
	200 - 300	5,000	0	-
26Ek3032/39	200 - 300	2,500	0	-
26Ek3032/36	100 - 200	25,000	1	.40
	200 - 300	5,000	0	-
26Ek3208	0 - 100	32,500	0	-
	100 - 200	27,500	0	-
	200 - 300	5,000	0	-
	300 - 400	17,500	1	.57
26Ek3270	0 - 100	32,500	1	.31
	100 - 200	67,500	0	-
	200 - 300	82,500	6	.73
	300 - 400	77,500	23	2.97
	400 - 500	72,500	35	4.83
	500 - 600	72,500	23	3.17
	600 - 700	75,000	3	.40
	700 - 800	77,500	5	.65
	800 - 900	82,500	3	.36
	900 - 1000	82,500	5	.61
	1000 - 1100	67,500	14	2.07
	1100 - 1200	50,000	3	.60
26Ek3084	0 - 100	32,500	2	.61
	100 - 200	50,000	0	-
	200 - 300	60,000	0	-
	300 - 400	72,500	1	.14
	400 - 500	70,000	0	-
	500 - 600	80,000	4	.50
	600 - 700	87,500	2	.23
	700 - 800	75,000	4	.53
	800 - 900	32,500	0	-

As reflected in Table 228, distance-dependent densities in the Western Periphery are generally much lower than in the East, in part a function of the much larger areas contained within individual quarry zones. In large part, too, they are less meaningful in the aggregate since so many quarries lie outside the quarry zone to which they pertain, thereby lacking first, second, or, in one instance (26Ek3032/182), even third-order distance domains for comparison. (This is not strictly true; such domains of course occur around each quarry, but they lie beyond the boundary of the area for which we control data on the incidence of reduction stations).

To emphasize the variability of patterning in the West, Figure 280 compares reduction station densities by distance domains in the quarry zones only of 26Ek3084 and 26Ek3270, both of which lie within the subarea boundary (26Ek3208, the only other major quarry in the subarea, generates a quarry zone containing only one reduction station and is not plotted). Both patterns require comment, as neither appears to approximate the anticipations of the distance minimization model.

Both quarries lie on Red Hill and, as discussed above, give rise to quarry zones dominated by prohibitively steep slopes and in which the availability of even moderately level ground is severely limited. In the case of 26Ek3270, the nearest significant expanse of level ground occurs in distance domains 4 - 6 (i.e., 400 - 600 m from the quarry), precisely coincident with the peak of the distance/density profile in Table 230; most of these reduction stations, as well, fall within the residential zone of the Western Periphery. The quarry zone of 26Ek3084 is even more topographically constrained; level ground occurs only at a distance of 600 - 800 m from the quarry, again reflecting the distance/density profile. In this case, too, most reduction stations lie within the residential zone. These data suggest that the expectations of the model expressed in Chapter 4 and characterized in Figure 275 need to be qualified to accommodate the negative effect of pronounced slope on the location of reduction stations.

A second peak in the distance/density profile of 26Ek3270 (at a distance of 1000 - 1100 m from the quarry) is less easy to explain. All of these reduction stations are associated with six sites (26Ek3131, 26Ek3132, 26Ek3133, 26Ek3134, 26Ek3153, and 26Ek3154) lying, by project design, beyond the compass of both our testing and data recovery programs, and are known exclusively from initial survey data. 26Ek3154, however, containing nearly half this population, was found in survey to exhibit a few residential characteristics (Budy 1988:31), and it may be that a secondary residential zone lies about 1100 m from the quarry.

Comparison of the quarry zones around 26Ek3084 and 26Ek3270 exposes both liabilities and benefits of the analytic approach adopted here. In the first place, delineation of quarry zone boundaries does *not* mean that we assume all lithic material at reduction stations within the zone must have derived only from the central quarry, but rather that for all such places *that* was the quarry closest at hand and, other things being equal, probably the cheapest to exploit. Selection based on quality of material, however, as well as the depletion of exploited sources, topographically induced irregularities in travel patterns, and intervening opportunities and constraints all might result in the importation of toolstone from more distant sources. A case in point is found at residential site 26Ek3092 (in the quarry zone of 26Ek3270), where some highly distinctive debitage appears unquestionably to have derived from the red and purple jasper source at 26Ek3084 (in the adjacent quarry zone).

In the second place, the trends suggested by the approach generate expectations about the use of toolstone in a spatial context that could yield to explicit testing were it ever to become feasible to characterize toolstone by source unequivocally.

And in the third place, the approach in one instance yielded an unexpected, anecdotal corroboration. The largest quarry zone in either subarea encloses that portion of the Western Periphery closer to 26Ek3270 than to any other quarry. At the time of initial survey, the surface manifestation of 26Ek3270 had been compromised severely by recent mining activity (Budy 1988:26), and the site was included in neither testing nor data recovery programs. Its potential importance as a source became eclipsed in our concentration on the other exceptional

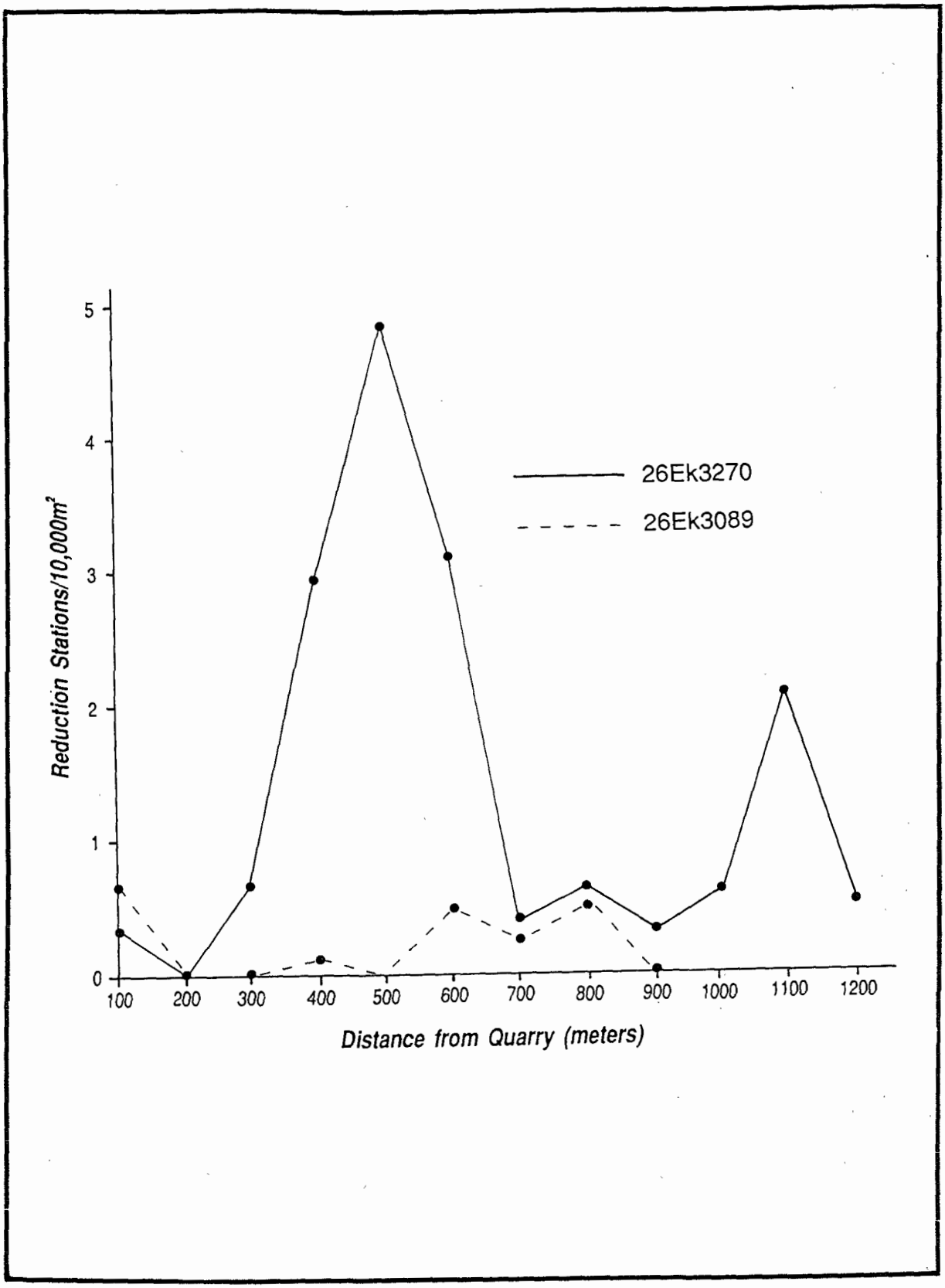


Figure 280. Areal frequency of Reduction Stations by distance from two nearest quarries, Western Periphery.

Red Hill quarries (26Ek3084 and 26Ek3208), and further consideration of it was dismissed. In spatial terms, however, it clearly is the most favorably located quarry in the entire subarea, and an astonishingly high number of reduction stations (121) are nearer it than any other source. Upon the dismantling of Red Hill in 1990, it was disclosed that the disturbed surface of 26Ek3270 in at least one area concealed quarry pit deposits containing an exceptional volume of high quality material, perhaps commensurate with the site's spatially inferred role as the preeminent toolstone source of the West.

To compare overall distance/density profiles in the Eastern and Western Peripheries, Table 231 ignores individual quarry zone boundaries but expresses areal frequencies of reduction stations exclusively as functions of distance domains. The resulting data, represented graphically in Figure 281, constitute the cumulative evaluation of how well the distribution of quarries actually predicts the location of reduction stations.

Table 231. Mean Areal Frequency of Reduction Stations by Distance from Nearest Quarry, Eastern and Western Peripheries.

Subarea	Radial Distance from Quarry (m)	Area (m^2)	Reduction Stations n	Reduction Stations/ 10,000 m^2
Eastern Periphery				
	0 - 100	100,625	43	4.27
	100 - 200	210,000	48	2.28
	200 - 300	201,875	42	2.08
	300 - 400	93,125	2	.21
	400 - 500	24,375	0	-
Western Periphery				
	0 - 100	100,000	3	.30
	100 - 200	237,500	10	.42
	200 - 300	260,000	13	.50
	300 - 400	282,500	37	1.31
	400 - 500	242,500	46	1.90
	500 - 600	242,500	38	1.57
	600 - 700	237,500	9	.38
	700 - 800	217,500	10	.46
	800 - 900	162,500	8	.49
	900 - 1000	117,500	6	.51
	1000 - 1100	92,500	14	1.51
	1100 - 1200	5,000	3	.54

Expressed as a pattern of overall areal frequencies, reduction stations in the Eastern Periphery accord very well with the expectations of the distance-dependent model; fall-off in density is rapid, articulated chiefly in the 200 - 300 m distance domain by the cluster of reduction stations at 26Ek3184. The Western Periphery, even with the uncorrected addition of attenuated quarry zones along its northern margin, exhibits a profile generally yielding to the dominance of the large population of reduction stations surrounding 26Ek3270; the topographic constraint of steep slopes in the lower distance domains (0 - 300 m from the quarry) is still evident, as are peaks at 400 - 600 m and 1000 - 1100 m representing clusters of reduction stations on flat ground and in the vicinity of residences.

Reduction Stations and Residences

To test the distance-dependency of reduction station locations relative to residences, the foregoing exercise was repeated with other variables; the residential zones of both subareas were

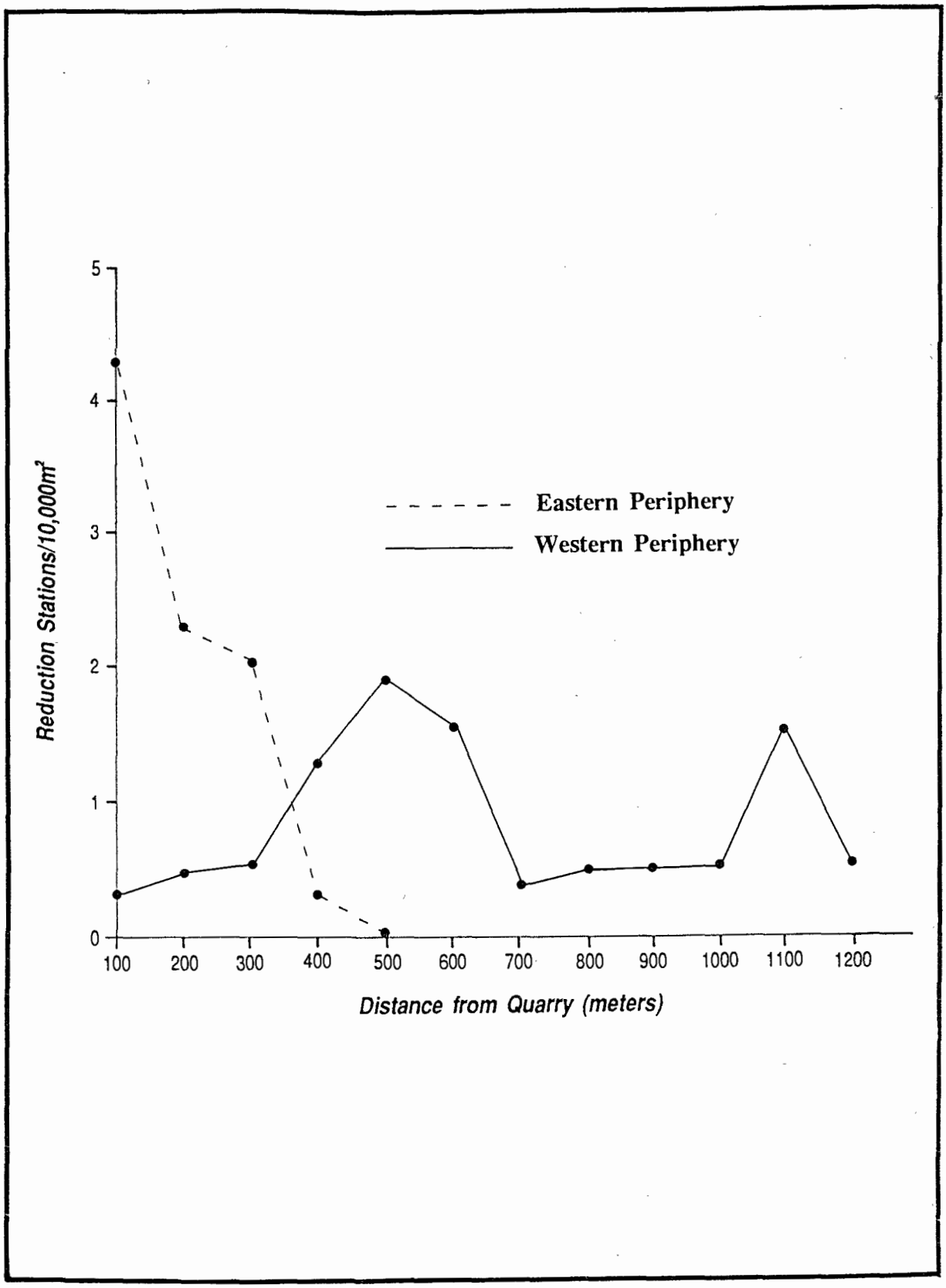


Figure 281. Mean areal frequency of Reduction Stations by distance from nearest quarry; Eastern and Western Peripheries compared.

delineated, and concentric margins representing 100 m increments of distance from them were mapped. Reduction stations were counted within each distance domain, and densities calculated by domain. The results of the exercise are presented in Table 232.

Table 232. Mean Areal Frequency of Reduction Stations by Distance from Residential Zone, Eastern and Western Peripheries.

Subarea	Distance from Residence (m)	Area (m^2)	Reduction Stations n	Reduction Stations/ 10,000 m
Eastern Periphery				
	Res. Zone	198,307	96	4.84
	0 - 100	147,020	18	1.22
	100 - 200	119,080	15	1.26
	200 - 300	111,588	4	.36
	300 - 400	52,825	2	.38
	400 - 500	1,180	0	--
Western Periphery				
	Res. Zone	314,036	81	2.58
	0 - 100	224,050	17	.76
	100 - 200	265,375	13	.49
	200 - 300	302,800	13	.43
	300 - 400	308,875	11	.36
	400 - 500	284,475	21	.74
	500 - 600	196,800	9	.46
	600 - 700	130,325	8	.61
	700 - 800	118,300	16	1.35
	800 - 900	53,650	5	.93
	900 - 100	36,600	3	.89
	1000 - 110	12,214	1	.82

The pattern expressed in Table 232 has some interesting characteristics that correspond well, but not perfectly, to the expectations of the model. As depicted in Figure 282, the residential zones of both subareas contain the highest densities of reduction stations, although that of the Eastern Periphery is packed almost twice as densely as the west. Too, the Eastern Periphery profile exhibits a fairly rapid, but slightly staggered, fall-off in frequency of reduction stations away from the residential zone (as expected).

The profile of the Western Periphery is more articulated; while fall-off occurs cleanly from the heart of the residential zone to some 400 m from its margin, a somewhat higher trend prevails beyond 500 m and peaks between 700 and 800 m from the zone. This deviation from expected patterns is difficult to explain in terms of variables observable within the immediate subarea precinct, and we suspect the influence of external factors. The various quarries lying in 26Ek3032 north of the subarea, for instance, induce the clustering of numerous reduction stations in their vicinity (500 - 1100 m from the residential zone), and the effect of undetected residences beyond surveyed boundaries should be similar. It may be, in fact, that the bimodal profile of the Western Periphery expresses the pattern depicted in Figure 275, in which high densities of late stage reduction stations are replaced, at increasing distance from residences and increasing proximity to quarries, by high densities of early stage reduction stations. The issue cannot be tested with data in hand, however, since no debitage patterns have been characterized in the northwestern half of the subarea (i.e., where most of the outlying reduction stations occur).

Additional to expectations regarding distance from residences and quarries, we advanced in Chapter 4 the proposition that, since toolstone comes *from* quarries and generally (we assume)

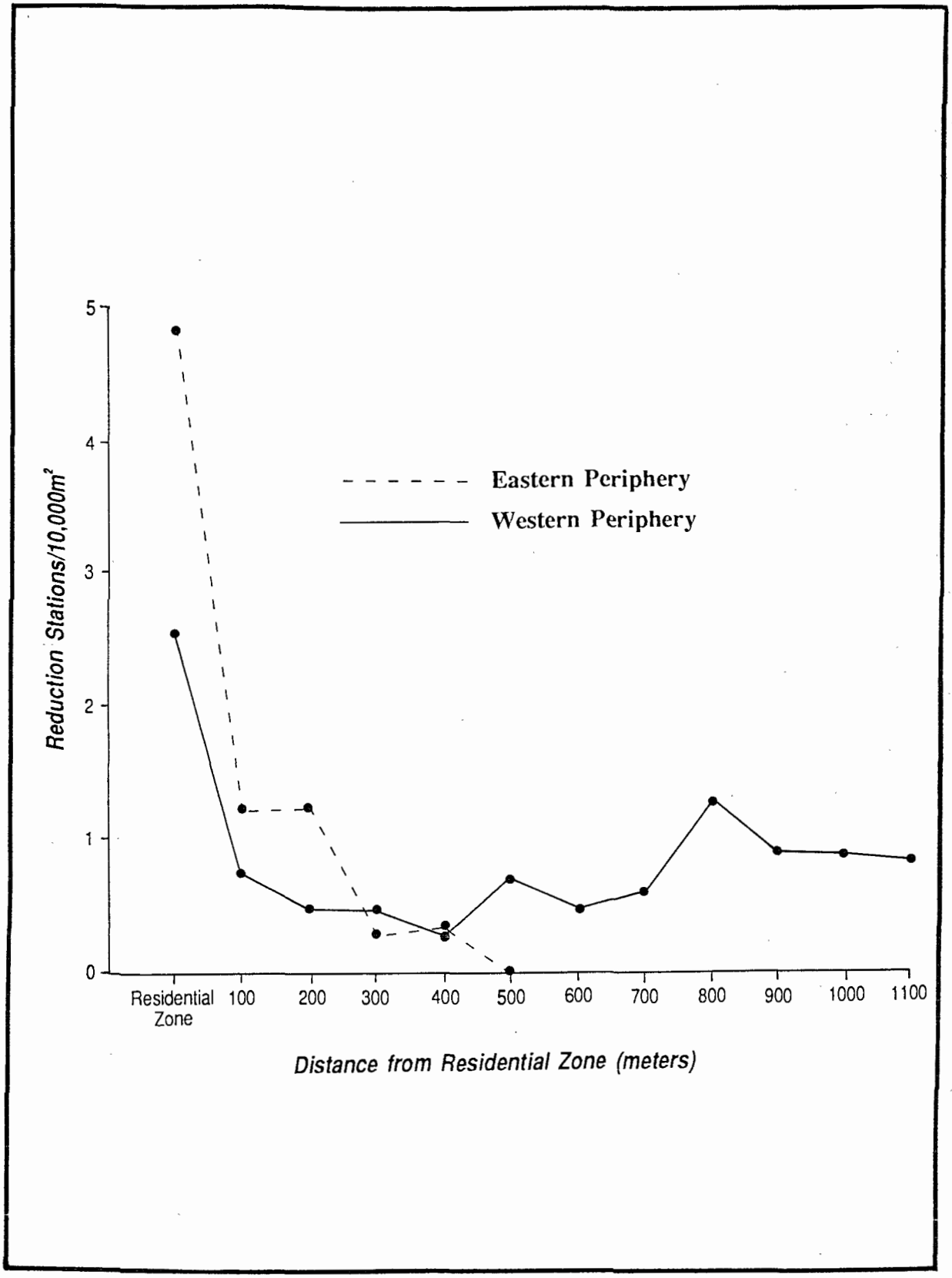


Figure 282. Mean areal frequency of Reduction Stations by distance from residential zone; Eastern and Western Peripheries compared.

is transported *to* residences, the location of reduction stations should exhibit directional preference for corridors between sources and destinations. To test this, we divided quarry zones into six sectors, centered on the subject quarry as in Figure 283; sectors were numbered, and oriented so that what we called Sector 1 always lay directly facing the nearest principal residence. Lacking areal data, we did not include the Northern Corridor in the examination. In the Eastern Periphery, sectors were oriented to the center of the Ramadan Ridge residential zone (especially 26Ek3170 and 26Ek3171), in the West, to the nexus of 26Ek3092 and 26Ek3095. We limited inquiry to quarries lying within the two subareas, eliminating that at 26Ek3171 because it falls within the principal residential zone of the East. We then counted reduction stations within each sector, ignoring those lying in quarry zones intervening between the subject quarry-residence pair, and calculated areal frequencies. Table 233 compares the cumulative Sector 1 densities with those of the remaining sectors in both subareas.

Table 233. Areal Frequency of Reduction Stations by Quarry Zone Sector.

Sector	Reduction Stations n	Area (m^2)	Reduction Stations/ 10,000 m^2
Eastern Periphery (26Ek3195, 26Ek3197, 26Ek3200)			
1	19	93,125	2.04
2-4	40	265,000	1.51
Western Periphery (26Ek3084, 26Ek3270)			
1	117	835,000	1.40
2-4	17	425,000	.40
Eastern and Western Peripheries Combined			
1	136	928,125	1.47
2-4	57	690,000	.83

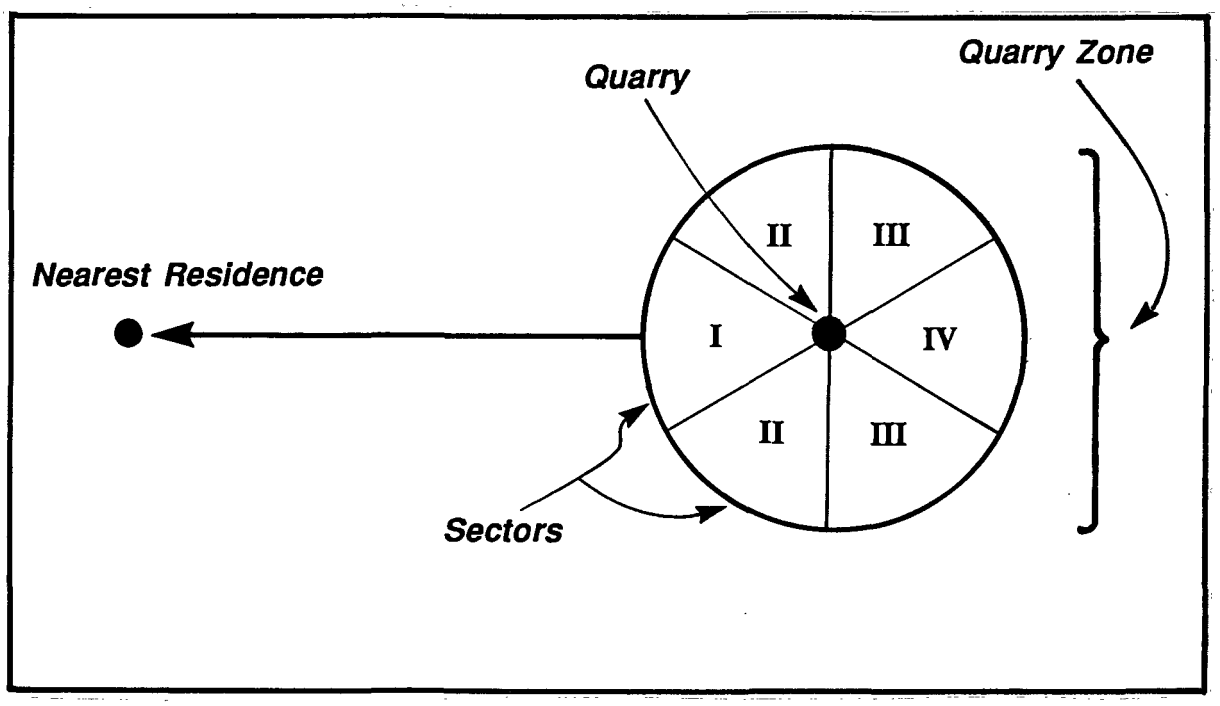


Figure 283. Quarry zone divided into sectors defined by direction of nearest residence.

Both subareas exhibit notable directional preference in favor of placing reduction stations toward residences, apparently imposing another level of order on the distance-dependency that organizes the location of reduction stations with respect to quarries. The pattern is somewhat less pronounced in the Eastern Periphery owing, probably, to the "noise" induced by the greater density of quarries in that subarea and the likely spill-over of related reduction stations into adjacent quarry zones. In both subareas, however, as in their combined figures, the areal frequency of reduction stations lying in the direction of residences is greater, and that of those lying away from residences lower, than would be expected were they located at random throughout the field (random expectation is 1.65/10,000 m^2 in the Eastern Periphery, 1.06 in the Western Periphery, and 1.19 in both subareas combined).

A final observation on the location of reduction stations is prompted not by expectations advanced in Chapter 4, but rather was inspired by carrying heavy excavation equipment (after a substantial breakfast of biscuits and gravy) up a steep slope to the canyon-rim rockshelter 26Ek3204. Throughout the Eastern and Western Peripheries, 77% of all reduction stations (61% in the East, 88% in the West) lie at elevations lower than the nearest quarry. This trend prevails despite that in both areas only slightly less than half the surface area lies higher than the major quarries. There is, of course, considerable opportunity for causes other than the obvious to have influenced this correlation; residences, for instance, which attract reduction stations, tend often to occupy lower settings where water gathers. Whatever the source of correlation, however, it meant that, more often than not, toolstone was carried *down*hill rather than up; we suspect that, even absent the attraction of residences, prudent quarriers would have seen the advantage in that.

Bifaces as Indices of the Geography of Production

It was observed in Chapter 23 that, on a macroscopic scale, the relative proportion of later stages of lithic reduction reflected in debitage tends to increase as a function of distance from toolstone sources. This accords well with expectations of the model depicted in Figure 275, and encouraged us to look at patterns smaller in scale to see whether we could determine within how narrow a compass distance minimization continued to influence where reduction was enacted and where its products were carried. We examined the distribution of bifaces in the Eastern and Western Peripheries, inquiring particularly how the frequency of occurrence of their stages relates to the location of quarries and residences.

In order to assemble populations of manipulatable size, we lumped the finer classificatory shadings by which bifaces are analyzed elsewhere in this report (Chapter 6) into a tripartite scheme recognizing only an early stage (equivalent to analytical Stage 1 through early Stage 3), a middle one (middle Stage 3), and a late (late Stage 3 through Stage 5). We ignored bifaces that, due to fragmentation, could not be assigned to stage. Too, we abandoned consideration of "site" associations, looking instead at the absolute distance each piece lies from the quarry or residence nearest it, on the assumption that each reflects a distinct and separable event of reduction or transport.

The 1780 classifiable specimens recovered from the Western Periphery lie on average 76 m from the nearest edge of the residential zone and 466 m from the nearest quarry; in the Eastern Periphery, the same distances of 1027 specimens average 81 m and 142 m, respectively. When average distances are calculated by subarea for each of the stages considered here, we can begin to test the efficacy of the model represented by Figure 275. As depicted in Figure 284, the pattern in the Western Periphery accords very well with the general expectations of the model; each successive stage of biface reduction lies progressively further from the nearest quarry than the immediately preceding stage, while each lies progressively closer the nearest residential zone. At this level of abstraction, however, neither

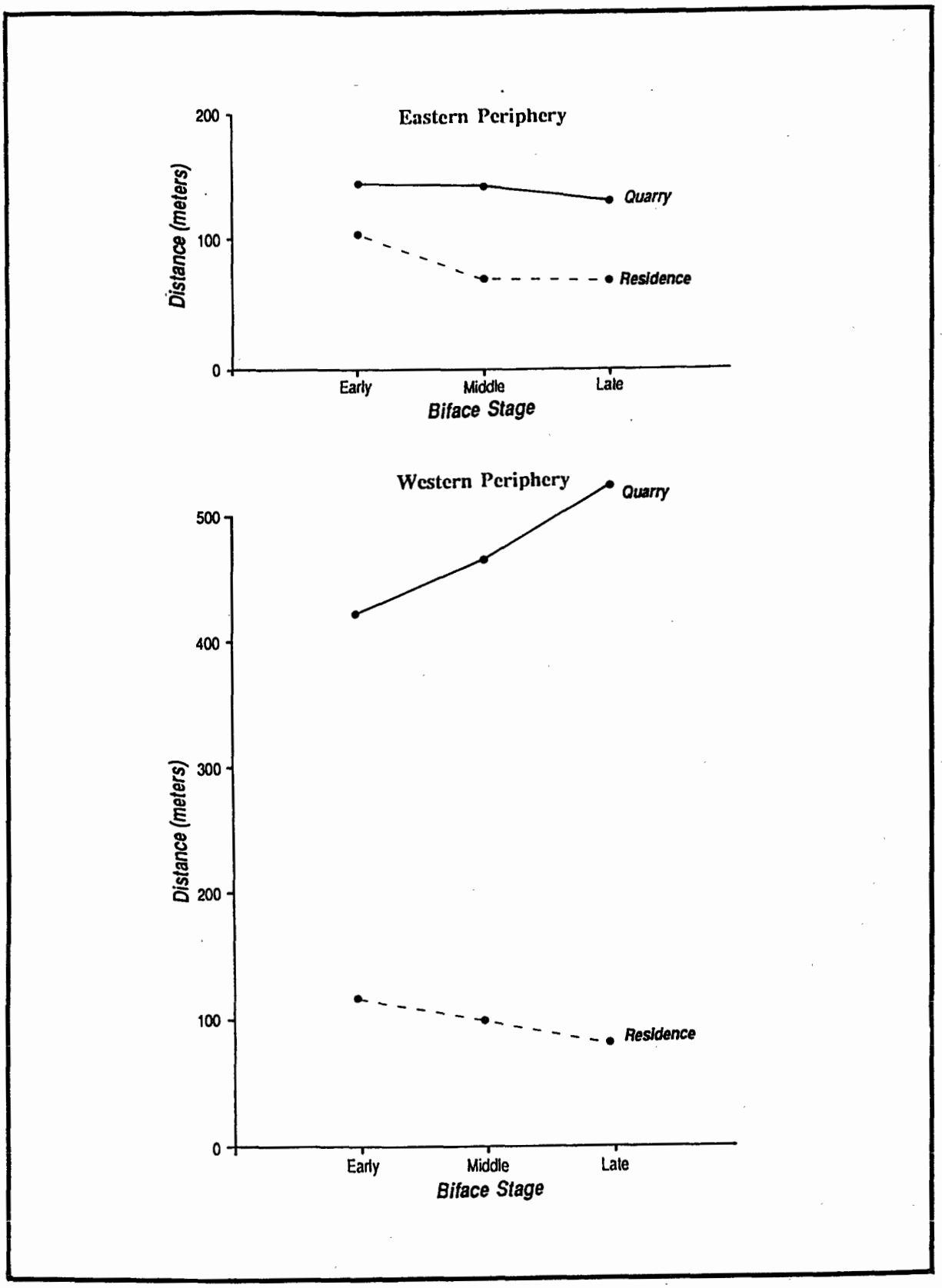


Figure 284. Average distances of bifaces by stage from nearest quarry and residence.

of the expected patterns is reflected in the Eastern Periphery, where later stages of biface appear on average to lie *closer* to quarries than earlier stages, and closer to residences than middle stage ones; two factors doubtless influenced this distribution.

In the first place, available distances between *all* classes of phenomenon simply are very much smaller in the East than in the West, with the result that opportunities for distance minimization to come into play necessarily were less frequent and less relevant to the efficiency of local spatial strategies. In the second place, the preponderance of quarries in the East occurs *within* the eastern residential zone, so that decisions regarding the appropriate relationship of transport to reduction stage cannot have been very important; as depicted in Figure 285, all stages of biface reduction occur most frequently within 100 m of the nearest quarry, but all, as well, occur within 100 m of the residential zone (cf. Figure 284). Thus there were fewer strategic motives to move unreduced, or preliminarily reduced, packages of toolstone around the local landscape of the Eastern Periphery, since origins and destinations there so frequently coincide.

Frequency distributions of all biface stages tend to peak in the Western Periphery at distances of about 400 m from the nearest quarry (Figure 286), a pattern reflecting, as discussed above, the distribution of relatively level ground in the subarea; at this average distance we find not only the nearest topographic opportunities to stage prolonged reduction episodes comfortably, but also the proximal edge of the residential zone. Beyond 400 m from quarries the relative frequency of early reduction stages declines in the relationships predicted by the model, while a second, slightly higher peak of late stage reduction (at about 600 m from quarries) clearly is induced by the location of far-lying residences at 26Ek3160 and, particularly, 26Ek3165.

While our data on the distribution of biface stages relative to distance from residences does not bear too much scrutiny (since in both subareas most of our work was conducted within or adjacent residential zones), the overall distributions of biface stages as a function of distance from nearest quarry exhibit strikingly different patterns in the Eastern and Western Peripheries. As can be seen in the area graph of Figure 287, the relative proportion of early stage bifaces declines with increasing distance from quarry in the West, that of middle stages increases modestly and irregularly, and that of late stages increases substantially. No such trend is evident in the East, where early stages dominate *furthest* from quarries, at a distance where no late stages are encountered whatsoever. We conclude, therefore, that it is only at distances greater than ca. 400 m, and in settings where major toolstone sources tend not to be coincident with residences, that principals of distance minimization visibly begin to affect the distribution of reduction activities in the immediate Tosawihi vicinity.

Clusters of Clusters

Archaeological places designated "sites" at Tosawihi consist of aggregations recognized at various scales, ranging from single clusters of artifacts widely separated from other, similar clusters in the same region to quite large complexes (clusters of clusters) unified topographically, functionally, or spatially. In many instances, discrimination of sites and delineation of their boundaries depended in the field on a kind of intuitive spatial analysis responding to perceptions of meaningful clustering, with the predictable result that various functional classes sometimes were grouped by proximity while more dispersed clusters sometimes were grouped by functional unity. While this is not intrinsically wrong, it means that sites do not constitute particularly useful units of comparison without fairly explicit qualification of what is being compared. Fortunately, most identifiable activity areas at Tosawihi have to do chiefly with toolstone extraction, lithic reduction, and residence, and most sites consist of various mixes of the features left by those activities.

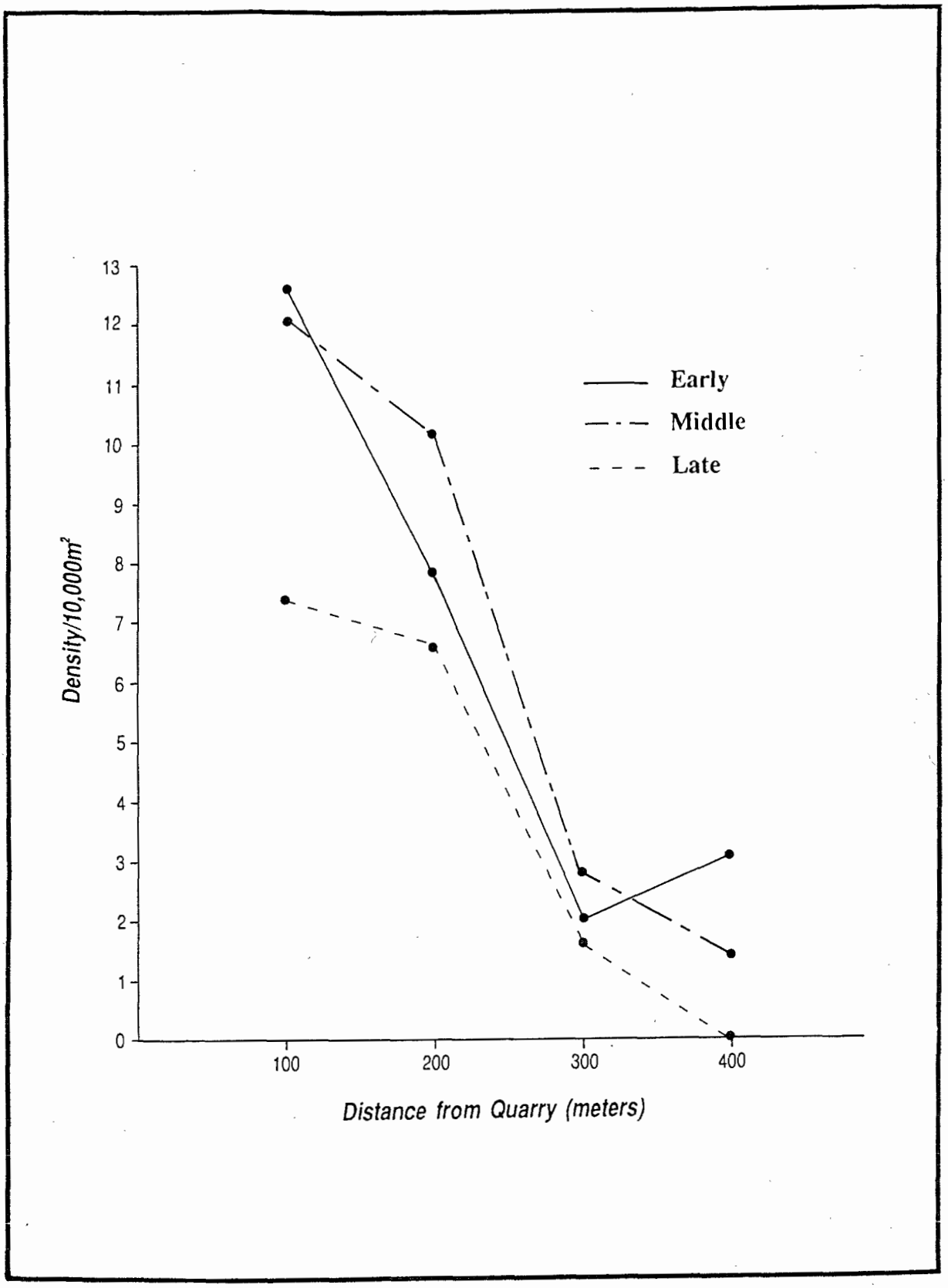


Figure 285. Areal frequency of biface stages by distance from nearest quarry, Eastern Periphery.

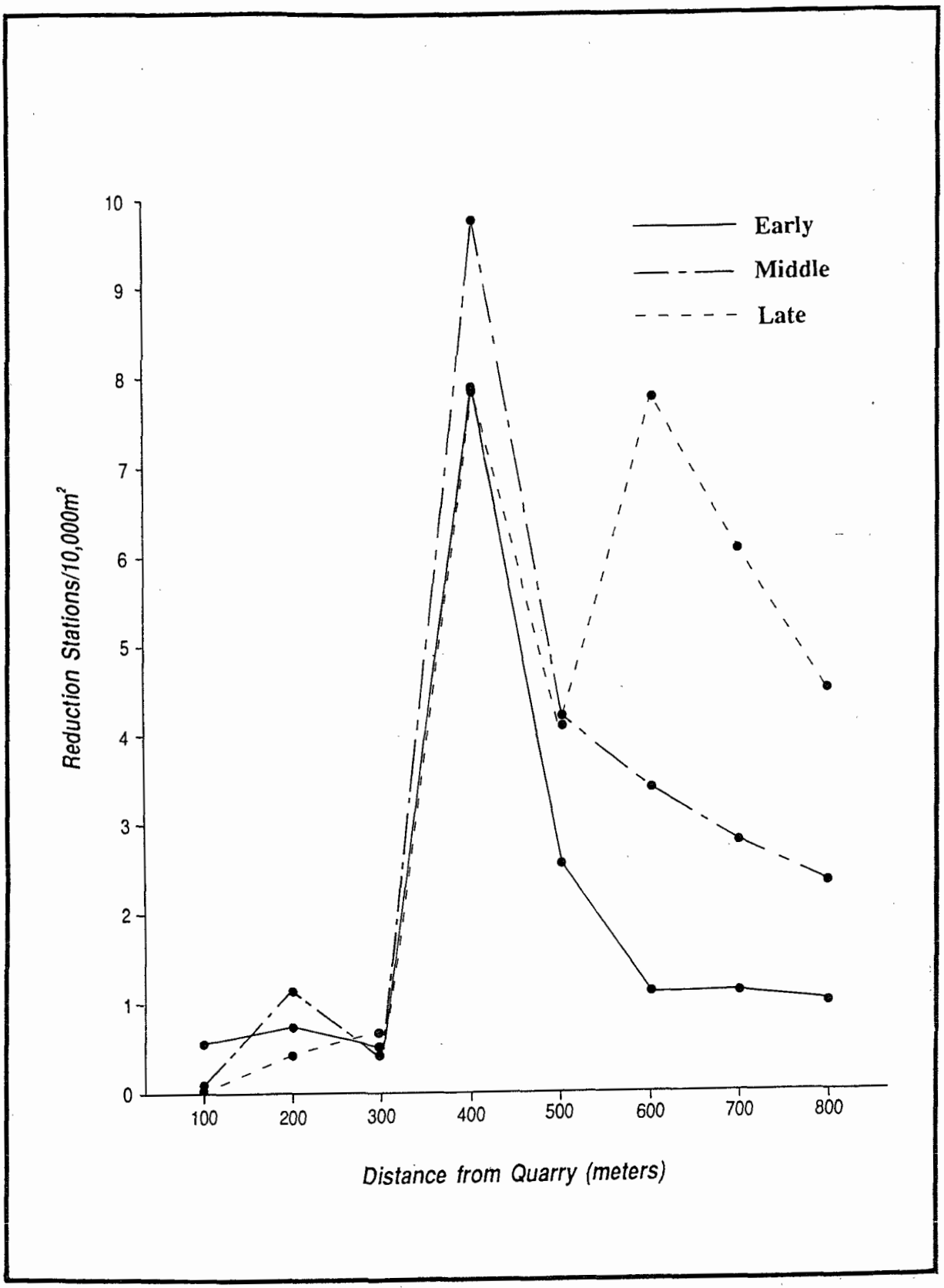


Figure 286. Areal frequency of biface stages by distance from nearest quarry, Western Periphery.

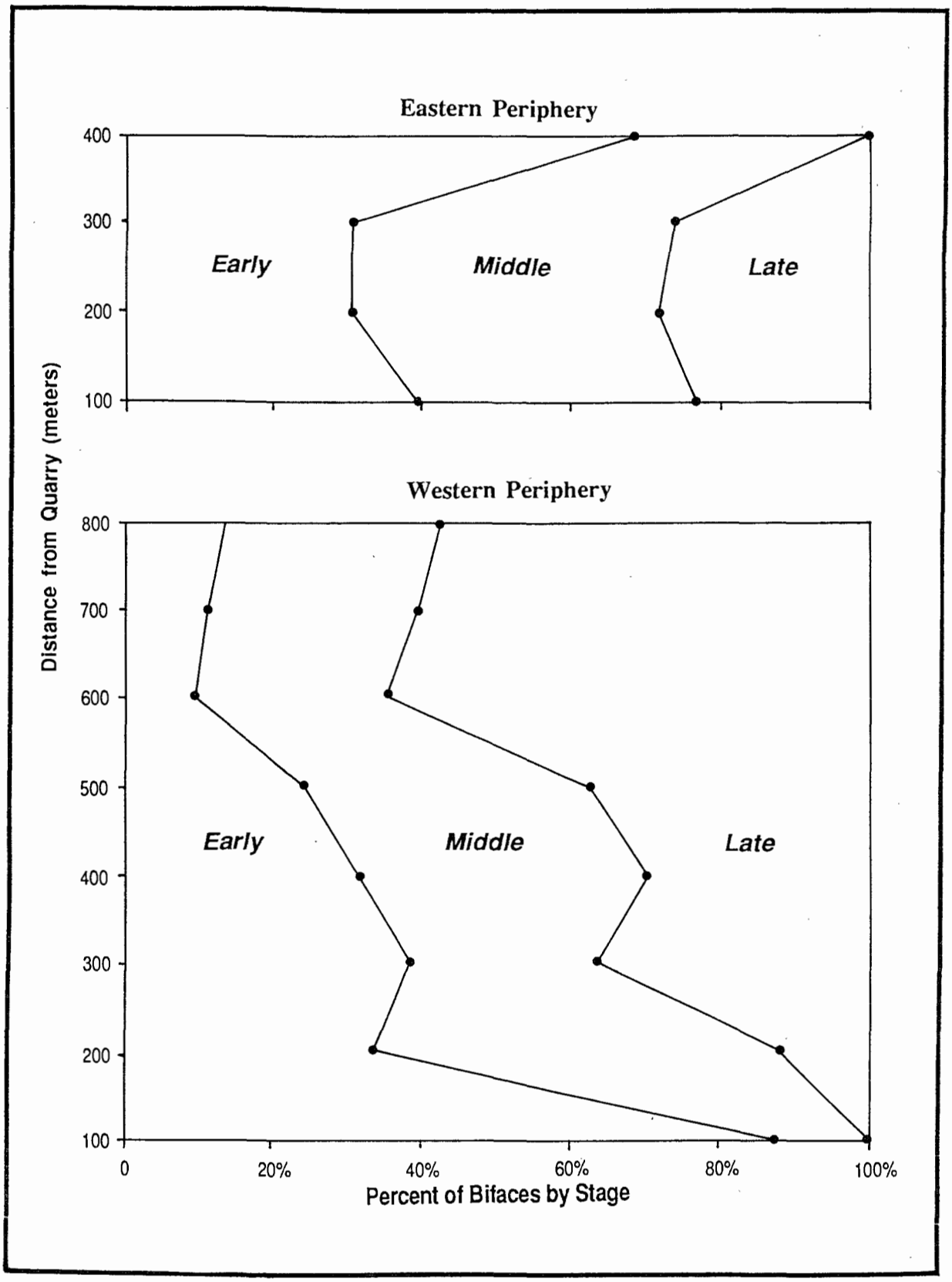


Figure 287. Percentage of bifaces by stage as a function of distance from nearest quarry.

Chapter 22 has dealt at length with the site formation processes and resulting spatial structures attending various strategies of toolstone extraction, and the units of that discussion (particularly quarries and quarry pits) will be employed here without further examination. We are more concerned at present with how quarries, reduction stations, and residential features form distinctive aggregates on the landscape. As in our discussions of location and distribution, reduction stations constitute our most populous and varied data class.

Reduction stations at Tosawihi occur in isolation or, more frequently, in aggregates composed of from two to as many as 25 members. Larger aggregates, particularly, may co-occur with quarry features and/or residential characteristics (cf. Chapters 23 and 24). Large aggregates of reduction features are self-evidently clustered with respect to surrounding patterns, and the site boundaries that now enclose them reflect a rapid fall-off in density at their perimeters. In order to inquire whether their spatial clustering is more likely the product of activity organization or simply the consequence of repeated use of the same spatial field, we looked at a sample of such aggregates from the perspective of the arrangement of reduction stations within them.

To ensure manipulability, we limited the sample to aggregates with populations having 20 or more reduction stations for which we control mapped locational data; these criteria selected three sites in the Western Periphery (26Ek3095, 26Ek3160, and 26Ek3271; cf. Chapter 16) and two in the east (26Ek3184 and 26Ek3198; cf. Chapter 17). To varying degrees, all exhibit residential attributes; two of them (26Ek3184 and 26Ek3198) contain very minor quarrying features as well.

We are less interested here in the density with which reduction stations are packed into these aggregates than we are in trends toward patterning in their arrangement. We assume, for instance, that multiple, concurrent episodes of work performed within a single spatial field are likely to be clustered, and that clustering is likely to intensify over longer periods of use as task-specific segmentation of site precincts emerges under the momentum of conventional usage. Absent locational constraints (e.g., microtopographic zonation) or the establishment of reusable facilities, however, we assume that aggregates resulting from repeated short-term visits are likely to be distributed largely at random.

Nearest neighbor analysis (Clark and Evans 1954; Boots and Getis 1988) measures trends toward clustering, randomness, and uniformity in the distribution of points in a field, and we applied the technique to our sample of reduction station aggregates. The results are summarized in Table 234.

Table 234. Summary Nearest Neighbor Statistics for Five Reduction Station Distributions.

Site	n	ρ	$\bar{r}_a$	$\bar{r}_e$	R	$\sigma \bar{r}_e$	C
26Ek3160	23	.0006889	11.96	19.05	.6278	2.076	-3.41
26Ek3184	25	.001242	12.92	14.19	.9105	1.483	-.86
26Ek3198	20	.0017974	14.25	11.79	1.2086	1.378	1.78
26Ek3271	22	.0009653	14.77	16.09	.918	1.7935	-.74
26Ek3095	25	.0017195	11.72	12.06	.9718	1.2606	-.27

n = number of cases (reduction stations)
ρ = density; n/area (m^2)
$\bar{r}_a$ = mean distance to nearest neighbor (m)
$\bar{r}_e$ = expected mean in random distribution of density ρ
R = nearest neighbor statistic, expressing deviation from random expectation
$\sigma \bar{r}_e$ = standard error in randomly distributed population of density ρ
C = standard variate of normal curve

The first issue of note is that nearest neighbor distances between reduction stations differs very little among the various sites (considerably less, for instance, than would be expected were all sites characterized by random distributions). Too, they appear relatively closely spaced; any reduction station from the population as a whole is likely on average to lie only 13.12 m from its nearest neighbor. More interesting is the nearest neighbor statistic (R), which characterizes the degree to which the individual populations deviate from randomness. In a random distribution, R will have a value of 1. R values less than one indicate trends toward clustering, to the point where, when R=0, all points occupy the same location. R values greater than one indicate trends toward uniformity, with the limit that when R=2.1491 the distribution is maximally dispersed and perfectly uniform (Clark and Evans 1954).

R values for the sample of reduction station aggregates reflect very slight degrees of clustering at 26Ek3184 and 26Ek3271, a very slight tendency toward uniformity at 26Ek3198, and an almost perfectly random distribution at 26Ek3095. C scores for these values, however, indicate that none of them differs significantly from randomness at the .05 level (C=1.96 at .05). This means, then, that we have no reason based on distribution to assume that the placement of reduction stations at these four sites responded to anything but a random process. Put another way, we cannot say that the use of space within their precincts was structured in any way reflected by the distribution of reduction stations. This may imply that the sites grew over a period of time, the consequence of several revisits during the cumulative course of which reduction stations were added to the population without being influenced by the locations of earlier episodes and without being added during any one visit in numbers sufficient to confer detectable patterning.

The case is different at 26Ek3160, where a low R value indicates a rather high degree of clustering and a high C score indicates a significant deviation from randomness (C=2.58 at the .01 level). This might imply that the site was formed during a single, highly structured occupation, but this is contradicted by the substantial depth of deposit and the wide diversity of projectile point types which it exhibits (cf. Chapters 8 and 16). Rather, it would appear that the site was reoccupied frequently, and that the use of space within it tended to follow generally reiterative patterns. The emergence of a dense background scatter of cultural materials and a deep deposit composed of blurred palimpsests of numerous activity episodes is characteristic of various other residential aggregations in the Eastern and Western Peripheries (most notably, 26Ek3170, 26Ek3171, and 26Ek3092), where intensive and frequent reuse of portions of the site has resulted in maximal clustering. At 26Ek3092, the most spatially constrained of these sites, the degree of overlap and blurring is so pronounced that discrete surface features are barely detectable, although excavation revealed a formidable concentration and "stacking" of features adjacent a large boulder constituting the site's principal activity focus. 26Ek3160 (as well as 26Ek3170 and 26Ek3171) occupies much broader, convex expanses (as opposed to the relatively small concavity occupied by 26Ek3092), and thus tolerated more diffuse patterning of activities. Within each, however, the attraction of a broad, relatively level zone (in each case toward the downridge margin of the site) resulted in the accumulation of a pattern so highly clustered that it has become extraordinarily difficult to discriminate its units.

The random distributions of reduction stations at 26Ek3184 and 26Ek3095 is particularly instructive, in that both sites occupy very similar spatial relationships to major residences (26Ek3170 and 26Ek3095, respectively). Both are proximal to sites in which activity areas have achieved the blurred degree of clustering described above, yet both are composed of a large number of discrete, relatively shallow reduction features the assemblages of which exhibit various residential attributes. It would appear that the broad, generally level expanses of both precincts may have served as occasional workshops satellite to the more intensely focused occupation of the neighboring residences, but that neither provided a degree of attraction resulting in highly structured use of their space.

Facilities in Clusters

Immovable, potentially reusable facilities can have particular spatial significance by attracting repetitions of the same activity to the same location (Binford 1983a:144-148; Wagner

1960). They are potent elements of place-making and, among mobile populations, may induce a spatial focus for certain classes of activity spanning numerous episodes of revisitation. In the Great Basin, for instance, house floors (O'Connell 1971; Zeier and Elston 1986), drive fences (Pendleton and Thomas 1983), and storage facilities (Ingbar 1985; Raven 1988) constitute diverse facilities likely to influence, over various scales of time, the activities performed in their vicinity. At Tosawihi, of course, the excavation of quarry pits constituted a quintessential act of place-making, since both the effort initially expended and the improved access to toolstone encouraged revisitation until the source was depleted. For this reason much of the present chapter has been concerned with how other aggregates of the archaeological record are related spatially to the location of quarries.

Other kinds of facility are likely to have exerted other kinds of influence, however, and we were at particular pains to look for residential structures, storage facilities, and hearths, suspecting that their patterns of co-occurrence with various classes of site and feature would help explain why activities were performed in certain locations. The hoped-for data, however, proved very slender. *No* residential facilities were detected, for instance, despite concerted efforts to discover them in what seem likely locations (i.e., major residential precincts in all three subareas), and we conclude that shelter at Tosawihi generally tended to be so ephemeral that it left little by way of detectable traces.

We were interested in hearths both as foci of small scale activity (warming hearths) and components of lithic reduction technology (heat-treatment facilities), and we expected to find them at residences as well as in occasional association with reduction stations away from residences. We found, however, only six indisputable hearths, all of them in residential or semi-residential contexts (two in the Western Periphery, at 26Ek3092 and 26Ek3160, one in the Eastern Periphery, at 26Ek3198, and three along the Northern Corridor, all at 26Ek3237). It was not possible to conclude from excavation of their contents whether the hearths at 26Ek3237 served primarily for cooking, personal warming, or the heat-treatment of toolstone, although the former two functions seem more likely (cf. Chapter 18). That they all occur within an 8 m radius suggests similar, reiterative use of the same location over time, but radiocarbon assay (spanning some 17 centuries) implies that the decision to build a fire in the vicinity probably was induced by factors other than the proximity of earlier fireplaces. Likewise, hearths at 26Ek3198 and 26Ek3160 proved not functionally diagnostic; although both occur within fairly complex reduction features, neither yielded subsistence residues or thermally altered opalite in quantities sufficient to clarify their use. Only the hearth at 26Ek3092 appears unequivocally to have functioned as a heat-treatment facility (cf. Chapter 16), although we were able to discern no evidence arguing convincingly that it had been used more than once.

The only functional equivalents of storage facilities we encountered consist of apparent caches of largely non-heat-treated bifaces (cf. Chapter 6). Four such features were found during testing and excavation, three in the Eastern Periphery (at 26Ek3170, 26Ek3192, and 26Ek3197) and one in the West (at 26Ek3095). All save that at 26Ek3197 (a quarry/reduction complex) occur in contexts exhibiting independent residential attributes, suggesting that the caching of bifaces tended to occur in places likely to be revisited for other reasons. Since storage of any resource implies at least the *contemplation* of a return to recover the cached goods, this accords well with the logic of distance minimization as a spatial strategy.

Conclusions

We have looked at several kinds of spatial relationship in Tosawihi archaeology, and tried to identify some of the regularities in how space was used prehistorically. We were interested particularly in how work was organized in space, and in how that organization was influenced by the geographies of resources and cultural places. The intent of our inquiry was

to learn whether spatial strategies are likely to have contributed importantly to improving the benefit/cost ratio of getting toolstone.

We have learned that principals of distance minimization seldom were violated at the quarries, especially where larger distances came into play, and that spatial decisions affecting the locations and distributions of various kinds of activity generally can be regarded as effective economizing measures. The spatial relationships of residences, quarries, and reduction stations all appear to have succeeded in reducing debts of travel and transport, so we conclude that prudent manipulation of the use of space was a beneficial, significantly rewarded strategy for diminishing the costs of extracting, reducing, and moving toolstone over the landscape.

Chapter 26

ECONOMICS AND STRATEGIES OF LITHIC PRODUCTION AT TOSAWIHI

Robert G. Elston

...it would be unprofitable to transport masses of material of which nine-tenths would finally have to be consigned to the refuse heap.
—William Henry Holmes 1897:26

Chapter 3 presented a cost-benefit model of hunter-gatherer lithic procurement and use in which components of lithic production strategies (mobility patterns, labor organization and technology) are varied to meet different contingencies that affect costs and risks of toolstone procurement. Basic cost reduction strategies and their archaeological consequences were discussed in Chapter 4. In both chapters, we assumed that prudent foragers seek to improve the benefit/cost ratio for lithic acquisition by minimizing procurement costs, thus freeing time and energy for other purposes, and also decreasing venture risk (the probability of investing more in toolstone procurement than is returned in tool utility). As discussed at length in previous chapters of this report, foragers may find the most latitude in cost reduction among *indirect costs* (lost opportunity, support, social overhead), through use of scheduling, labor organization and positioning.

Direct costs in lithic procurement (extraction and processing) are likely to offer less room for manipulation. It is true that foragers can adjust direct costs of procurement by choice among lithic sources, by choice of toolstone available at a specific source, and by choice of procurement technology. But such choices may be limited by access, scheduling conflicts, or time constraints. In any case, the decision to use a particular source and technology may narrow considerably the range of possible per-unit procurement costs.

Quarrying bedrock is the most costly means of directly acquiring lithic resources. A quarry such as Tosawihi thus strongly indicates that minimizing direct procurement cost was not the dominant consideration in lithic procurement. The advantages offered by bedrock quarrying all seem to involve production returns: yields are predictable under a range of conditions, quarries may withstand intensive production for long periods, and they may sustain high return rates. Indeed, the most compelling reason to quarry seems to be the need to maximize return (*profits*) that arises when the utility of a certain amount of toolstone is required in a given amount of time (e.g., when access to other sources is limited, subsistence tasks consume large amounts of toolstone over short intervals, or demand exceeds local needs).

The present study, focused on Tosawihi itself, sheds little light on *why* people quarried at Tosawihi; this is a question for future research on a regional scale. In this chapter we accept the fact that people *did* quarry at Tosawihi, and attempt to model some of economics of the process. First we outline costs and constraints of lithic procurement, then present experimental data regarding quarrying and processing returns. These data are employed to explore the marginal value of lithic processing, and to model tradeoffs between processing and transportation costs. Finally, we turn to an evaluation of archaeological evidence for use of various strategies of lithic procurement at Tosawihi in light of costs and benefits.

So far, our descriptions and analyses of Tosawihi sites and lithic artifacts confirm what has been suspected since Mary Rusco's pioneer work: the main business of quarrying at Tosawihi was biface production. While the production of flakes also occurred, this activity is not particularly visible in our analyses of the archaeological record. Indications from sites in the surrounding region suggest that flakes were produced at Tosawihi and transported *as flakes* prior to heat-treatment; how much of that went on we do not know, but we assume

that it was less important than biface production. Consequently, our actualistic experiments in quarrying and replication are focused on biface production, and the reader should be aware that unless some other technology is mentioned specifically, models and strategies of "lithic production" in the following discussions refer to only biface production.

Costs and Constraints of Lithic Procurement

The various costs of lithic procurement are outlined in Table 235. Direct costs are grouped under the rubrics of search and handling, while indirect costs include lost opportunities, subsistence activities that support the procurement foray, and social overhead. The former are amenable to estimation from ethnographic analogy and experimentation; the latter are much more difficult to quantify. In the following sections, each of these costs is discussed and data from our reduction and quarrying experiments are employed to estimate time and energy required for bedrock quarrying and processing, utility/waste ratios, extracted toolstone package size, point in reduction trajectory when bifaces should be transported, and risks of heat-treatment.

Table 235. Costs of Lithic Procurement.

DIRECT		INDIRECT
Search	**Handling**	**Opportunity**
Travel to Source	Extraction excavating wasterock quarrying bedrock	Non-Lithic Resources Unpursued
Prospecting inspection assaying excavating overburden	Processing blank production biface reduction heat-treatment	**Support** **Social Overhead** Maintenance of Trade Partners
	Transportation to Place of Use	Permission to Forage Permission to Quarry

Travel and Transportation

Time and energy expended in travel to source is a cost directly proportional to the distance traveled. Jones and Madsen (1989) estimate the cost of walking to be 100 calories per kilometer at 3 kilometers per hour, and the cost of load carrying to be 1.25 calories per kilogram per kilometer. For simplicity, this often is measured as straight line distance between source and point of departure. In actuality, long distance travel in a straight line often may be quite expensive in terms of opportunity costs, particularly if the route traverses passless mountains or waterless areas. Regional data from the Monitor Valley project (Thomas 1988:592-615) suggest that central Great Basin hunter-gatherers on long distance residential or logistic moves were more likely to travel over passes and along riparian routes offering natural shelter, where plants and game were more likely to be encountered and water more easily procured. In other words, the additional costs of taking a less direct route are likely to be more than balanced by the greater safety, comfort, and opportunities such a route can offer (Werner 1985:26-33). We assume that long distance moves to and from Tosawihi were made along major riparian routes.

Problems of supply should be less pressing for diurnal forays than for long distance travel. Nevertheless, travel time still is a crucial factor because with greater distance from camp, less time remains for work at the resource location. Therefore, as suggested in Chapter 4, the radius of diurnal travel should constrain procurement technique. With each increment of diurnal travel distance, the lithic forager must choose a less labor intensive extraction technique, defer processing, or both. This suggests a continuum for lithic resource procurement within a given daily foraging radius (Figure 288). At the maximum diurnal range, it would pay only to procure very high quality, pre-processed lithic material (for example, to retrieve cached flake blanks and bifaces). With shorter distances or travel times, a likely target might be previously quarried, but relatively unprocessed material available from the surface in cobble fields, in stream deposits, or on quarry pit berms and dumps. Closer still to the base camp, it might pay to grub through quarry pit berms in hopes of encountering chunks of high quality material that require minimal processing. Thus, bedrock quarrying, requiring a considerable investment of time and energy before any toolstone can be extracted (even from a known and productive quarry pit), is not expected beyond a relatively short distance from the base camp.

Work time (Tw) for lithic extraction and processing varies not only with travel time (Tt), but also with available daylight hours (Tl) and with the number of hours spent in activities other than travel or lithic work (Ta):

$$Tw = Tl - (Tt + Ta)$$

Belovsky (1987) suggests that time available to human foragers is constrained by their physiological ability to maintain thermal equilibrium (assisted, of course, by cultural adaptations such as clothing, fire, and shelter). In cold seasons, activities other than work and travel may include waiting for the air temperature to rise in the morning before venturing forth; in summer, folks may need to seek shade and rest during the hot part of the day.

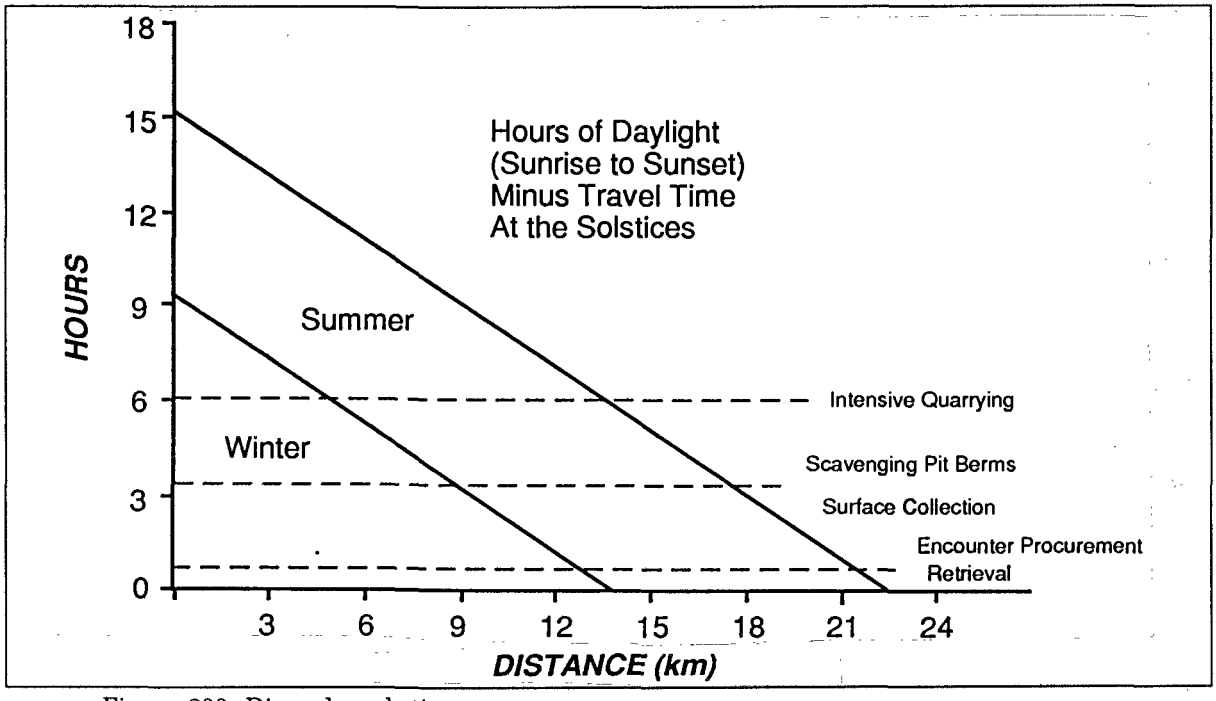


Figure 288. Diurnal work time.

As modeled in Figure 288, at the latitude of the Tosawihi Quarries (North 41° 7") there are 15 hours 13 minutes between sunrise and sunset at the summer solstice (June 21), but only 9 hours 15 minutes at the winter solstice (December 22). Assuming an average walking speed of 3 km per hour, the maximum one-way distance a forager can walk in the 15.13 hours of daylight at the summer solstice is 45.39 km. This translates to a maximum diurnal range of 22.7 km if the entire day is consumed in travel. In the high summer of north-central Nevada, a forager can make a 10 km round trip from base camp, consuming 6.7 hours, and still have 8.4 hours of work time at the procurement destination. Foragers making summertime lithic forays within something less than a 10 km range should have a surplus of time in which to pursue other activities, allowing greater flexibility in base camp location.

In contrast, foragers can walk only 27.75 km in the 9.25 hours of daylight at the winter solstice, yielding a maximum mid-winter diurnal range of 13.86 km. A forager making a 10 km diurnal foray to a lithic source in winter would consume 6.7 hours in travel and have only 2.5 hours of work time. Thus, available daylight appears to seriously constrain winter diurnal range and work time.

Prospecting

Prospecting involves the active search for toolstone. The prospector is looking not only for material that meets some standard of quality, but also is assessing other benefit/cost variables; attention is given the type of toolstone available, the structure of the deposit, the amount of overburden, the form in which the material occurs, the package size in which it can be extracted, and the difficulty of extracting it. Prospecting occurs at two scales. At one scale, people are involved in a search for toolstone sources; they watch for toolstone, and sample it when it is discovered (encounter prospecting), as they travel and forage through the annual range. We assume that shortly after the earliest people entered the north-central Great Basin, all the important sources of lithic material, including Tosawihi Quarries, were thus discovered and "mapped" into the culture as personal experience and myths passed on from generation to generation (cf. Gould and Saggers 1985; Jones and White 1988).

At the smaller scale of a known and previously exploited lithic source, such as the Tosawihi Quarries, the prospector's task is to find the most productive patch to exploit. Since the materials most easily collected and extracted probably were exhausted soon after initial discovery, this kind of prospecting requires experience, special knowledge, and focused attention; unlike encounter prospecting, it cannot be embedded as fully in other activities, if at all. Both direct and opportunity costs of focused prospecting are thus high, as they are with other search and extraction aspects of quarrying. The degree to which the establishment of a quarry results in reduced need for local prospecting, the lower the investment risked in the venture. As with any other kind of mining, the best prospect is a productive mine; this strategy explains efforts to expand or reexcavate existing quarry pits. Also a good bet is a place *near* a productive or formerly productive mine, which probably accounts for clusters of quarry features in the same locality. A third exploration strategy is to look for new places with geology, surface morphology, or other surface indications similar to those surrounding productive quarry pits.

Inspection and Assaying

Ethnographic accounts (Binford and O'Connell 1984:409-412; Jones and White 1988: 59-61) suggest that the first step in prospecting at a quarry is *inspection* of the surface to locate indications of buried toolstone. In the cited examples, such clues involved the presence of surface toolstone clasts (and possibly flakes), but we might imagine that the presence of toolstone in surface outcrops is the most reliable indicator. During inspection, likely pieces of toolstone are *assayed* to check quality by breaking or flake removal; the same process can be applied to outcrops.

Overburden Removal

When surface indications and assaying suggest the location of a likely spot, the next step is excavation of an exploratory pit, during which inspection and assay continues. An analogous process, but one with probably different time and energy requirements, is the removal of weathered and checked material from surface outcrops. Also included as "search time" is the removal of overburden when a productive pit is being expanded to expose additional toolstone deposits.

We have no ethnographic points of comparison for prospecting costs applicable to Tosawihi. The few ethnographic cases (Binford and O'Connell 1984; Jones and White 1988) for which prospecting is described involve extraction of cobble clasts from a sandy matrix, rather than from bedrock. People had not visited either ethnographic quarry for a long time prior to the recorded foray, and more prospecting probably was required than necessary had the quarry been recently active. O'Connell (personal communication) recalls that prospecting at the Alyawara quarry by three Aborigine men consumed about half an hour (1.5 person hours).

In a clast quarry, one need only remove soil matrix to isolate clasts which then can be assayed and processed if of adequate size and quality. Prospecting and extraction are the same when clasts are relatively small, as at Ngilpitji Quarry (Jones and White 1988); they are distinct only when clast size is sufficient to require a technique (fire setting, percussion reduction) for extraction different from that used for discovery (cf. Binford and O'Connell 1984). Compared to clast quarries, prospecting in bedrock offers quite different problems. For instance, experimental bedrock quarrying (Carambelas and Raven 1991) suggests that prehistoric prospectors at Tosawihi had to evaluate the type and amount of fracturing present to determine whether the bedrock allowed points of ingress through cracks or tuff beds. These factors influence difficulty of extraction (and even the *possibility* of extraction) and the size of extractable packages, which in turn affect net yield. Material easily extracted but available only in small packages may have less utility in terms of potential flexibility (number of different types of tools) than material more difficult to extract but available in larger packages. While the quality of raw material is lessened by many fractures, flaws, or high tuff/opalite ratio, massive, unfractured opalite is extremely difficult to quarry.

In the case of surface outcrops or ledges with substantial above surface exposure (Type 1 quarry; cf. Chapter 22), raw material quality can be judged in part from examination of the outcrop itself and the talus (if any) accumulated below it. At a previously unquarried outcrop, Carambelas and Raven (1991) removed nearly twenty kilos of weathered and fractured waste stone in several minutes, without exposing any toolstone they considered worth extracting and processing. Tuman ax makers spent up to one month removing poor quality stone from an outcrop before reaching toolstone quality material (Burton 1984).

Where beds of toolstone intersect the slope of the surface (Type 2 quarry; cf. Chapter 22), toolstone clasts on the slope below the outcrop will signal their presence even if buried by colluvium. Prospectors encountering toolstone clasts on colluvial slopes have merely to follow the material upslope to its source and excavate to expose it. Quarriers then face the same problems of evaluation outlined for the Type 1 quarry above, exacerbated, however, by the smaller window into the deposit that excavation provides. Getting a better look requires more work. The steeper the slope, the easier pit excavation may be, as gravity provides some help in moving waste material. The pit may not hit any good toolstone, however, in which case it must be expanded, another pit excavated, or the site abandoned.

Where a bed of toolstone parallels the surface (Type 3 quarry; cf. Chapter 22), soil processes may bring toolstone clasts to the surface, but where slope is gradual, the distribution of clasts is likely to provide fewer clues to the location and quality of subsurface deposits. The cost of exploration pits at Type 3 quarries should be somewhat higher than for Type 2 quarries, as lack of slope may make excavation and waste disposal more difficult.

Experimental Prospecting and Extraction

Five actualistic quarrying experiments were conducted at Tosawihi during the 1989 and 1990 field seasons (Carambelas and Raven 1991; Carambelas, personal communication). Three experiments involved removal of overburden. Experiment 1 was located north of Feature 7 (a Type 3 quarry) in site 26Ek3171. It entailed the excavation of a vertical pit through overburden and into tuff bedrock in an unsuccessful attempt to open a Type 3 quarry into an opalite bed thought to be parallel to the surface. Experiment 2 involved excavation from the margin of a cleaned quarry pit (26Ek3271, Feature 7), through a prehistoric berm, then against a vertical face of virgin soil to expose new toolstone; this was equivalent to moving into new ground from an existing pit. Experiment 3 entailed excavation through debris filling a prehistoric quarry pit (Feature 24 in Locality 36 of 36Ek3032) to bedrock, equivalent to cleaning out an old pit.

Overburden Excavation

Excavation rates (including time employed to resharpen digging sticks, clean out debris, and search the vicinity for hammerstones) for different types of soil and tuff bedrock are given in Table 236. The highest rates were achieved excavating loose, coarse material in the berm of an old quarry pit. This suggests that excavation rates also should be high in natural colluvium and talus-like debris piles found at the foot of outcrops in Type 1 quarries, or through coarse openwork layers in old pit fill. High excavation rates also were achieved in excavating loose surficial material typical of the upper 5 to 10 cm of soil profiles throughout the Tosawihi study area. Surprisingly high excavation rates were possible in moist clay containing large cobbles; the cobbles accounted for a large proportion of the volume and could be pried out with relative ease. Rates were low in clay with smaller or fewer clasts, and particularly so in clay lying directly on bedrock. Excavation of clay-rich fill in old quarry pits is similarly difficult. Moderate excavation rates were achieved in compact silts typical of undisturbed soil profiles in the area, as well as in silty fill of old quarry pits. The lowest rates are associated with excavation of tuff bedrock.

Table 236. Experimental Excavation Rates (liters per minute).

Deposit	Experiment 1	Experiment 2	Experiment 5
Loose Surficial	5.45	n/a	n/a
Compact Silt	2.26-3.34	n/a	n/a
Moist Clay w/ Large Cobbles	3.06-3.68	n/a	n/a
Moist Clay w/ Smaller Clasts	0.87-1.91	0.17-1.46	n/a
Moist Clay w/ Few Clasts	1.13-1.16	n/a	n/a
Moist Clay on Bedrock	0.40	0.91	n/a
Tuff Bedrock	0.25-0.27	n/a	n/a
Old Berm	n/a	8.58	n/a
Old Fill, silty	n/a	n/a	2.20
Old Fill, clayey	n/a	n/a	0.53-0.92
Mean	1.73	2.17	1.10
σ	1.47	2.57	0.78

Mean excavation rates illustrate the relative difficulty of the three goals represented by these experiments. Extending or moving a quarry pit (Experiment 2) entails cutting through the berm and excavating into a more or less vertical face. This offers several benefits compared to digging a vertical pit, as in Experiment 1: larger work space, greater mechanical advantage excavating against the vertical wall, better visibility, and easy waste disposal down hill into the older portion of the existing pit. It is interesting that the lowest mean excavation rate was returned by Experiment 5, entailing reexcavation of an old quarry pit. Reexcavation has all the disadvantages of a new vertical pit (small work space, poor visibility, awkward waste disposal) and, in this experimental case, the lower portion of the old pit also contained clay-rich fill that was particularly difficult to excavate.

Experiment 2 was terminated when tuff bedrock was encountered. Attempts to "penetrate" the tuff (hoping for a bed of opalite below) with hammerstone percussion failed; too little progress could be made for the effort expended, and the risk of continuing was too great. In retrospect, the attempt to batter through tuff was a losing exploration strategy.

In comparison, Jones and White (1988) observed the extraction of toolstone clasts at Ngilipitji Quarry from a sandy soil matrix, leaving a quarry pit measuring 1.20 x 1.00 x 0.55 m deep. One hour was spent excavating the pit. Assuming the pit to be roughly hemispherical, its volume would be about .070 m^3, or 35 liters, for an excavation rate of 0.58 liters per minute. This is at the low end of the range we observed in experimental overburden removal at Tosawihi.

Toolstone Extraction Returns

Extraction involves the removal of toolstone once it has been exposed, in packages (blanks) suitable for processing. Extraction includes the concurrent removal of poor quality toolstone and wasterock in order to isolate masses of better material. At Tosawihi, waste materials include tuff, opal, and vuggy, cracked, or otherwise badly flawed opalite, along with pieces of good quality opalite damaged by the quarrying process or too small for processing into bifaces. Prehistoric extraction techniques include hammerstone percussion, wedging with antler (and probably wood), and fire setting, all of which we employed in actualistic experiments.

Prehistoric quarriers took advantage of (and perhaps depended upon) natural features in the bedrock to improve return rates. At 26Ek3208 (cf. Chapter 16), quarriers created a Type 3 quarry by working into the face and along the foot of a bedrock outcrop, taking advantage of opportunities to isolate toolstone masses offered by alternating bands of tuff and toolstone, to detach these using large hammerstones and fire, and to use gravity to help dispose of waste down the slope. At 26Ek3200 (cf. Chapter 17), a Type 2 quarry, quarriers apparently started in weaker rock along a fissure, from which they worked back into the slope to form a face. In 26Ek3171 (cf. Chapter 17), Features 2 and 7 are Type 3 quarries excavated into beds of opalite more or less parallel to the surface. In the case of Feature 7, 20 cm of weathered tuff appears to have lain between solid overburden and opalite bedrock. We assume fissures or crack systems somehow provided ingress through the tuff into the bedrock; Experiment 2 suggests that, otherwise, vertical penetration of massive tuff is too expensive a strategy.

Toolstone Packages

Extracted toolstone packages include both blocks of toolstone and large flakes, some of which were struck from bedrock. Flakes account for most blanks from which cached bifaces were made (cf. Chapter 6), and we observed a few flake scars of the right size and shape for

biface blanks on bedrock quarry surfaces. In experimental extraction (conducted in Type 3 quarries), quarriers were never able to isolate bedrock masses large enough, and with surfaces meeting at the proper angles, to remove large flakes directly from the bedrock, nor were they able to detach large masses of toolstone. Although we have no return data for those strategies, we suspect they *can* produce the highest returns under the most favorable conditions (e.g., bedrock morphology of either Type 1 or Type 2, with sufficient crack systems and/or tuff stringers to permit ingress, etc.). In controlled experiments, quarriers removed only relatively small blocks ranging from 300 to 6250 grams.

Boulder Breakup Experiment

If extraction is defined as creation of toolstone packages suitable for processing into bifaces, then extraction (rather than processing) subsumes reduction of large, detached toolstone masses into smaller blocks and flake blanks. Many of our experimental flake blanks were produced from large blocks found in, or extracted from, historic mining features using steel tools; the blocks were not weighed, nor was flake blank production timed. A large opalite boulder was encountered during backhoe trenching in Locality 36 of 26Ek3032 (Leach and Botkin 1991). Although neither the boulder nor reduction waste was weighed in this experiment, the probable boulder weight exceeded 75 kg. It was reduced to blocks and flake blanks using stone hammers, the activity timed, and the products (blocks and flake blanks) weighed. Returns from the experiment are presented in Table 237.

These data inform regarding the relative efficiency of working on a large detached mass of toolstone. The greatest technical advantage lies in the ability to move the mass around to obtain the best striking angles as reduction proceeds, allowing the work to be accomplished in minimum time. In this experiment, series of block removals alternated with series of flake blank removals. Removal of groups of blocks helped set up platforms and surfaces for subsequent flake removal. Once this was done, several flake blanks could be removed in a matter of seconds, giving a high return rate for flake blanks. This rate is somewhat misleading, however, because it is difficult to sustain for more than a few flake blank removals.

Table 237. Returns for Timed Boulder Breakup.

	Blocks	Flake Blanks
Number	13*	11
Weight	48,650 gm mean 4,054.17 σ 3,742.11	8,400 gm mean 763.64 σ 386.06
Time	26.00 min	3.43 min
Minutes per Item	2.00	0.31
Return Rate	1,871.15 gpm	2,448.98 gpm
Total Time	29.43 min.	
Total Return	57,050 gm	
Overall Return Rate	1,938.50 grams per minute (gpm)	

* One item not weighed

Quarrying Experiment 4

Very different results were obtained in Experiment 4 (QE 4), the only timed experiment in which toolstone was extracted from bedrock and transformed into bifaces. The experiment was conducted in previously unquarried bedrock exposed in the bottom of a backhoe trench, adjacent a prehistoric quarry pit. The margin of the pit offered a short (10-15 cm) bedrock face from which to work, and the situation was more or less equivalent to extending an old pit into new territory, without, however, having to remove the 50 cm of overburden. The overburden consisted initially of 30 cm of silty colluvium over about 20 cm of red, pedogenic clay, which lay upon massive opalite. The opalite was not monolithic, but contained systems of cracks, especially at the upper surface. The backhoe operator tried to strip off the overburden with as little damage to the opalite as possible. Nevertheless, the bucket gouged the cracked surface in places and loosened some material which then could be picked up. We have noticed similar loose material on quarried opalite surfaces left exposed to winter weather, and have speculated that such weathering and frost action may have been sought deliberately as a low cost quarrying technique (Carambelas and Raven 1991).

In QE 4, quarrying was divided into timed work periods, or episodes, punctuated by note taking and rest, pit cleaning, and tool maintenance. The time devoted to these activities was included in an episode; time thus includes quarrying plus rest and maintenance. Time, returns, and other data describing the experiment are summarized by episode and presented in Table 238. QE 4 was conducted by a lone quarrier whose goal was to produce as many usable toolstone packages as possible, as fast as he could do so. Prior experience suggested that heavy hammerstone bashing of massive opalite yields little but dust and angular chunks covered with intersecting ring cracks. In this experiment, the quarrier attempted to finesse the stone, opening cracks by tapping it repeatedly with a small hammerstone, driving wedges, and enlarging the cracks with more tapping. He saved all extracted toolstone packages large enough, in his judgement, to process into bifaces. These later were culled by a knapper who, on the basis of size, shape, and toolstone quality (particularly the presence of cracks and vugs), discarded some without assay or further examination, and kept others for processing. The mean weight of the eighteen blocks rejected as too small was 577.78 ± 264.70 gm (already near the mean weight of Stage 3 bifaces), while that of the other fourteen other rejects was 1232.14 ± 526.46 gm. Of course, under aboriginal conditions, such culling probably was coincident with quarrying, "bad" pieces ending up in the pit berm or filling an adjacent pit. The knapper gauged the suitability of each piece at a glance; this process was not timed, but, if conducted during quarrying, is unlikely to have added significantly to extraction time.

In the following discussion, *Gross extraction return* (geR) is total mass (in grams) of material extracted, while *net extraction return* (neR) is geR minus culled material. The *net extraction return rate* (neRr) is neR divided by extraction time (Te):

$$neRr = neR / Te$$

In 820 minutes of work, the quarrier extracted 61 blocks of toolstone weighing 81,250 gm, for a gross extraction return rate (geRr) of 99.08 grams per minute (gpm). Of these, 31 blocks, weighing 27,650 gm (34.03%), later were rejected without assay by the knapper for a net extraction return (neR) of 53,600 gm and a net extraction return rate (neRr) of 65.37 gpm. In the first episode, the quarrier spent two minutes collecting loose material from the opalite surface exposed in the bottom of the backhoe trench, for a net return of 4825 gpm, twice that of the best rate (in creation of flake blanks) achieved in the Boulder Breakup experiment. We suspect that this reflects the rate possible for collecting material loosened from exposed quarry surfaces after a winter or two of frost action. The supply of loose material was limited, however, and extraction rates dropped sharply as soon as the quarrier began to attack the bedrock. Table 238 shows considerable variation in gross and net returns (geR and neR) per episode, as well as in return rates (geRr and neRr). There is virtually no correlation between the amount of time (Te) spent in an episode and either geR ($r = 0.183$) or neR ($r = 0.148$).

Table 238. Quarry Experiment 4 Extraction Returns and Return Rates.

Episode	Te	Blocks	geR (grams)	Mean geR	σ	gRr (geR/Te)	RejBlok	RejWt	% RejWt	neR (grams)	neRr (neR/Te)
1	2	7	10,800	1,542.86	1,320.17	5,400.00	2	800	7.40	10,000	4,825.00
2	11	6	5,450	908.33	494.39	495.46	5	3,850	70.60	1,600	145.46
3	13	3	3,400	1,133.33	689.81	261.54	1	350	89.70	3,050	234.62
4	29	8	13,300	1,662.50	2,055.61	458.62	4	2,900	21.80	10,400	358.62
5	35	8	7,050	881.25	302.30	201.43	6	4,950	70.21	2,100	60.00
6	49	3	6,250	2,083.33	1,172.96	127.55	0	0	0.00	6,250	127.55
8	4	4	4,200	1,050.00	529.15	4,200.00	4	4,200	100.00	0	0.00
19	44	1	1,350			30.68	0	0	0.00	1,350	30.68
20	12	1	900			75.00	0	0	0.00	900	75.00
24	37	1	650			17.57	1	650	100.00	0	0.00
25	1	1	1100			61.11	1	1,100	100.00	0	0.00
27	34	2	3150	1,575.00		92.65	1	1,250	39.70	1,900	55.88
31	36	1	800			22.22	0	0	0.00	800	22.22
37	97	2	1700	850.00		17.53	2	1,700	100.00	0	0.00
38	13	1	2500			192.31	0	0	0.00	2,500	192.31
39	34	2	2450	1,200.00		72.06	1	700	28.57	1,750	51.47
42	95	2	1900	950.00		20.00	1	450	23.70	1,450	15.26
43	7	1	6150			878.57	0	0	100.00	6,150	878.57
44	8	1	1400			175.00	1	1,400	100.00	0	0.00
49	146	2	1400	1,400.00		9.59	0	0	0	1,400	9.59
50	31	3	2850	950.00	100.00	91.94	1	850	29.82	2,000	64.52
52	65	1	2500			38.46	1	2,500	100.00	0	0.00
53	17	0	0			0.00	0	0	0.00	0	0.00
Totals	820	61	81,250			99.08	32	27,650	34.04	53,600	65.37

geR: Gross Extraction Return
geRr: Gross Extraction Return Rate (gm per min.)
neR: Net Extraction Return
neRr: Net Extraction Return Rate (gm per min.)
Te: Extraction Time
RejBlok: Rejected Block
RejWt: Rejected Weight

There is, however, a pattern to the work that *is* connected to toolstone yield. Figure 289 plots cumulative geR and cumulative neR against elapsed extraction time (Te). A curve is fitted to each distribution (weighted average LOWESS smoothing method; Cleveland 1979, 1981; Wilkinson 1989) that describes trends in the gross and net rates of extraction through the quarrying session. Gross rates are, of course, higher, but the curves are quite similar. Variability in neR per episode are plotted in Figure 290a, and elapsed time of each work episode against total elapsed time in Figure 290b. Although yields and work times are variable, the upward trend in extraction rate is relatively steep to episode 6 but then decreases. Through episode 6, geRr and neRr are, respectively, 332.7 gpm and 240.29 gpm, falling thereafter to 51.39 gpm and 29.66 gpm.

In spite of longer work sessions, the quarrier could gain no momentum after episode 6. A more experienced and prudent aboriginal quarrier might have recognized a losing proposition and abandoned the pit sooner, particularly if he or she had culled blocks during extraction for feedback on net extraction return, which, we see in Figure 289, describe a flatter curve after episode 6. Perhaps, too, a more experienced quarrier, particularly if assisted, could have changed techniques and continued to extract toolstone at a higher rate.

Compared to the Boulder Breakup, even neRr for episodes 1 through 6 may seem poor. But recall that the boulder was a gift of the backhoe. If quarriers had spent 139 minutes (the duration of episodes 1 through 6) detaching this mass of toolstone and breaking it up, their net extraction return rate would have been only 410.43 gpm; with 250 minutes of work, the net extraction return rate falls to 228.20 gpm, exactly that for episodes 1-6.

In fact, neither the Boulder Breakup nor QE 4 involved the removal of significant overburden. Excavating a pit with a two meter surface diameter at the location of Experiment 4 requires removing 86 liters of silty soil and 50 liters of clay. At the lowest experimental rates given in Table 236, removal of virgin overburden at this location would require 82 minutes. Added to the 139 minutes of episodes 1 through 6, this would decrease the net return rate to 143.89 gpm. Reexcavation of a filled pit would have required about 148 minutes at the highest rate for clay-rich fill, which would decrease the episode 1-6 net extraction rate to 110.87 gpm.

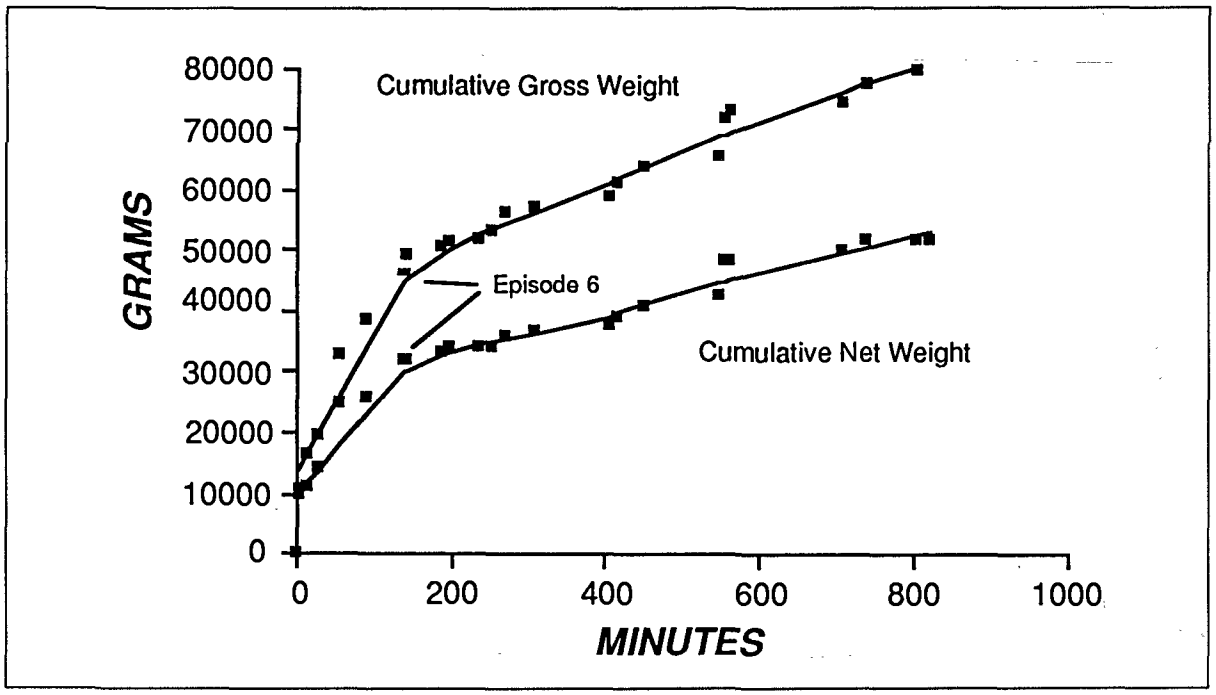


Figure 289. Quarry experiment 4: cumulative gross and net extraction returns.

Experimental Processing

Processing involves rendering a package of extracted toolstone into usable form; at Tosawihi, this meant processing reduced toolstone blocks and large flakes into bifaces. Experimental bifaces were produced in a number of experiments performed by several knappers of both genders and various skill levels. The results of these replications are summarized in Table 239.

In the following discussion, the *processing return* (pR) is the mass of processed tools with fU of 1.0., and is a net return because processing failures are subtracted by definition. There is, however, a *gross processing return rate* (gpPr), which is pR divided by processing time (Tp). *Net processing return rate* (npRr) is pR divided by extraction time plus processing time:

$$npRr = pR/(Te + Tp)$$

Processing Returns

Of the twenty-nine blocks retained for processing in QE4, eighteen (weighing 34,150 grams) failed (half to breakage, half to flaws) during processing and were rejected. Fifteen bifaces were produced from the remaining eleven blocks. The discrepancy between numbers of blocks and bifaces is due to further reduction of fragments and spalls produced during processing some of the larger blocks; this also occurred in other processing experiments and accounts for deviations between numbers of blanks, failed bifaces, and completed bifaces. Altogether, processing the quarry blocks consumed 145 minutes; added to extraction time, search and processing time consumed 965 minutes, for a net processing return rate (nepRr) of 2.74 grams of biface per minute. Extraction and processing combined required an average 64 minutes

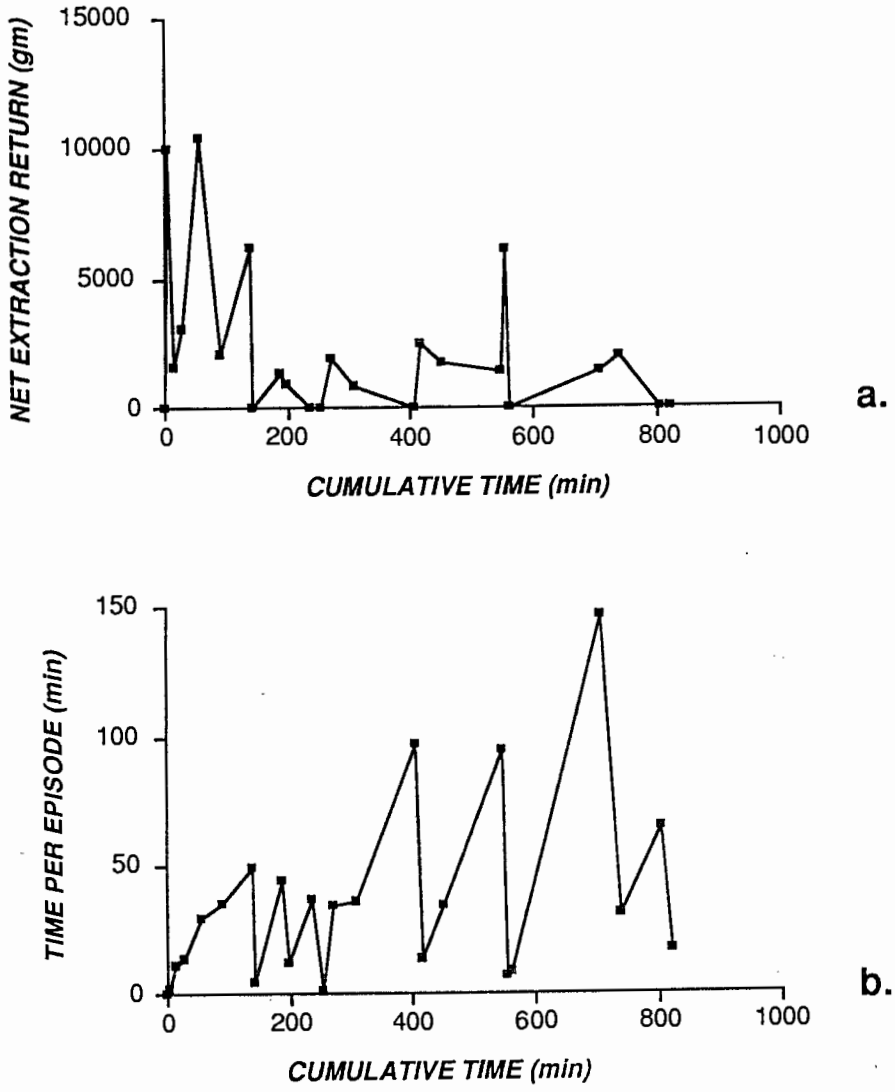


Figure 290. a. Net extraction return per episode; b. time per extraction episode.

per biface. Processed bifaces comprised 4.93 percent of the gross blank weight (Wbl) and 3.31 percent of all material extracted; over 95 percent of the processed material and over 98 percent of the extracted raw material was waste. While cost of this waste may be mitigated by retrieval of flakes from debitage for use as expedient tools and tool blanks, we ignore this for the time being.

Table 239. Experimental Processing Returns and Rates.

Experiment	Blank No. & Type*	Wbl	Nf	Np	pR	Tp	gpRr	npRr	nepRr	gbTbf	nTbf	gProbf	nProbf
QE4	29 BL	53600	18	15	2643	145	369.66	18.23	2.74	9.67	64.00	4.93	3.31
Boulder	13 BL	42550	2	20	18050	126	337.70	143.25	-	6.3	-	42.42	-
Breakup	11 FB	8400	0	11	3680	24	350.00	153.33	-	2.18	-	43.81	-
	1 RM	6100	-	1	6100	-	-	-	-	-	-	-	-
Moore	5 BL	5900	2	5	1640	83	71.08	19.76	-	16.60	-	27.80	-
Misc.	5 FB	3150	1	4	771	37	85.14	20.81	-	9.25	-	24.44	-
Bloomer/ Ataman	15 FB	15800	4	11	1983	577	27.38	3.44	-	52.46	-	12.55	-
Knap-In	40 FB	28406	8	32	4404	614	46.26	7.17	-	19.19	-	12.55	-
Totals	119	144456	35	99		39270	1606	89.95	125.45	-	16.22	-	27.18	-

*BL = Block; FB = Flake Blank; RM = Remnant bifacial core left at end of boulder reduction

Wbl: grams of blanks at beginning of processing.
Tp: Processing Time
Nf: Number of Failed Bifaces
gpRr: Gross Processing Return Rate - Wbl/Tp (gpm)
nepRr: Net Extraction & Processing Return Rate - pR / (Te + Tp)
npTbf: Net Processing Time per Biface - (Te + Tp) / Np
nProbf: Net Biface Proportion - pR / (gpR + Wbl)
pR: Processing Return (grams of processed bifaces)
Te: Extraction Time
Np: Number of Processed Bifaces
npRr: Net Processing Return Rate - pR/Tp (gpm)
gpTbf: Gross Processing Time per Biface - Tp/Np
gProbf: Gross Biface Proportion - pR/Wbl

Processing return data are compared in Table 239. Since extraction times and weights in the other experiments were not controlled, net statistics are calculated only for bifaces processed from blanks extracted in QE 4. Overall, the average time required to process a biface was 16.22 minutes, but Table 239 reveals considerable variation in processing rates and returns even for the same knapper. Notice that although Moore's gross processing return rate is similar for QE 4 and Miscellaneous (blocks collected by Elston and flake blanks produced by Moore), the net processing return rates (npRr) for the blanks he produced during the Boulder Breakup are nearly an order of magnitude greater, possibly due to the high quality of material and the opportunity to create blanks of optimum size and shape for application of his own technique. Moore also assayed the material as he struck off blocks and flakes, rejecting all but the best.

These data strongly indicate that one does not necessarily gain bifaces by investing more time in processing. In most of Moore's experiments (Boulder Breakup, Miscellaneous), less processing time per biface is associated with a much higher Gross Biface Proportion (proportion of raw material turned into bifaces). The exception was QE 4, where raw material quality was low. Here, each piece required assaying, accomplished in the initial flake removals of processing; over half the blanks failed, but most did so after only a few blows were struck. In this situation, it is doubtful that taking more time would have resulted in more successes, and Moore's high gross processing return rate (gpRr = 370 grams per minute) served to keep the average gross processing time per biface to a relatively low 9.67 minutes. Twenty to twenty-nine percent of blanks failed in those processing experiments where the gross processing return rate (gpRr) ranged between 27 and 85 grams per minute. The combined failure rate for blanks processed in QE 4 and Boulder Breakup experiments (where gpRr was over 337 grams per minute) was, at twenty-seven percent, in the same range. This suggests that, in the long run,

failure rates may remain about the same irrespective of processing speed; if substantiated by further experimentation, we may conclude that it always pays to process as fast as possible.

Experimental and Archaeological Bifaces

Experimental knappers sought to reproduce the range of size, morphology, and stage of Tosawihi bifaces as closely as possible. They did this not by calling on a base of quantitative data regarding these characteristics, but by examining examples in the Tosawihi collection and getting a feeling for what constitutes a "Tosawihi" biface. The knapper's ability or inability to approach some set of normative values is not in itself particularly interesting, but, as a reflection of the human ability to judge qualities and quantities subjectively in a consistent fashion, it has implications for the ability of people to perform in ways assumed by our model. It also speaks to the relevance of experimental statistics regarding processing returns and rates. Our confidence in these should be in direct proportion to the degree the experimental assemblage replicates the attributes of the archaeological assemblage.

One difference between the assemblages of experimental and archaeological bifaces is their distribution among reduction stages. While Tosawihi archaeological biface assemblages contain between 70 and 76 percent Stage 3 bifaces and one to eight percent Stage 4 bifaces, by design (we asked experimental knappers to stop reduction in stage 3), 86 percent of experimental bifaces are Stage 3 and over 10 percent Stage 4. We might expect, therefore, to find experimental bifaces smaller and lighter in weight than the archaeological specimens, but, as shown in Table 240, this is not the case. In fact, the mean weight for all experimental bifaces is nearly three times that of all intact Tosawihi bifaces, and over one and one-half times as great as bifaces from caches. Experimental bifaces produced from blocks are consistently heavier than the archaeological mean, but experimental bifaces made from flake blanks are lighter in all cases but one.

Table 240. Mean Weights (in grams) of Experimental and Archaeological Bifaces.

Experiment & Blank Type	Mean	σ
Quarry Experiment		
Blocks	285.96	128.95
Boulder Break up		
Blocks	902.50	948.93
Flake Blanks	334.55	86.53
All	790.30	1122.19
Moore Misc.		
Blocks	488.33	1465.00
Flake Blanks	192.62	121.88
Bloomer/Ataman		
Flake Blanks	165.25	160.87
Knap-In		
Flake Blanks	137.62	111.48
All Experimental Bifaces		
Various	419.13	791.56
Tosawihi Caches		
Various	275.30	130.21
All Intact Tosawihi Bifaces	202.50	148.88

The relatively small size of archaeological bifaces may owe to many causes; two seem obvious. First, nearly all the archaeological specimens are discards; the largest successful bifaces were transported. Second, the larger the piece, the easier it is to remove an isolated flaw, recover from a small failure, or redirect reduction after a massive failure, all of which make it less likely for large pieces to be discarded without further reduction in size and weight.

Bifaces recovered from caches are the most likely to reflect the prehistorically acceptable range of size and morphology. Processing opalite blocks extracted during Quarry Experiment 4 produced a set of bifaces with a mean weight (and morphology) nearly identical to that of bifaces from Tosawihi caches.

All in all, experimental and archaeological bifaces reflect a similar *range* of variability in size and form, and we are confident that experimental processing returns and rates are well within an order of magnitude of those achieved by prehistoric knappers.

Heat-Treatment

Heating microcrystalline minerals such as flint or opalite to a critical threshold called the eutectic temperature (which varies with the chemistry of the particular mineral) causes certain physical changes in the intercrystalline matrix surrounding the quartz microcrystals (Crabtree and Butler 1964; Purdy 1971, 1975). Compressive strength of the material is lowered, reducing the amount of force required to detach flakes. Most accumulated mechanical and thermal stresses are relieved and vitreousness is increased, making fracture more predictable and increasing the sharpness of resulting edges. These all serve to increase compliance during reduction, which in turn should allow a higher tool/waste ratio and increase ability to predict tool use life. These features must outweigh the attendant increase in brittleness and somewhat lower durability since among opalite artifacts in the Tosawihi collections, heat-treatment is found in most preforms and projectile points, in approximately half the bifaces, and in smaller proportions of other flaked stone tools.

Approximately 50 heat-treating experiments (the number is vague because some informal experiments were not recorded) were performed to address three methodological and analytical problems: recognition of heat-treated artifacts, effects of heat-treatment on durability and flaking quality of Tosawihi opalite, and time and effort involved in heat-treatment.

Actualistic experiments sought to replicate prehistoric techniques. In one set of experiments, 10 to 20 bifaces were placed in pits at a depth of 20 to 30 cm below the surface and covered with soil and then pine firewood. The pits were fired for up to eight hours and allowed to cool slowly. This procedure resulted in all bifaces in each trial reaching the eutectic point (not recorded owing to lack of pyrometer) with very little loss due to thermal stress.

Experiments using sagebrush as fuel were less successful. Sets of 10 to 20 bifaces were buried shallower (as little as 5 cm), but fires were maintained for up to 12 hours (one firing consumed two pickup truckloads of sagebrush). Burning sagebrush, however, created a great deal of fluffy, white ash which appeared to insulate the pit bottom, with the result that only bifaces at the top of the pit were well treated (again, temperature was not recorded due to lack of a pyrometer). Although not predicted by the concept of a finite eutectic "point," some pieces appeared to have been altered only slightly, improving their flaking qualities somewhat but not vitrifying them. This would account for artifacts of similar appearance noted in analysis as "possibly altered." We conclude that successfully firing quantities of bifaces with sagebrush fuel might be accomplished by placing bifaces in a special heat-treating earth oven lined with stones, perhaps with a preliminary firing to heat the pit. Only one possible heat-treating hearth (26Ek3092, Feature 9) was observed at Tosawihi, and such features have not been noted frequently anywhere in the world (Griffiths et. al 1987). In general, this series of experiments

suggests that in areas such as Tosawihi where sagebrush was the principal available fuel, it may have been necessary to fire only a few items at a time.

In the laboratory we had no trouble heat-treating experimentally produced artifacts to high degrees of vitreousness using a sand-filled electric deep fryer, thermometers, and a pyrometer. We tested the effect of heat-treatment on flakes versus bifaces and on different varieties of raw material from Tosawihi, with these findings:

The critical temperature for heat-treating Tosawihi opalite is relatively low: 450°F - 475° F (205°C - 230°C). Critical temperatures vary with source; finer materials require slightly lower temperatures to attain good results while jasper-like materials and local non-opalite cherts, as well as weathered pieces, need slightly higher temperatures. Once reached, the critical temperature need not be maintained; slow heating (at least two hours) and cooling (at least 12 hours), however, prevents thermal failure. A small amount (1-5%) of weight is lost in heat-treating.

Opalite does not change color significantly when heat-treated, although the exterior surfaces of light colored varieties sometimes become slightly stained with brown. Heat-treated opalite becomes more brittle, and when heat-treated well, extremely lustrous; it also may become slightly more opaque and quite glassy. Heat-treatment of opalite decreases the force needed to detach flakes, thereby resulting in easier pressure flaking and less attrition of soft hammer billets. When heat-treated opalite is flaked and then reheated, lustrous surfaces remain lustrous and the difference between original and post-heat-treatment flake scars remains visible.

Our experiments indicate that while Tosawihi opalite can be heat-treated successfully at relatively low temperatures, altering large quantities of bifaces in one firing with fuel available at the quarries could not be accomplished without special firing technology for which there is presently no evidence. We must conclude, therefore, that most heat-treatment occurred in ordinary campfire hearths, a few artifacts at a time. One of Steward's (1941) Reese River Shoshone informants recalled that flint was placed under the campfire for five days. We believe, however, that, under ideal conditions, in a campfire tended continuously, it is possible to heat-treat sets of up to six bifaces in a few hours (cooling is riskier), so that one person might be able to fire a dozen artifacts in one day. In less than ideal conditions, the number handled would be lower and the success rate probably would fall.

Prehistoric heat-treating probably worked sometimes and sometimes did not. A single biface might need to be cooked several times before heat-treatment "took." Heat-treatment certainly is risky, and can be very costly to support under some circumstances. On the other hand, it can be embedded easily in down time activities at camp if a few bifaces are slipped into the campfire each evening before sleep. Moreover, it can be accomplished anywhere: at any overnight stop, just throw another biface or two on the fire. This low volume strategy may account for both the increasing incidence of heat-treatment with distance from the quarries as well as the low proportion of heat-treated cached bifaces. Transporting as many heat-treated bifaces as possible and caching the unheat-treated remainder defers cost. Even though caching defers benefits, it does not extend venture risk beyond the procurement episode if sufficient bifaces also are transported. Moreover, future retrieval of unheat-treated caches incurs no extraction or processing costs, opportunity costs are minimized, and venture risk is reduced to that inherent in heat-treatment.

Modeling Lithic Procurement Decisions

So far, we have summarized ethnographic and experimental data regarding costs of prospecting for, extracting, and processing toolstone, as well as travelling to and from sources and transporting toolstone packages. We now employ these data in some simple models that allow us to

estimate cost in time and effort of lithic procurement at Tosawihi, and consider the basis of processing decisions that affected the structure of the archaeological record at Tosawihi Quarries.

Proportional Utility and Marginal Value

Lithic foragers are caught between the conflicting goals of minimizing the cost of both procuring and transporting toolstone. The more material removed during processing, the lower the transport cost, but the higher the processing cost. Metcalfe (1989; cf. Metcalfe and Barlow 1991) has developed a simple, deterministic model based on a model of central place foraging (Orians and Pearson 1979) in which the decision to transport a resource is partly a function of its *proportional utility*, or ratio of usable to non-usable material in a resource. Consider a nut that by weight is 70% edible meat with a utility of 1.0 and 30% non-edible shell with a utility of 0.0. Removing shells increases the utility of a load of nuts to 0.7; an unshelled load has a proportional utility of 1.0, and a partially shelled load a proportional utility of something in between. While it might be worthwhile to transport an unshelled load of nuts a short distance, at greater distances it would pay to first process the nuts, increasing the proportional utility of the load and decreasing the transport costs. Knowing the transport distance and the processing costs, the model predicts the amount of processing that *should* occur, given any transport distance.

Since reduction of lithic artifacts in manufacture constitutes processing during which unwanted material is removed and utility increased, Elston (1988c, 1990) and Metcalfe (1989) propose use of the proportional utility model to study variability in lithic debitage assemblages. Metcalfe and Barlow (1991) suggest that proportions of primary, secondary, and tertiary flakes should vary predictably in response to distance of the assemblage from known lithic sources and the relation of proportional utility to reduction stage. At Tosawihi, since most debitage was subjected to mass analysis, the data are not sufficiently fine grained to employ the Metcalfe and Barlow model. The Tosawihi biface sample, however, is large, and each artifact reflects reduction stage unambiguously. The following exploration illuminates both strengths and weaknesses of proportional utility in modeling lithic procurement.

In Chapter 3 we argued that although tools of different functional types differ in benefits of use, we can avoid having to consider this variability by assuming that the *functional utility* (fU) of any tool is 1.0 through its use life. This allows use life to be the measure of utility, with the further assumption that, for a given lithic material, mass is a proxy for *use life utility* (ulU) as long as objects under consideration have a similar range of function and morphology.

We assume that processing increases the functional utility (fU) of stone tools by removing lower quality and functionally superfluous material and by improving functional form. Since a biface is made by reducing a blank, the ratio of waste to usable material in a processed biface is a measure of cost that affects net returns, and monitors both functional and use life utility. As gross biface proportion (gProbf, Table 239), we used it to compare overall returns for processing different sizes and types of blanks in each reduction experiment. Here we use a variation of the measure to monitor the amount of material lost at different stages through reduction. Because experimental knappers employed blanks of different sizes and shapes, and found it difficult to halt a knapping episode at the threshold between analytically defined reduction stages (or even to stop episodes consistently at precisely the same stage), the number of episodes per reduction, as well as stage at end of episode, varies between experiments and among knappers. Nevertheless, reduction stage and biface weight were recorded at the end of each episode; they are used to calculate the proportion by weight remaining of the original blank (Probl). For instance, starting with a blank weighing 1000 gm and reducing it to a biface weighing 250 gm gives:

$$\text{Probl} = 250/1000 = .25$$

The following analysis employs only data from successfully processed experimental bifaces. Because several bifaces were reduced in two or three episodes, there are more data points than bifaces.

Figure 291 is a graph with two Y axes; that on the left is proportion of blank remaining (Probl), that on the right, time (Tp) per episode. Points on the graph are plots of stage versus Probl, showing a wide range of Probl in all stages of reduction, as we might expect from variability in toolstone quality and knapper skills. Probl tends to decrease as stage increases, although the spread of values keeps the linear correlation coefficient relatively low ($r = .517$; $P = 0.0$). That is, progressively less material is removed at each stage. At the same time, there is a general tendency for Tp to increase.

The slope of a line fit to the Probl data with the weighted average LOWESS smoothing method (not linear regression) trends downward, is steep to about middle Stage 3, and then flattens out. The slope of the line fit to the time data trends upward, is relatively shallow to middle Stage 3, then steepens. As in the similar analysis of gross and net extraction rates for QE 4, the changes in slope reflect a decrease in the rate at which material is removed, and an increase in the amount of time it takes. Together, these trends suggest that throughout reduction, it takes more and more time to remove less and less material; reduction after middle Stage 3 appears particularly costly. The rate changes at Middle Stage 3 signal the switch to soft hammer percussion (generally removing less mass), as well as patterned flake removal, and the greater difficulty of recovering from failures and mistakes; both necessitate more planning and platform preparation time.

Most Tosawihi bifaces are Stage 3. Most bifaces are heat-treated at Stage 3, and the spatial distribution by stage suggests that most are transported away from the quarries at Stage 3, as well. In this light, Figure 291 strongly suggests that Stage 3 is the point in lithic processing where functional utility (fU) approaches 1.0 and further reduction results in *loss* of use-life utility (ulU) without much change in the cost of transportation (Elston 1990); otherwise, most Tosawihi bifaces would reflect smaller, later stages.

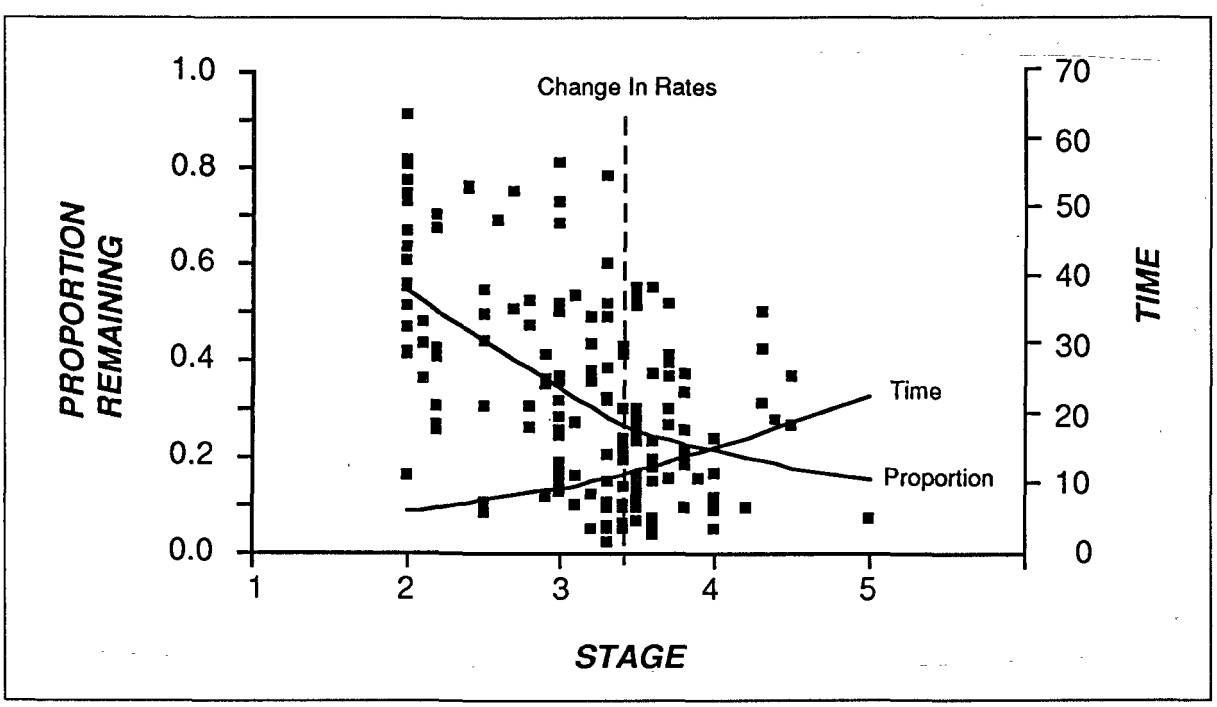


Figure 291. Proportion remaining of original blank and elapsed time per reduction episode by stage.

Because (as we have seen in other chapters) biface size tends to decrease with distance from source, and biface processing involves diminishing returns, the marginal value model can be used to explore relationships between lithic processing and transportation costs. For instance, proportion of original blank remaining (Probl) is scaled from 1.0 (no reduction; all of the original blank remains) to 0.0 (nothing of the original blank remains). Among experimental reductions plotted in Figure 291, Probl ranges from 0.91 to 0.02; the mean for middle Stage 3 is 0.253 ± 0.17.

If proportional utility approaches 1.0 as unusable material is removed, then the lower the Probl value, the higher the utility. In fact, if we transform our Probl values by subtracting each from 1.0, and plot these against reduction stage, our data now form something that looks like a scale of proportional utility (pU) which we will call a *pseudo-utility scale* (*pU*) in order to denote our current inability to evaluate fully its validity (Figure 292). Out of several smoothing methods tried, a quadratic curve ($Y = a + bX + cX^2$) fitting these data approximates a marginal returns curve and reflects our general assumption regarding the waxing and waning of proportional utility through reduction. It does not exactly fit our model where pU is 1.0 at middle Stage 3 because of the large spread of *pU* values at every stage.

The reduction stage scale on the X axis is an approximation of processing cost. Extending the X axis of our graph to the left of the Y axis gives us a place to plot a cost factor such as transport time or distance. Metcalfe and Barlow (nd:9) explain:

> If the foragers maximize the utility of the load per unit time spent transporting, procuring and field processing, then they should decide whether to field process in a manner consistent with maximizing the value of the *y*-axis divided by the value of the *x*-axis. Graphically, the value to be maximized is the slope of the line originating from the required travel time and tangent to the utility function. Where the line touches, but does not intersect, the function indicates the appropriate decision.

The empirically derived distance-stage data presented by Raven in the previous chapter (Figure 287) suggest that, in the Western Periphery (where there is greatest separation between quarry and non-quarry sites), 66% of bifaces transported 200 meters have been reduced to middle Stage 3 or later, and by 600 meters, over 90% have been so reduced. I drew a tangent line from the middle Stage 3 point on the marginal value curve to a point on the cost axis I labeled "600 m" (Figure 292).

The swarm of points in the graph illustrates one reason why, while there is an inverse relationship between distance from source and biface stage (or weight), all biface stages occur at all distances from the quarries: there is considerable variation in biface *pU* at every stage, reflecting variation in material quality and knapper skills; we might add variation in production technology to this. All these factors influence the benefit derived from processing, and the larger the processing benefit, the shorter the transport time or distance at which processing pays off (Metcalfe and Barlow n.d.:15). For example, we expect rough block blanks, possessing little or no functional utility, to be processed at the spot they are extracted. In contrast, processing might be considerably deferred for large flake blanks having a certain amount of functional utility from the moment they are struck from a core. Another complication is that our analysis is based on bifaces, a mobile artifact class, rather than on relatively more static debitage. People may have cycled sets of bifaces through different stages as insurance for contingency risk, which certainly would obscure patterns of the kind we are looking for here. Our subsequent modeling exercise suggests a number of other reasons why processing might not occur at the source, or why it might occur in variable amounts. During any particular foray, any of these alternatives might or might not be employed, depending on the situation.

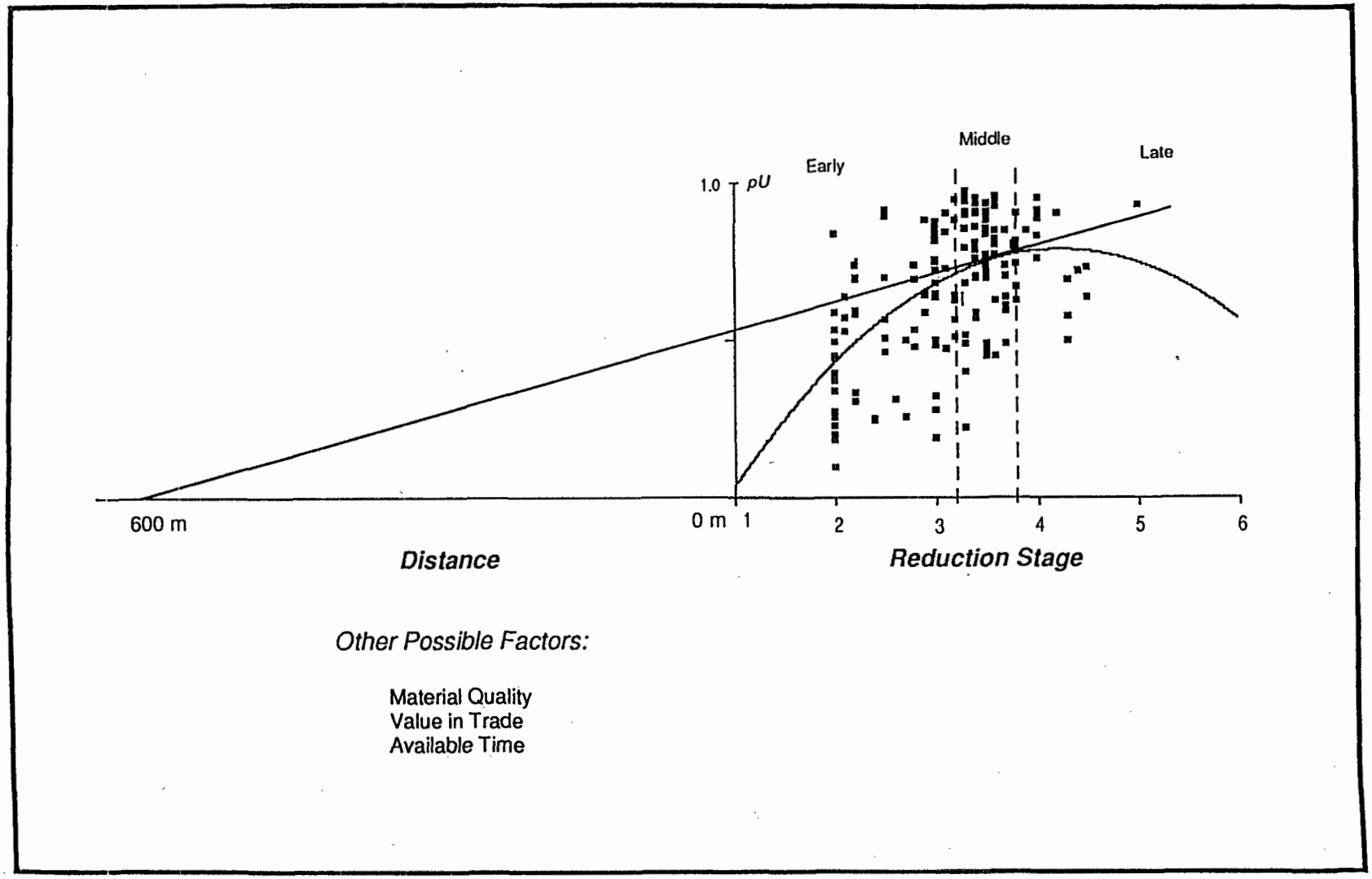


Figure 292. Marginal value model for biface reduction.

The Metcalfe and Barlow marginal value model calls for a unique solution to each processing cost-transportation cost decision. Our analysis suggests, however, that there are no unique solutions to the processing cost problem in our data, and this will be true of any archaeological data set. One might approach the problem by converting the deterministic model into a dynamic one that assigned a probability distribution to each alternative along with a range of possible outcomes (Stephens and Krebs 1986; Mangel and Clark 1988), taking care not to introduce so much complexity that the results could not be interpreted.

Processing and Transportation

Human load carrying capacity is the ultimate ceiling for the amount of toolstone that can be transported without vehicles or draft animals. Actual loads transported by hunters and gatherers seem to be much lower than the maximum; ethnographic ranges of between 5 and 30 kg are given by Metcalfe and Barlow (1991). Using the QE 4 extraction and processing data (Tables 238 and 239), we model the effects of varying procurement and transportation costs in the acquisition of 10 kg of toolstone (about the same weight as the biface cache from 26Ek3192). We also employ the transportation cost estimates of Jones and Madsen (1989), and estimates of caloric consumption for extraction and processing (Table 241) based on activities of roughly equivalent effort (ditch digging and gardening) given in Southmayed and Hoffman (1981:418-419). Our models do not include heat-treatment as a processing cost, which, aside from failures (the rate of which we cannot estimate at present) and the low volume mode described above, appears to amount to very little. Also, for simplicity, we assume the forager exploits a developed quarry pit and incurs no prospecting costs.

Table 241. Estimated Caloric Requirements for Various Activities.

Extraction	400 calories per hour
Processing	220 calories per hour
Walking	300 calories per hour (at 3 km per hour)
Carrying	1.25 calories per kg per km

Deferred Processing

First, we consider a lithic forager who makes a 50 km trip to Tosawihi and returns to home base on the Humboldt River (Table 242). Walking the 100 km will consume 10,000 calories, and carrying 10 kg of toolstone 50 km, 625 calories. Let us assume that the forager can extract toolstone at the 240 gpm average rate achieved in episodes 1 to 6 of QE 4; extracting 10 kg of toolstone consumes 41.67 minutes and 277.80 calories. At the gross processing rate of 369.66 gpm, processing requires 27.05 minutes and 99.28 calories. Let us assume, too, that, in light of these minimal costs, the forager decides to forgo processing until he returns home, dismissing the high failure rate intrinsic to Tosawihi opalite that results in a low net biface proportion (nProbf) of 3.31 percent. Reduction of the 10 kg of toolstone at the home camp yields only 331 grams of biface. The total cost of this foray (ignoring lost opportunity and a host of other costs that accrue in the real world) is 11,001.80 calories, so at home base the biface costs 33.24 calories per gram (cpg). It may be a nice biface, but 331 grams has a much lower use life utility than 10,000 grams. Would it pay not to process at the

source were the forager closer to home? Using the same returns, we see that the cost falls as transport distance decreases (Table 242), but at nProbf of 3.31, ulU cannot rise above 331 gm when 10 kg is the whole load; even at the highest possible nProbf, 10 kg of unprocessed toolstone will never yield 10 kg of tools. The steep slope of the line in Figure 293 describes the cost-distance relationship for deferred processing reflects the cost of transporting 9,669 gm of waste in order to procure 331 gm of bifaces.

Table 242. Effects of Distance on Caloric Costs of 10 kg Toolstone Procurement: Deferred Processing (neRr = 240 gpm; gpRr = 369.66 gpm).

	50 km	10 km	1 km	0 km
Travel (cal)	10,000	2,000	200	0.0
Transport (cal)	625	125.0	1.25	0.0
Extraction (cal)	277.8	277.8	277.8	277.8
Processing (cal)	99.0	99.0	99.0	99.3
Total (cal)	11,001.8	2,502.8	578.1	377.0
Net Return (gm)	331	331	331	331.0
Cost(cpg)	33.24	7.56	1.75	1.14
Benefit/Cost	0.03	0.13	0.56	0.88

Processing at the Source

Now the forager sees the light and vows never to move toolstone so much as an inch without processing it (Table 243), although remaining determined to carry a 10 kg load. With the high Tosawihi failure rate and net biface proportion of 3.31 percent, he must extract and process 302,114.8 grams of toolstone to obtain 10 kg of bifaces. Extraction of this much stone

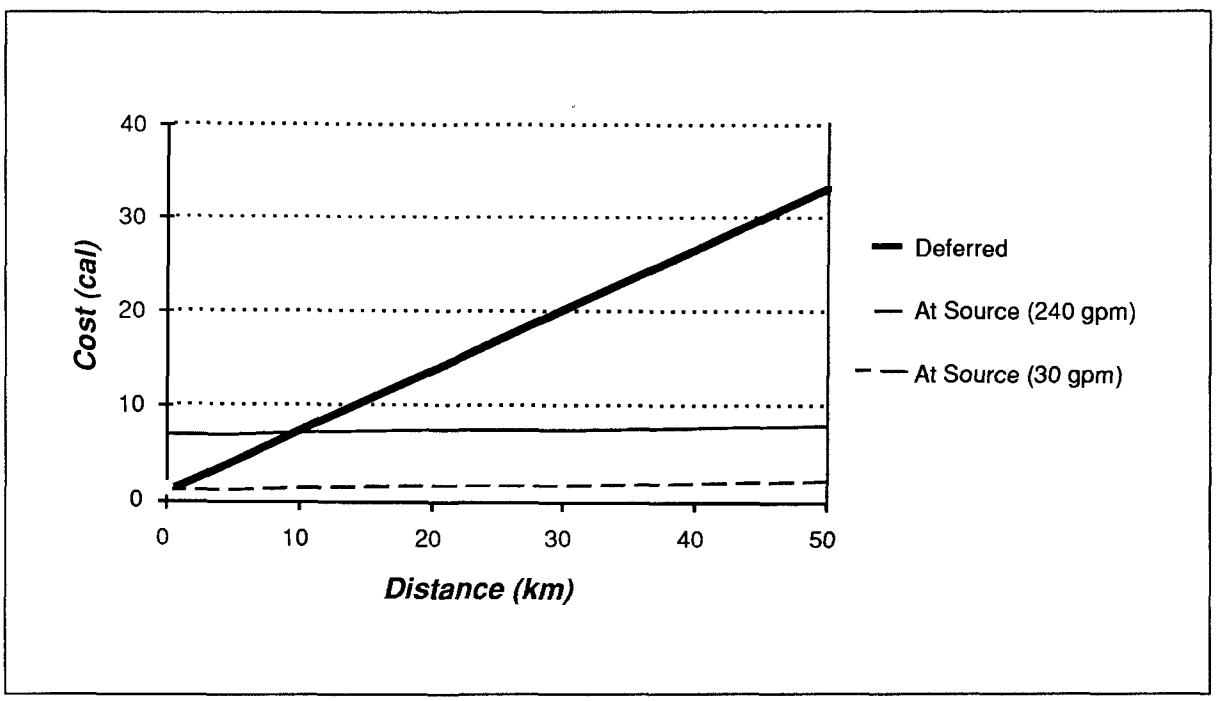


Figure 293. Biface cost per gram by transport distance with processing at source or deferred.

at 240 gpm takes about 21 person/hours, and processing it takes another 14 hours, consuming over 11,000 calories. With travel and transportation, the 50 km foray takes eight and half days and over 22,000 calories. Still, back at the base camp, the forager has 10,000 grams of bifaces and they cost only 2.20 calories per gram. This is a bargain compared to the returns of deferred processing; in fact, costs per gram for the 50 km foray with processing at the source are the same as costs for deferred processing and transport distance of about 1.3 km (Figure 293), and about 30 times as productive in terms of use life utility.

Table 243. Effects of Distance on Caloric Costs of 10 kg Toolstone Procurement: Processing at Source (neRr = 240 gpm; gpRr = 369.66 gpm).

	50 km	10 km	1 km	0 km
Travel (cal)	10,000	2,000	200	0
Transport (cal)	625	125.0	1.25	0
Extraction (cal)	8,392.8	8,392.8	8,392.8	8,392.8
Processing (cal)	2,999.7	2,999.7	2,999.7	2,999.7
Total (cal)	22,017.5	13,517.5	11,596.9	11,395.7
Net Return (gm)	10,000	10,000	10,000	10,000
Cost (cal/gm)	2.20	1.35	1.16	1.14
Benefit/Cost	0.45	0.64	0.86	0.88

On the next series of trips, the forager finds that the net extraction return rate of his favorite quarry pit has fallen to 29.66 gpm (the worst case in Quarry Experiment 4). This increases his costs, but he perseveres and procures his 10 kg load of bifaces. Now, however, he discovers that the cost per gram of biface for processing at the source is higher than experienced in deferred processing out to a transport distance of 8 or 9 kilometers (Table 244, Figure 293); beyond that, the cost per gram for bifaces processed at the source is lower than that for deferred processing. Moreover, at all distances, he has the use life utility of 10,000 grams of bifaces.

Table 244. Effects of Distance on Caloric Costs of 10 kg Toolstone Procurement: Processing at Source (neRr = 29.66 gpm; gpRr = 369.66 gpm).

	50 km	10 km	1 km	0 km
Travel (cal)	10,000	2,000	200	0
Transport (cal)	625	125.0	1.25	0
Extraction (cal)	67,136.6	67,136.6	67,136.6	67,136.6
Processing (cal)	2,999.7	2,999.7	2,999.7	2,999.7
Total (cal)	80,761.3	72,261.3	70,348.8	70,136.3
Net Return (gm)	10,000	10,000	10,000	10,000
Cost (cal/gm)	8.08	7.23	7.03	7.01
Benefit/Cost	0.12	0.14	0.14	0.14

Cost (calories per gram of biface) by distance for each of our three examples are plotted in Figure 293. This plot suggests that at the highest average experimental net return rate and biface failure rate, it will always pay to process at the source no matter what the transport distance. On the other hand, with the same biface failure rate and our lowest net return rate,

deferred processing is less expensive out to about 9 km; at longer transport distances, deferred processing is cheaper. Figure 294 is another way of looking at the data, where the benefit/cost ratio of biface procurement is plotted by distance for each of our three examples. Here we see that at less than 9 km, the benefit/cost ratio for deferred processing is much better than processing at the source when net return rate is low, but we also see a drastic change in the slope of the benefit/cost line for deferred processing between 5 and 10 km. This inflection suggests a logical decision point for prehistoric quarriers, from which we predict a change in assemblage composition: At distances less than about 10 km from the quarry source, we expect relatively high proportions of early stage bifaces and debitage, and the occasional occurrence of cores and/or unreduced blanks. At about 10 km from the quarry, we expect a sharp decrease in proportions of cores, blanks, early stage bifaces and debitage.

The venture risk model presented in Chapter 3 (Figure 11) assumes that the probability of costs exceeding benefits is highest between the times extraction begins and sufficient toolstone has been processed to amortise search and handling costs. In our modeling exercise above, deferred processing not only increased the caloric cost per gram of transported toolstone but also extended the duration of highest venture risk. A forager who transports loads of toolstone that deliver a low net biface proportion (nProbf) might get lucky and occasionally beat the odds, but in the long run will have less success in predicting returns. This increases the venture risk involved with each procurement foray, as well as the contingency risk of meeting situational demands adequately: perhaps there will be sufficient tool use life utility on hand to accomplish subsistence tasks, but perhaps not.

When Deferred Processing Pays Off

In light of the foregoing, we might predict that the higher the costs of travel, prospecting, and extraction, the more likely it is that processing will occur at the source. This may not always

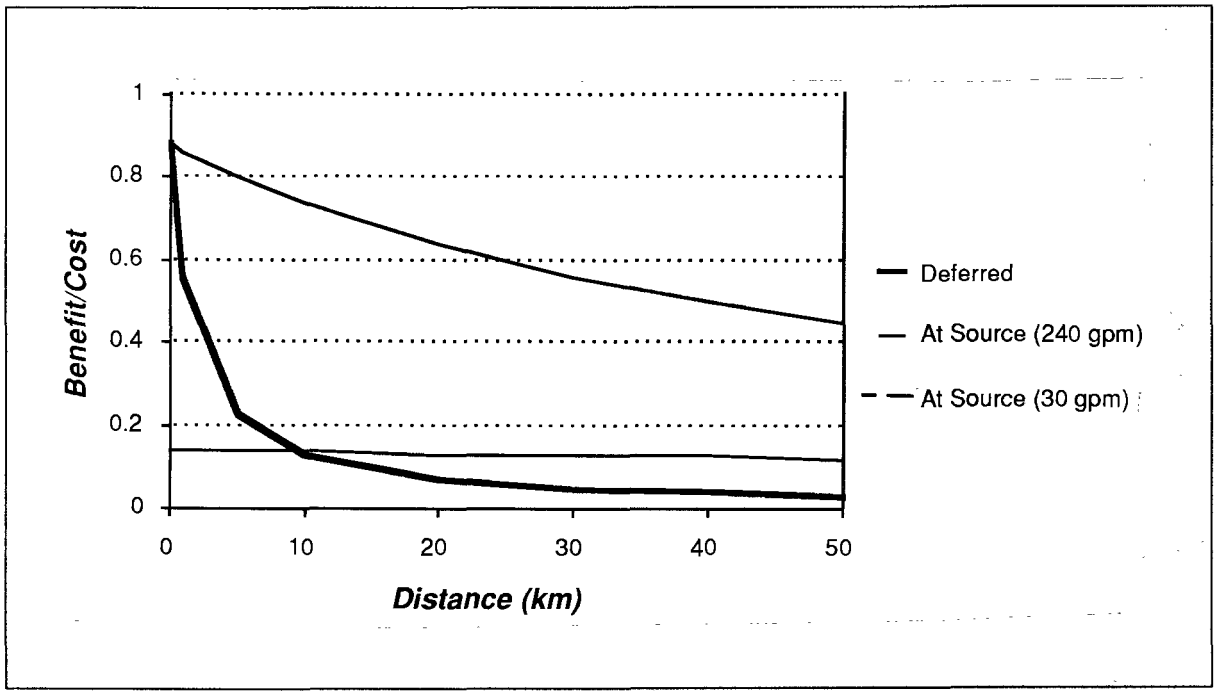


Figure 294. Benefit/cost ratio by transport distance with processing at source or deferred.

be the case, however. Studies in behavioral ecology (reviewed in Stephens 1990) suggest that animals may prefer certainty (low variation in amounts of food taken) when not stressed by hunger, and may prefer risk (wide variation in amounts of food taken) when they are hungry. Similarly, deferred processing seems an appropriate response to acute situational demands, particularly those that impose constraints on time at the quarry. When immediate contingencies must be met, one can gamble on toolstone quality, use life utility may be unimportant. If cache retrieval is not an option, most situational needs probably could be satisfied through surface collection or scavenging waste in quarry pit berms; processing could be deferred to point of use with little penalty in cost. Other situations limiting time at the source include inclement weather, lack of water, or presence of hostile people (particularly if poaching in another group's patch).

Since deferred processing has high costs and risks, anything that decreases venture risk makes deferred processing more viable. Consider a forager with access to a toolstone source of such high quality that nProbf is 50.0, that is, fifty percent of extracted mass can be processed into bifaces. After making the 50 km trip to and from the quarry, the forager arrives home with 10 kg of unprocessed raw material and manages to make 5000 grams of bifaces. Their cost is only 2.2 calories per gram, comparable to, or better than, the cost of poorer quality material processed at the source. Although the forager ends up with the use life utility provided by only 5000 grams of bifaces, the difference conceivably could be offset by avoided opportunity costs. Venture risk and cost also can be decreased by experience and skill of quarriers and knappers in finding high quality material to increase net extraction and processing rates. A forager who is able to judge toolstone quality more finely can estimate net biface proportion better, taking less chance on transporting unprocessed material.

The smaller the amount of toolstone procured, the less the cost, and at some point, cost becomes negligible. The cost of extracting 1000 grams of Tosawihi opalite is 27.8 calories and processing adds another 9.9 calories; carrying it 50 km costs 62.5 calories. At these levels, cost hardly can influence the decision of when and where to process. The combination of high quality and small package size converge with technology in the obsidian nodules that were transported over 100 km to Tosawihi without processing. These items apparently were intended to produce flake tools as well as blanks for projectile points and small bifaces, and served to decrease contingency risk. The proportion of waste in this core and flake technology probably was low; at less than 100 grams per item, carrying cost was next to nothing.

Deferred processing also might pay off in trade, where the producer and consumer are not the same. Time and effort involved in processing is small compared to that expended on bedrock extraction, so avoiding only processing cost is unlikely to balance the increased cost of transporting unprocessed material. In our experiments, the major cost of processing is reflected in processing failures and debitage. By trading unprocessed or minimally processed material (Jackson 1988), the producer can pass on to the consumer the costs of both processing and rejection, along with the associated venture risk. For deferred processing to be profitable to the producer in the long run, the return in trade (goods, foraging rights, access to mates, prestige, etc.) must be greater than the cost of extracting and transporting the unprocessed material.

Strategies of Lithic Procurement at the Tosawihi Quarries

This conclusion summarizes our view of lithic procurement strategies employed at Tosawihi in light of what we know about the economic costs of lithic procurement. In Chapter 3 we proposed that people can call on a variety of organizational and technological options for lithic procurement, depending on the nature and distribution of toolstone in the landscape, the location and distribution of food resources, seasonality, and other variables that affect costs and risks. But we see evidence for a limited number of possibilities at Tosawihi, suggesting that only a few procurement strategies were employed there; only one of those has much archaeological visibility.

Direct Winter Procurement from Humboldt Valley/Rock Creek Camps

Two days from the nearest recorded ethnographic winter camp on Rock Creek, winter lithic procurement would necessitate either winter residence at or near Tosawihi, a winter residential move there, or a logistical trip by a small, specialized task-group. Let us quickly dismiss the first two of these; Tosawihi is too cold, too dry, and too unproductive to support many people for any length of time even in the best season. Long-term residential occupation of the quarries, particularly over-wintering, by Tosawihi Shoshone (or earlier groups) is therefore unlikely. A residential move to the vicinity in winter would be even more costly and dangerous. It is possible, however, that intensive exploitation of the quarries was accomplished through logistically organized, direct toolstone procurement from winter residential base camps on the Humboldt River or lower Rock Creek.

In risking winter at Tosawihi, people would encounter conditions roughly equivalent to those at high altitude Great Basin sites such as Alta Toquima (Thomas 1981) and the White Mountains (Bettinger in press), and, reasonably, we might expect the presence of similar substantial residential structures and elaborate hearths, or the occupation of rockshelters. To date, however, there is *no* archaeological evidence for winter use of the Tosawihi Quarries.

In the event of toolstone shortage in the winter camp, it nearly always would pay to pursue alternatives such as scavenging, recycling, and use of lower quality local materials. If a visit *must* be made, the highest payoff would accrue from the shortest possible trip and retrieval of a cache; in fact, this might be the only payoff sufficient to justify a winter trip to the quarries. Cache retrieval, however, would create little or no archaeological signature.

Diurnal Lithic Procurement During Spring Foraging

Tosawihi lies near the center of the region exploited by the Shoshone in their spring and summer foraging mode. The perceived need for new supplies of toolstone probably was highest after winter in the base camp. Tosawihi is within the diurnal radius of foraging camps on Willow Creek, Rock Creek, Little Antelope Creek, Antelope Creek and Ivanhoe Creek; logistical procurement also is possible from camps outside that range.

In a residential-diurnal pattern, people collect toolstone at a source and return to camp the same day. However, the time available for toolstone procurement decreases with distance from the residential base, so lithic procurement is likely to be limited to encounter procurement, surface collection, or retrieval, none of which leaves a distinctive archaeological signature. Perhaps the most probable indicators of diurnal use are shallow pits excavated in quarry pit berms, apparently to glean previously quarried but discarded toolstone. Archaeological visibility of spring and summer logistical procurement also is low, but perhaps is signaled by the presence of domestic equipment at quarry localities (cf. Chapter 24). There remains, however, no sure way to distinguish very short term residential occupation from logistical use.

Intensive Spring Lithic Procurement

Our experimental quarrying and processing data indicate that, working 8 hours per day, it would take two people about 4 days to obtain 20 kg of Stage 3 bifaces. This leaves very little time (or energy) to obtain water, procure and prepare food, construct shelter (no matter how simple), and perform all the tasks of daily life. This suggests that quarriers were

either supported by other people or that quarrying required occupation of even longer duration. If full scale quarrying and processing required at least several days residence at the quarries by relatively large groups, we must imagine greater demands on local resources to support the foray. Local productivity is greatest in late spring and early summer, so we suspect strongly (although we have no *direct* evidence of seasonality) that Tosawihi quarrying was scheduled for that season. We have suggested further that the greater the demand on local resources, the more likely is occupation of places located not with perfect propinquity to toolstone sources, but with reference to water and food resources as well; the "sweet spots" in the Western Periphery are examples. Indeed, all such places are occupied by large sites with abundant and diverse assemblages, classified as domestic reduction sites. Are these sites in fact residential bases occupied during the spring and early summer by large groups on intensive quarrying forays? Perhaps, but they also exhibit the greatest time depth of all sites investigated, so their large and diverse assemblages might be solely the result of long term accumulation. On the other hand, assemblages of sites in this functional class are distinct; content differences are robust, even when domestic equipment is removed from consideration (Chapter 24). We suspect that domestic reduction sites are indeed the result of intensive procurement as modeled, expressed so vigorously in the archaeological record that everything else is nearly overshadowed. Confirmation of that hypothesis waits further study.

Conclusions

We provisionally conclude, therefore, that prehistoric foragers came to the quarries in the spring, mostly for the purpose of getting toolstone, when it was easiest and least costly to do so. This was expensive, requiring such a sustained effort one wonders whether people ever worked as hard to procure other kinds of resources. With this level of effort, we should not be surprised to find individual or family ownership of quarry pits (or perhaps entire localities), similar to pinenut groves and fish weirs (Steward 1938). The paucity of old tool discards indicates the move to the quarries was planned and deliberate—no need to pack all your old knives when you are going to the hardware store for a new set of cutlery. On the one hand, the lack of structures, constructed hearths, or intensely used ground stone suggests that few people tarried at Tosawihi longer than necessary. On the other, the occupation of sweet spots and the evidence for procurement of local resources in addition to toolstone suggest that intensive quarrying and processing forays may have involved residential moves by household groups. This makes sense if winter tool supplies had been consumed, and a spring foray to the quarries, located in the middle of the foraging range, would position people well for the rest of the foraging season.

The archaeological evidence suggests that opalite procurement was an important activity for prehistoric people and ethnographic Shoshone living along the Humboldt, imbued with ethnic and mythic significance. We do not want to leave the impression, however, that getting toolstone consumed these hunter-gatherers during every waking hour. Every once in while, people went to Tosawihi and worked hard for several days to accomplish a goal that helped them sustain life and make things easier. Then they went off and did a lot of other things.

EPILOGUE

Were this report the last word on the Tosawihi Quarries, the reader might expect a grand synthesis, a critique of methodology, and comprehensive recommendations for future research. As it happens, much more archaeological work remains to be reported and many new insights described. In the summer of 1990, data recovery was conducted at Locality 36 of 26Ek3032. The analysis and report currently in progress will provide a detailed look at a complex of more than fifty quarry pits with a history extending back to about 2000 B.C. In addition to examining such topics as technological change through time, quarry pit volumetrics, and relationships between toolstone occurrence, toolstone quality, and variability in extraction technique, the pending report will review and critique the methods of lithic data collection and analysis we have employed here. Too, the summer of 1991 saw field work completed on an intensive survey of over 400 acres adjacent the Eastern Periphery, and on a stratified random sample of a 44.5 square mile study area centered on the Tosawihi Quarries. These surveys will inform an understanding of the value of the Tosawihi uplands as a lithic terrane, as well as its environmental variability and productivity vis-à-vis other resources. Moreover, we expect to gain greater insight into the economic effects of distance on size and reduction stage of lithic artifacts than our present, areally restricted view allows.

In short, a synthesis is premature at present—it would have to be revised too soon to validate the cost of writing it or reading it—but later chapters of our undertaking will confront many of the questions that, only here, we have learned how to pose.

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APPENDIX A

Chert Chemistry Analyses

UNIVERSITY OF MISSOURI

Research Reactor Facility

Research Park
Columbia, Missouri 6521
Telephone (314) 882-421

February 10, 1989

Robert G. Elston
Intermountain Research
Drawer A
Silver City, NV 89428

Dear Bob:

I have completed the NAA work on the samples of Tosawihi chert samples which you sent in November. By using a combination of three different irradiations with four measurements a total of 30 elements were measured in most samples. For your information, I will briefly describe the analytical procedures and measurements for you:

The samples were initially prepared by extracting interior fragments (chips) from each specimen. This was accomplished using a hand press to crush the large specimens. The specimens were placed inside plastic bags and cushioned with styrofoam to prevent contamination from the press. The resulting chips were of order 10-20 mg in mass. The chips from each of the crushed specimens were cleaned in alcohol and DI water and finally dried in an oven to remove any loose particles.

Three analytical samples were prepared from each specimen (a one gram sample for prompt gamma NAA, a 150 mg sample for short irradiation NAA and a one gram sample for long irradiation NAA). The PGNAA sample was irradiated for 1-2 hours per sample in the MURR PGNAA facility and the element B was measured. The short NAA sample was irradiated for 5 seconds and counted after a 25-minute decay with the elements Cl, Dy, K, Mn and Na being measured. The long NAA sample was irradiated for 72 hours and counted twice (after 10 days and then after 8 weeks) with the elements As, Ba, La, Lu, Nd, Sm, U, Yb, Ce, Co, Cr, Cs, Eu, Fe, Hf, Rb, Sb, Sc, Ta, Tb, Th, Zn, Zr and Hg being measured.

The data was then assembled into a spreadsheet using Lotus 2.01. An ASCII file was created and the data were then studied with the Brookhaven codes which I obtained from Ed Sayre. Note that due to the limited number of specimens many of the programs could not be used.

The first program I used was MADSTAT which can be used to output the univariate statistics for an input group of specimens. MADSTAT lists the input data and both the arithmetic and geometric means and standard deviations for the input group. A MADSTAT listing is enclosed. The second program was MADPLOT which outputs a bi-variate plot for a selected pair of elements. A MADPLOT output for several pairs of elements has been enclosed. From studying the MADSTAT and MADPLOT output results, I selected those elements which in my judgement were the most discriminating. In my opinion these elements were: Eu, Cs, Fe, Hf, Sb, Sc, Ta and Tb. These elements were then input to the program MCONDIST which calculated a distance matrix based on the Mean Euclidean Distance between specimens. The data were log normalized before calculating this distance matrix. The distance matrix calculated by MCONDIST was then input into the program MAGCLUS which outputs a dendrogram that illustrates the similarity between ecimens. The resulting dendrogram is also enclosed.

In addition to the computer printouts mentioned above, I have enclosed an IBM diskette which contains the following:

1. A spreadsheet file named NEVADA.WK1 which is in LOTUS 2.01 format. The data are given in parts per million on this diskette.

2. An ASCII file named NEVADA.PRN which contains data from the above LOTUS spreadsheet also in parts per million. The data for each specimen is stored on three lines using 130 characters per line and the format of the data is as follows:
   On the first line there is a six-character id, three blank spaces, a single letter C indicating the sample type to be chert, twelve concentration in fields of 10 characters each;
   on the second line a repeat of the six-character id, followed by the three blank spaces, the letter C, and the next twelve concentrations; on the third line the six-character id is repeated, with three blank spaces, the letter C and finally the last six concentrations.

   If you are familiar with FORTRAN, the format could be written:
   (A6,3X,A1,12F10.3,/A6,3X,A1,12F10.3,/A6,3X,A1,6F10.3)
   The ordering of elements is:
   Line 1: As, Ba, La, Lu, Nd, Sm, U, Yb, Ce, Co, Cr, Cs,
   Line 2: Eu, Fe, Hf, Rb, Sb, Sc, Ta, Tb, Th, Zn, Zr, Hg,
   Line 3: Cl, Dy, K, Mn, Na, B
   All concentrations are given in parts per million.

A hard copy printout of the above listed ASCII file is also enclosed.

One of my students (Mike Elam) who is familiar with the use of the SAS procedures will be studying these data using SAS to see what he he may be able to learn.

Please look at these data for a couple of weeks and then call me. We can discuss what further treatment should be applied to these data. Also, we can discuss whether you are interested in addition analyses of specimens and the means of payment for these and future analyses. I would prefer one payment (by purchase order) which would be placed into a single grant account. However, we can discuss other options. If you decide that this will be your only request for specimen analyses, you will need to provide a P.O. for $2,100 according to our originally agreed charge of $100 per sample.

I look forward to hearing from you in a couple of weeks.

Sincerely,

Michael D. Glascock

Michael D. Glascock

Enclosures:

UNIVERSITY OF MISSOURI

Research Reactor Facility

Research Park
Columbia, Missouri 65211
Telephone (314) 882-4211

February 16, 1989

Dr. Robert G. Elston
Intermountain Research
Drawer A
Silver City, NV 89428

Dear Dr. Elston:

I have completed the statistical analysis of the Tosawihi Chert trace element data. This analysis was performed using the SAS procedures as Dr. Glascock informed you in his letter of February 10. These results are complimentary to the ones obtained using the Brookhaven codes.

The data were assembled into the SAS format via an ASCII file created from a Lotus 2.01 spreadsheet. As Dr. Glascock noted for the Brookhaven codes, the small sample size of the Tosawihi data set precluded use of some of the more rigorous statistical procedures available in SAS (any type of Factor Analysis for example) as well.

I first calculated the basic univariate statistics and a test for normality utilizing the UNIVARIATE procedure. The results of this procedure revealed the majority of elements to have a large amount of variance and several exhibited quite pronounced skew and kurtosis. However, most were found to be normally distributed by the Shapiro-Wilks Test for normality. Nonetheless, normality was improved by taking the base ten logarithms and all additional statistical tests were performed using the log-normalized variables. The bivariate plots obtained by Dr. Glascock via the MADPLOT program were then examined to determine the most discriminating elements. I came to the same conclusion as Dr. Glascock that the most discriminating elements were Eu, Cs, Fe, Hf, Sb, Sc, Ta, and Tb. These elements were then used to test the groupings of the samples.

Because the data obtained for the Tosawihi chert were rather rough, I felt that some improvement in the ability to group the data could be obtained by calculating Canonical Discriminant Functions and using these functions in the clustering procedure rather than the log-normalized scores. These were obtained with the ACECLUS procedure and I have included the results of this procedure. The initial estimate of the within-cluster covariance structure was obtained using the total-sample covariance. I felt this was necessary due to the degree of dispersion observed in the variables and looking at only sample variances or identities would result in a loss of discriminating power (as it turned out, no improvement was obtained through use of sample variances or an identity matrix). The ACECLUS procedure derived four (4) Canonical Discriminant Functions from the eight (8) log-

normalized variables. While the procedure will derive discriminant functions equal to the number of variables input, more than four Canonical Discriminant Functions caused the subsequent clustering algorithms to fail due to arithmetic errors such as attempts to divide by zero or to take square roots of negative numbers. The Canonical Discriminant Functions (defined as ELE1-4) were then plotted against each other. The samples are defined as letters such that sample numbers 1-3=A, 4-6=B, etc. As is apparent from the plots, the discriminant functions did not do very well in discriminating the samples into meaningful groups. The Canonical Discriminant Functions were then input into the procedure CLUSTER to see if they would be useful in grouping the samples by conventional cluster analysis. Three different clustering algorithms were used; average linkage, centroid (squared Euclidean Distance), and Ward's Minimum Variance. Unfortunately as can be seen from the tree diagrams, the Canonical Discriminant Functions did not do any better in discriminating the samples into meaningful groups through a clustering algorithm than they did by simply plotting one against the other. I concluded from this that discriminant functions would not be of much use in grouping the specimens into meaningful sets.

Because the discriminant functions failed, I then turned to using the log-normalized scores in the same clustering algorithms as mentioned above. SAS has a wider variety of algorithms than do the Brookhaven codes and I hoped that perhaps a better fit could be obtained using these algorithms. Average linkage is the most commonly used clustering algorithm. The Brookhaven codes use a variant of this algorithm and the results that Dr. Glascock sent you are via an average linkage analysis. Average linkage is usually defined as the average distance between pairs of observations, one in each cluster. The centroid method is similar, but the distance measure is defined as the squared Euclidean distance between the means of two clusters. It is more robust to outliers than most other clustering algorithms. Ward's minimum variance algorithm measures the distance between two clusters as the ANOVA sum of squares summed over all variables. It has the advantages of being biased toward producing clusters with roughly the same number of specimens (important in a data set such as the Tosawihi chert), but is very sensitive to outliers. The results of these analyses are presented in the

second enclosed printout. As can be seen by a perusal of the tree diagrams, the solutions obtained using the log-normalized scores and the average linkage and centroid algorithms are sensible. Samples 1-3, 10-12, 13-15, 16-18 and 19-21 are linked together as expected. The remaining samples did not link in the manner expected. This would tend to show the many of these samples are more similar than originally surmised. The solution obtained by the average linkage and centroid are slightly better than that obtained by the MCONDIST and MAGCLUS programs. The Ward's algorithm did not produce as good a solution as did the average linkage or centroid methods probably due to the methods susceptibility to influence by outlying observations.

These results are probably as good as are obtainable given the small size of the data set and the fact that there is a fair amount of heterogeneity in groups of samples that were considered to be homogenous. Also, since the Canonical Discriminant Functions did not work well as classification criteria, it is doubtful that other types of discriminant functions (i.e. quadratic) or dimension compression techniques (i.e. multidimensional scaling) would work well in this regard either.

I hope that these results are of some use to you in your research endeavors. If you have any questions, please do not hesitate to contact me. My phone number is (314) 882-5268. Thank you for your collaboration with both Dr. Glascock and myself. We enjoyed working with you on this project. If we can ever be of assistance in the future in other archaeometric investigations, please don't hesitate to contact us.

Sincerely,



Michael Elam, MA
Grad. Research Assistant

enclosures

APPENDIX B

Photographic Methods

Appendix B: Photographic Methods

To emphasize flaked surfaces on projectile points and most other tools, artifacts were treated with a smoked layer of ammonium carbonate. This opaque coating obliterates all but topical features, focusing on flaking patterns rather than on color, tone, or material type.

Artifacts were photographed with a *Pentax* 6 cm x 7 cm format camera and a *Macro-Takumar* 1:4/135 mm lens. Field photographs were made with a variety of 35 mm cameras and lenses.

Artifacts were photographed under artificial lighting. Smoked artifacts were arrayed on a light box designed to give even illumination, balanced for daylight (5000°K). One or two photoflood lamps supplied light. The main source was placed low, at the upper left or upper right corner. A white card occasionally was used to provide extra fill light from the shadow side. It was sometimes necessary to use a fill light at a 1:3 ratio with the main light. Untreated artifacts were staged on a plate of clear glass, suspended 12.5 cm from a background of milk-white plexiglass. The lighting ratio between the artifacts and the background varied from plate to plate, allowing grayness to vary as much as one-half zone on the gray scale.

A cm scale was included in each original negative, but was cropped from the print. Scales included in the reproductions were added subsequently.

Kodak Plus-X Professional 120 format film was used exclusively for the artifact plates. This film, normally rated at 125 ASA, was rated at 100 ASA for this project. It was developed normally in Ilford ID-11 developer without dilution. This combination allows very fine grain structure and full shadow detail. Field photographs were made using *Kodak Plus-X*, *Kodak Ektachrome*, and *Fujichrome*. Black and white internegatives were made from color slides for reproduction.

All images were printed on *Kodak Polyprint RC*, a resin-coated paper with a glossy surface. Artifact photographs were printed using a #2 *Ilford* multigrade filter; field photographs were made using a variety of contrast filters. These filters were interposed between the light source and the negative to achieve a sharper image and greater contrast.

All black and white films were processed to archival standards and stored in appropriate sleeves.

APPENDIX C

Summary Data for Bifaces

APPENDIX C

Table 1. Summary Data for Bifaces.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
Subarea: **Quarry**																
3032	0	7	0	0	2	5	0	0	0	7	0	0	0	0	0	0
3032/L19																
	0	9	0	0	8	1	0	0	2	9	0	0	0	0	0	0
	1	45	0	6	35	1	0	3	2	45	0	0	0	0	0	0
Subtotal		54	0	6	43	2	0	3	4	54	0	0	0	0	0	0
3032/L20	0	4	0	0	3	1	0	0	0	4	0	0	0	0	0	0
	1	9	0	1	8	0	0	0	0	9	0	0	0	0	0	0
	2	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0
	3	3	0	1	2	0	0	0	0	3	0	0	0	0	0	0
Subtotal		17	0	3	13	1	0	0	0	17	0	0	0	0	0	0
3032/L21	0	4	0	1	3	0	0	0	0	4	0	0	0	0	0	0
	1	2	0	1	1	0	0	0	0	2	0	0	0	0	0	0
Subtotal		6	0	2	4	0	0	0	0	6	0	0	0	0	0	0
3032/L22	1	6	1	2	3	0	0	0	0	6	0	0	0	0	0	0
3032/L23	1	67	2	7	50	1	0	7	3	65	1	0	0	0	1	0
3032/L25	0	10	0	0	10	0	0	0	0	10	0	0	0	0	0	0
	1	5	0	1	3	1	0	0	0	5	0	0	0	0	0	0
	2	67	1	6	54	0	0	6	3	65	0	0	0	0	2	0
	4	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	5	8	0	2	5	0	0	1	0	8	0	0	0	0	0	0
Subtotal		91	1	9	73	1	0	7	4	89	0	0	0	0	2	0
3032/L27	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
3032/L98	1	7	0	0	6	0	0	1	1	7	0	0	0	0	0	0
Subarea: **East**																
0024	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
0118	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
0310	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
0311	0	3	0	0	1	1	0	1	1	3	0	0	0	0	0	0
0510	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
3170	0	124	0	4	99	12	0	9	40	114	3	0	0	4	3	0
	1	5	0	3	2	0	0	0	0	5	0	0	0	0	0	0
	2	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	3	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	5	6	0	0	5	1	0	0	3	6	0	0	0	0	0	0
	6	4	0	0	3	1	0	0	1	4	0	0	0	0	0	0
	7	9	0	2	6	0	0	1	2	9	0	0	0	0	0	0
	8	4	0	0	4	0	0	0	3	3	1	0	0	0	0	0
	9	2	0	1	1	0	0	0	0	2	0	0	0	0	0	0
	10	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	11	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	12	18	0	1	13	4	0	0	8	18	0	0	0	0	0	0
	13	7	0	0	5	1	0	1	4	7	0	0	0	0	0	0
	14	10	1	0	9	0	0	0	0	9	0	0	0	1	0	0
3170 A	8	7	0	0	5	1	0	1	6	7	0	0	0	0	0	0
3170 B	8	15	1	0	10	3	0	1	6	15	0	0	0	0	0	0
Subtotal		217	2	11	168	23	0	13	74	205	4	0	0	5	3	0
3171	0	50	0	3	33	10	0	4	10	46	0	0	2	0	2	0
	1	10	0	4	6	0	0	0	1	10	0	0	0	0	0	0
	2	9	0	2	7	0	0	0	0	9	0	0	0	0	0	0
	3	4	0	1	2	1	0	0	0	4	0	0	0	0	0	0
	4	4	0	0	4	0	0	0	0	4	0	0	0	0	0	0
	5	6	0	0	2	4	0	0	3	6	0	0	0	0	0	0
	6	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	7	6	0	0	6	0	0	0	0	6	0	0	0	0	0	0
	8	2	0	0	1	1	0	0	1	2	0	0	0	0	0	0
Subtotal		92	0	10	62	16	0	4	15	88	0	0	2	0	2	0
3172	0	5	0	0	5	0	0	0	0	5	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		6	0	0	6	0	0	0	0	6	0	0	0	0	0	0
3173	0	2	0	0	1	0	0	1	1	2	0	0	0	0	0	0
	1	6	0	0	5	1	0	0	0	6	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
Subtotal		9	0	0	7	1	0	1	2	9	0	0	0	0	0	0
3174	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0

Appendix C: Table 1, continued.

			REDUCTION STAGE							MATERIAL TYPE						
Site/Locus	Fea.	Total Bifaces	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
3175	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
3177	1	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
3178	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	1	13	0	0	9	1	0	3	3	13	0	0	0	0	0	0
Subtotal		14	0	0	10	1	0	3	4	14	0	0	0	0	0	0
3179	1	2	0	0	1	1	0	0	1	2	0	0	0	0	0	0
3180	1	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
3181	1	11	0	0	10	0	0	1	6	11	0	0	0	0	0	0
3183	1	4	0	0	2	1	0	1	0	4	0	0	0	0	0	0
3184	0	23	0	0	15	7	0	1	8	22	0	0	0	0	1	0
	1	16	0	0	13	3	0	0	6	15	1	0	0	0	0	0
	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	3	13	0	1	10	2	0	0	2	13	0	0	0	0	0	0
	5	5	0	0	5	0	0	0	1	5	0	0	0	0	0	0
	6	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
	8	101	0	2	85	11	0	3	46	101	0	0	0	0	0	0
	10	17	0	1	10	5	0	1	2	17	0	0	0	0	0	0
	11	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	12	23	2	0	18	2	0	1	6	23	0	0	0	0	0	0
	14	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	15	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	16	4	0	0	4	0	0	0	1	4	0	0	0	0	0	0
	18	3	0	0	3	0	0	0	1	3	0	0	0	0	0	0
	19	14	0	0	8	5	0	1	1	13	0	1	0	0	0	0
	20	3	0	2	1	0	0	0	0	3	0	0	0	0	0	0
	21	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
	22	6	0	0	3	3	0	0	5	6	0	0	0	0	0	0
	23	36	0	0	33	2	0	1	8	36	0	0	0	0	0	0
	24	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
	26	5	0	0	2	3	0	0	0	5	0	0	0	0	0	0
Subtotal		277	2	6	216	45	0	8	89	274	1	1	0	0	1	0
3185	0	5	0	0	4	1	0	0	2	5	0	0	0	0	0	0
	1	8	0	0	7	1	0	0	2	8	0	0	0	0	0	0
	2	3	0	0	3	0	0	0	1	3	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0

Appendix C: Table 1, continued.

			REDUCTION STAGE							MATERIAL TYPE						
Site/Locus	Fea.	Total Bifaces	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
	5	4	0	0	4	0	0	0	0	4	0	0	0	0	0	0
	6	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		22	0	0	20	2	0	0	5	22	0	0	0	0	0	0
3186	2	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
3189	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
3190	0	12	0	0	12	0	0	0	1	12	0	0	0	0	0	0
	1	30	0	1	22	0	0	7	8	29	1	0	0	0	0	0
	2	13	0	0	9	0	0	4	2	12	1	0	0	0	0	0
	4	5	0	0	5	0	0	0	1	5	0	0	0	0	0	0
	5	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
	6	4	0	0	4	0	0	0	1	4	0	0	0	0	0	0
	7	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	11	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
Subtotal		69	0	1	57	0	0	11	15	67	2	0	0	0	0	0
3191	0	4	0	0	3	1	0	0	0	4	0	0	0	0	0	0
	1	3	0	0	3	0	0	0	0	0	3	0	0	0	0	0
Subtotal		7	0	0	6	1	0	0	0	4	3	0	0	0	0	0
3192	0	9	0	0	7	2	0	0	2	9	0	0	0	0	0	0
	1	141	1	4	108	12	1	15	23	141	0	0	0	0	0	0
	2	68	1	2	49	7	0	9	23	66	1	1	0	0	0	0
	3	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0
	4	4	0	0	3	1	0	0	1	4	0	0	0	0	0	0
	5	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0
Subtotal		226	2	6	171	22	1	24	49	223	1	2	0	0	0	0
3193	0	7	0	0	5	2	0	0	1	7	0	0	0	0	0	0
	1	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0
	2	4	0	0	4	0	0	0	1	4	0	0	0	0	0	0
	3	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	4	4	0	0	4	0	0	0	0	4	0	0	0	0	0	0
	5	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
Subtotal		22	0	0	20	2	0	0	3	22	0	0	0	0	0	0
3195	0	15	0	0	14	1	0	0	0	15	0	0	0	0	0	0
	1	2	0	0	1	0	0	1	0	2	0	0	0	0	0	0
	2	11	0	1	8	0	0	2	0	11	0	0	0	0	0	0

Appendix C: Table 1, continued.

			REDUCTION STAGE							MATERIAL TYPE						
Site/Locus	Fea.	Total Bifaces	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
	3	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	5	4	0	0	4	0	0	0	0	4	0	0	0	0	0	0
	6	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0
	7	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0
	8	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	700	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		45	0	1	40	1	0	3	0	45	0	0	0	0	0	0
3196	0	5	0	0	5	0	0	0	0	5	0	0	0	0	0	0
	1	6	0	1	5	0	0	0	0	6	0	0	0	0	0	0
	2	8	0	1	7	0	0	0	0	8	0	0	0	0	0	0
	3	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	4	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	6	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		23	0	2	21	0	0	0	0	23	0	0	0	0	0	0
3197	0	6	0	1	5	0	0	0	1	6	0	0	0	0	0	0
	1	4	0	0	4	0	0	0	0	4	0	0	0	0	0	0
	3	3	0	0	3	0	0	0	1	3	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	5	17	0	3	14	0	0	0	0	17	0	0	0	0	0	0
	7	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	8	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	9	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
Subtotal		35	0	4	31	0	0	0	2	35	0	0	0	0	0	0
3198	0	5	0	0	4	0	1	0	0	5	0	0	0	0	0	0
	1	11	0	1	3	6	0	1	3	11	0	0	0	0	0	0
	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	3	5	0	0	4	1	0	0	1	5	0	0	0	0	0	0
	4	2	0	0	0	2	0	0	1	2	0	0	0	0	0	0
	5	5	0	0	5	0	0	0	2	5	0	0	0	0	0	0
	6	5	0	0	3	2	0	0	0	5	0	0	0	0	0	0
	7	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	8	3	0	0	1	2	0	0	0	3	0	0	0	0	0	0
	9	2	0	0	1	1	0	0	1	2	0	0	0	0	0	0
	11	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	14	8	1	1	5	0	0	1	0	8	0	0	0	0	0	0
	15	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	16	7	0	0	6	1	0	0	1	7	0	0	0	0	0	0
	17	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	19	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
	21	5	0	0	4	1	0	0	2	5	0	0	0	0	0	0
	23	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
Subtotal		66	1	2	44	16	1	2	12	66	0	0	0	0	0	0
3200	1	12	0	1	10	1	0	0	1	12	0	0	0	0	0	0
3201	1	13	0	1	10	0	0	2	4	13	0	0	0	0	0	0
	2	21	0	2	19	0	0	0	9	21	0	0	0	0	0	0
	3	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0
Subtotal		37	0	3	32	0	0	2	13	37	0	0	0	0	0	0
3202	1	2	0	1	0	1	0	0	1	2	0	0	0	0	0	0
3203	0	6	0	2	4	0	0	0	1	6	0	0	0	0	0	0
3204	0	43	0	4	34	2	0	3	5	43	0	0	0	0	0	0
	1	37	0	2	30	0	0	5	4	36	0	0	0	0	1	0
Subtotal		80	0	6	64	2	0	8	9	79	0	0	0	0	1	0
Subarea: **West**																
3084	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0
	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		2	0	0	2	0	0	0	0	1	0	0	0	1	0	0
3085	5	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
3086	0	4	0	2	2	0	0	0	0	4	0	0	0	0	0	0
3087	0	4	0	0	4	0	0	0	0	4	0	0	0	0	0	0
3088	0	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
3090	0	5	0	0	5	0	0	0	2	5	0	0	0	0	0	0
3091	0	6	0	0	5	1	0	0	1	6	0	0	0	0	0	0
3092	0	402	2	5	298	37	0	60	110	356	2	1	4	31	7	1
	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	2	3	0	0	3	0	0	0	3	3	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	5	2	0	0	2	0	0	0	2	2	0	0	0	0	0	0
	6	3	0	0	2	1	0	0	0	3	0	0	0	0	0	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
	7	9	0	1	6	0	0	2	0	6	0	0	0	3	0	0
	9	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	12	38	1	0	32	4	0	1	6	33	0	0	0	5	0	0
	13	20	0	0	17	3	0	0	8	18	0	0	0	2	0	0
	14	10	0	0	7	1	0	2	3	9	0	0	0	1	0	0
	16	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	20	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	21	3	0	0	3	0	0	0	1	3	0	0	0	0	0	0
	23	4	0	0	2	0	0	2	0	3	1	0	0	0	0	0
Subtotal		499	3	6	377	46	0	67	135	441	3	1	4	42	7	1
3093	0	4	0	0	2	2	0	0	0	4	0	0	0	0	0	0
	1	3	0	0	2	1	0	0	1	3	0	0	0	0	0	0
	3	2	0	0	1	0	0	1	1	2	0	0	0	0	0	0
	4	21	0	2	8	5	0	6	4	21	0	0	0	0	0	0
	5	8	0	0	4	4	0	0	1	8	0	0	0	0	0	0
Subtotal		38	0	2	17	12	0	7	7	38	0	0	0	0	0	0
3095	0	72	0	3	44	18	0	7	34	71	1	0	0	0	0	0
	2	4	0	1	3	0	0	0	3	4	0	0	0	0	0	0
	3	6	0	0	4	2	0	0	3	6	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	5	10	0	0	7	3	0	0	7	10	0	0	0	0	0	0
	6	19	0	0	12	4	0	3	8	19	0	0	0	0	0	0
	7	6	0	0	4	2	0	0	1	6	0	0	0	0	0	0
	8	3	0	0	2	1	0	0	0	3	0	0	0	0	0	0
	9	5	0	0	5	0	0	0	2	5	0	0	0	0	0	0
	10	83	0	2	60	10	0	11	45	82	0	0	1	0	0	0
	11	6	0	0	5	1	0	0	3	6	0	0	0	0	0	0
	12	4	0	0	3	0	0	1	1	4	0	0	0	0	0	0
	13	10	0	0	9	1	0	0	1	10	0	0	0	0	0	0
	15	55	0	0	31	11	0	13	30	54	0	1	0	0	0	0
	16	3	0	0	3	0	0	0	1	3	0	0	0	0	0	0
	17	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
	19	53	0	1	33	10	0	9	19	51	0	0	2	0	0	0
	20	7	0	2	4	1	0	0	3	7	0	0	0	0	0	0
	21	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	22	71	0	0	47	19	0	5	37	70	0	0	0	0	1	0
	23	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	24	45	0	1	26	11	0	7	2	43	0	0	0	2	0	0
	25	2	0	0	2	0	0	0	2	2	0	0	0	0	0	0
Subtotal		468	0	10	307	95	0	56	203	460	1	1	3	2	1	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
3096	0	5	0	1	3	0	0	1	3	5	0	0	0	0	0	0
	1	4	0	0	4	0	0	0	4	4	0	0	0	0	0	0
	2	2	0	0	2	0	0	0	0	2	0	0	0	0	0	0
	3	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		13	0	1	11	0	0	1	8	13	0	0	0	0	0	0
3099	0	3	0	0	3	0	0	0	2	3	0	0	0	0	0	0
	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	3	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0
	4	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
Subtotal		7	0	0	6	0	0	1	3	7	0	0	0	0	0	0
3101	0	16	0	0	13	1	1	1	12	14	0	1	0	0	0	1
3101 1	0	5	0	0	5	0	0	0	3	5	0	0	0	0	0	0
Subtotal		21	0	0	18	1	1	1	15	19	0	1	0	0	0	1
3102	0	8	0	1	6	0	0	1	4	8	0	0	0	0	0	0
	1	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		11	0	1	9	0	0	1	5	11	0	0	0	0	0	0
3104	0	7	0	0	7	0	0	0	0	7	0	0	0	0	0	0
3106	0	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
	1	24	0	1	20	1	0	2	15	24	0	0	0	0	0	0
	2	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	4	21	0	0	18	2	0	1	9	20	0	0	0	0	1	0
	7	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
Subtotal		50	0	1	43	3	0	3	27	49	0	0	0	0	1	0
3107	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	3	2	0	1	0	1	0	0	1	2	0	0	0	0	0	0
Subtotal		4	0	1	2	1	0	0	1	4	0	0	0	0	0	0
3110	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0
3114	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	1	14	0	0	9	2	0	3	8	14	0	0	0	0	0	0
Subtotal		15	0	0	10	2	0	3	9	15	0	0	0	0	0	0
3115	1	8	0	2	3	2	0	1	5	8	0	0	0	0	0	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
3116	0	5	0	0	5	0	0	0	0	5	0	0	0	0	0	0
	1	6	0	0	4	1	0	1	1	5	1	0	0	0	0	0
Subtotal		11	0	0	9	1	0	1	1	10	1	0	0	0	0	0
3149	0	8	0	0	6	2	0	0	4	8	0	0	0	0	0	0
	1	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	2	3	0	0	2	1	0	0	1	3	0	0	0	0	0	0
Subtotal		12	0	0	9	3	0	0	6	12	0	0	0	0	0	0
3160	0	444	1	11	308	111	0	13	306	435	1	0	4	1	3	0
3160 A	0	40	0	1	19	12	0	8	22	39	0	0	0	1	0	0
	17	15	0	1	9	4	0	1	6	15	0	0	0	0	0	0
	18	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	23	57	0	3	29	14	0	11	38	54	0	0	2	1	0	0
	24	7	0	2	4	1	0	0	3	7	0	0	0	0	0	0
3160 B	19	6	0	0	4	1	0	1	5	6	0	0	0	0	0	0
	20	8	1	0	6	0	0	1	5	8	0	0	0	0	0	0
	21	3	0	0	1	2	0	0	3	3	0	0	0	0	0	0
	22	4	0	0	4	0	0	0	1	4	0	0	0	0	0	0
3160 C	0	14	0	0	7	3	0	4	9	13	0	0	1	0	0	0
	1	82	0	1	48	20	1	12	52	81	0	0	1	0	0	0
	2	2	0	0	1	0	0	1	2	2	0	0	0	0	0	0
	3	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	4	6	0	1	0	4	0	1	5	6	0	0	0	0	0	0
	5	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
	6	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
	7	4	0	0	3	1	0	0	3	4	0	0	0	0	0	0
	8	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	11	5	0	0	4	0	0	1	2	5	0	0	0	0	0	0
	12	24	0	3	13	5	0	3	20	24	0	0	0	0	0	0
	13	2	0	1	0	1	0	0	1	2	0	0	0	0	0	0
	14	10	0	0	7	3	0	0	4	10	0	0	0	0	0	0
	15	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	16	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	25	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		742	2	24	475	183	1	57	493	727	1	0	8	3	3	0
3165	0	14	0	1	9	2	2	0	6	14	0	0	0	0	0	0
	1	3	0	0	2	1	0	0	0	3	0	0	0	0	0	0
	2	36	0	6	28	1	0	1	8	36	0	0	0	0	0	0
3165 A	0	21	0	1	16	4	0	0	10	21	0	0	0	0	0	0
Subtotal		74	0	8	55	8	2	1	24	74	0	0	0	0	0	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
3271	0	205	0	2	158	31	1	13	112	204	1	0	0	0	0	0
	15	2	0	0	1	0	0	1	0	2	0	0	0	0	0	0
	22	2	0	0	1	1	0	0	1	2	0	0	0	0	0	0
3271 A	0	9	0	0	7	0	0	2	7	9	0	0	0	0	0	0
	19	8	0	0	6	2	0	0	2	8	0	0	0	0	0	0
	20	7	0	0	6	1	0	0	3	7	0	0	0	0	0	0
	21	14	0	1	11	1	0	1	2	14	0	0	0	0	0	0
3271 B	12	67	0	4	44	13	0	6	32	67	0	0	0	0	0	0
	13	8	0	0	4	2	0	2	5	8	0	0	0	0	0	0
	14	15	0	1	9	4	0	1	3	15	0	0	0	0	0	0
	17	4	0	0	4	0	0	0	2	4	0	0	0	0	0	0
	18	7	0	1	1	1	0	4	2	7	0	0	0	0	0	0
3271 C	1	3	0	0	1	0	0	2	1	3	0	0	0	0	0	0
	2	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
	5	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	6	6	0	0	6	0	0	0	3	6	0	0	0	0	0	0
	8	3	0	2	0	0	0	1	1	3	0	0	0	0	0	0
	10	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0
	11	7	0	0	0	5	0	2	6	7	0	0	0	0	0	0
Subtotal		371	0	11	262	62	1	35	184	370	1	0	0	0	0	0
Subarea: **North**																
3228	0	4	0	0	3	1	0	0	2	4	0	0	0	0	0	0
	2	4	0	0	0	3	1	0	3	4	0	0	0	0	0	0
Subtotal		8	0	0	3	4	1	0	5	8	0	0	0	0	0	0
3231	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
	1	2	0	0	0	0	0	2	1	2	0	0	0	0	0	0
Subtotal		3	0	0	1	0	0	2	2	3	0	0	0	0	0	0
3232	0	2	0	0	2	0	0	0	2	2	0	0	0	0	0	0
	1	4	0	0	3	0	0	1	4	4	0	0	0	0	0	0
Subtotal		6	0	0	5	0	0	1	6	6	0	0	0	0	0	0
3234	0	2	0	0	2	0	0	0	2	1	1	0	0	0	0	0
3237	0	62	0	1	44	11	2	4	44	60	2	0	0	0	0	0
	1	3	0	0	3	0	0	0	1	3	0	0	0	0	0	0
3237 A	0	3	0	0	2	0	0	1	0	3	0	0	0	0	0	0
3237 C	0	125	0	1	75	26	0	23	49	114	0	5	2	0	4	0
3237 C	2	12	1	0	5	1	0	5	5	11	0	0	0	0	1	0
3237 C	3	2	0	0	2	0	0	0	1	2	0	0	0	0	0	0

Appendix C: Table 1, continued.

Site/Locus	Fea.	Total Bifaces	REDUCTION STAGE Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Indet.	Heat-treated	MATERIAL TYPE Opalite	Obsidian	Basalt	Chalcedony	Jasper	Opal	Other
3237 C	4	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Subtotal		208	1	2	132	38	2	33	100	194	2	5	2	0	5	0
3238	0	26	0	0	17	8	0	1	13	25	1	0	0	0	0	0
	1	8	0	1	5	1	0	1	3	8	0	0	0	0	0	0
Subtotal		34	0	1	22	9	0	2	16	33	1	0	0	0	0	0
3239	0	12	0	0	8	3	1	0	2	12	0	0	0	0	0	0
	1	19	0	0	7	6	0	6	14	18	1	0	0	0	0	0
Subtotal		31	0	0	15	9	1	6	16	30	1	0	0	0	0	0
3251	0	24	0	0	11	8	0	5	16	22	0	0	0	2	0	0
	1	82	0	2	33	12	0	35	73	82	0	0	0	0	0	0
	2	21	0	0	7	8	0	6	17	21	0	0	0	0	0	0
	4	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0
	5	1	0	0	0	1	0	0	1	1	0	0	0	0	0	0
	6	36	0	0	9	10	0	17	28	34	0	0	0	1	1	0
Subtotal		165	0	2	60	39	0	64	136	161	0	0	0	3	1	0
Total		4388	17	159	3091	666	12	443	1732	4248	24	11	19	56	28	2

APPENDIX C

Table 2. Summary Data for Cache Bifaces Analysis.

Specimen No.	Blank Type	Side-by-Side No. of Series	Skip-Patterned No. of Series	Flattening Scars	Margin Contouring Scars	Overstrikes	Thinning off Flat	Alternate Removals	Edge Run	Hard Hammer	Soft Hammer
Cache 26Ek3197											
2001-8	B	-	-	+	+	-	+	-	?	+	-
505-2	B?	-	-	-	+	-	-	-	-	+	-
2001-10	B	-	-	+	+	-	+	-	+	+	-
2001-1	F?	1	-	-	+	-	-	-	-	+	-
2001-2	B?	2*	-	+	+	-	+	-	-	+	-
505-3	B	-	-	+	+	-	+	-	+	+	-
2001-3	U	-	-	-	+	-	+	-	+	+	-
2001-7	B	1	-	+	+	-	+	-	+	+	-
2001-12	B	1	-	+	+	-	+	-	-	+	-
2001-5	F*	-	-	-	+	-	+	-	-	+	-
2001-4	F	-	-	-	+	-	-	-	-	?	-
505-1	U	-	-	+	+	-	+	-	-	+	-
2001-9	B	-	-	+	+	-	+	+	-	+	-
2001-11	B	-	-	-	+	-	-	-	-	+	-
2001-13	F?	1	-	+	+	+	+	-	+	+	-
505-4	F?	-	-	-	+	-	+*	-	+	+	-
2001-6	F?	-	-	+	+	+	-	-	-	+	-
	F = 6 (35%) B = 9 (53%) U = 2 (12%) Total = 16	6 (100%)	0	10 (59%)	17 (100%)	2 (12%)	12 (75%)	1 (6%)	7 (44%)	HH only = 17 (100%) SH only = 0 Both = 0	
Cache 26Ek3192											
2021-2	F	-	-	-	+	-	-	-	-	?	-
1010-8	B?	-	1?	+	+	-	+	+	-	+	-
2021-9	F?	1	-	?	+	+	-	-	-	+	-
2022-5	U	1	-	+	+	-	+	?	+	+	-
2021-10	B?	-	-	+	+	-	+	-	-	?	?
2022-10	U	-	-	+	+	-	+	-	-	+	-
2021-13	B?	1*	-	+	+	-	+	-	+*	+	?
1010-7	B	1	-	+	+	-	-	-	-	+	-
2021-5	B	-	-	-	+	-	-	+	-	+	-
2021-7	F?	-	-	+	+	+	-	?	-	+	?
2021-8	F	2	-	+	+	-	-	-	-	-	+
2022-2	U	?	-	+	+	-	-	-	-	-	+
2022-15	U	1	-	-	+	-	-	-	-	+	+
2021-6	B?	1	-	+	+	-	-	-	-	+	-
2022-14	F	1	-	-	+	-	-	-	-	?	?
2021-12	U	4	-	+	+	-	-	-	-	-	+
2021-11	B?	1	-	+	+	-	-	-	+	?	?
2022-22	U	1	-	+	+	-	+	-	-	?	+
1010-4	F	1	-	-	+	+	-	-	-	+	?
2022-8	F	-	-	-	+	-	+	-	?	?	?

APPENDIX C: Table 2, continued.

Specimen No.	Blank Type	Side-by-Side No. of Series	Skip-Patterned No. of Series	Flattening Scars	Margin Contouring Scars	Overstrikes	Thinning off Flat	Alternate Removals	Edge Run	Hard Hammer	Soft Hammer
Cache 26Ek3192, continued.											
2021-15	F?	-	-	-	+	-	-	-	-	+	-
1010-6	F	-	-	+	+	-	+	-	-	+	-
2021-1	U	2	-	+	+	-	-	-	-	+	?
2022-20	F	-	-	-	+	-	-	-	-	?	?
1012-2	F	-	-	?	+	-	-	-	-	+	-
2022-1	F	-	-	-	+	-	-	-	-	+	-
2022-9	B	-	-	+	+	-	+	-	+	+	-
2022-23	F?	1	-	-	+	-	-	-	-	+	?
1010-3	F	-	-	-	+	-	-	-	-	+	?
2022-13	B?	-	-	-	+	-	-	-	-	+	?
2022-18	F	-	-	+	+	-	+	-	-	?	+
1010-5	B?	1*	-	+	+	-	-	-	-	+	?
2022-21	B?	-	-	-	+	-	+	-	-	+	-
2022-19	B	1	-	+	+	-	+	-	+	+	?
2022-16	B	-	-	+	+	-	+	-	+	+	-
2021-14	B?	-	-	+	+	-	+	-	-	?	+
2021-3	F	1	-	+	+	-	+	-	-	+	-
2022-7	B?	-	1?	+	+	+	+	-	-	+	-
2021-4	F?	2	-	+	+	-	-	-	-	+	-
1010-9	F	-	-	-	+	-	-	-	-	?	?
2022-12	F	2	-	+	+	-	-	-	-	?	+
F = 19 (46%) B = 15 (37%) U = 7 (17%) Total = 41		26 (93%)	2 (7%)	27 (66%)	41 (100%)	4 (10%)	16 (39%)	4 (10%)	7 (17%)	HH only = 18 (44%) SH only = 3 (7%) Both = 20 (49%)	
Cache 26Ek3032											
1	U	-	-	+	+	-	-	-	-	+	?
2	U	1	1	+	+	-	-	-	-	?	?
3	U	1	-	+	+	-	-	-	?	?	+
4	U	1	~2*	+	+	-	-	-	-	-	+
5	U	-	?	+	+	+	-	-	-	+	?
6	U	-	-	+	+	+	-	-	-	+	-
U = 6 (100%)		3 (43%)	4 (57%)	6 (100%)	6 (100%)	2 (33%)	0	0	1 (17%)	HH only = 1 (17%) SH only = 1 (17%) Both = 4 (67%)	

APPENDIX C: Table 2, continued.

Specimen No.	Blank Type	Side-by-Side No. of Series	Skip-Patterned No. of Series	Flattening Scars	Margin Contouring Scars	Overstrikes	Thinning off Flat	Alternate Removals	Edge Run	Hard Hammer	Soft Hammer
Cache 26Ek3095											
1081-1	U	1	1	-	+	-	-	-	-	?	+
2082-3	U	1	-	+	+	-	-	-	-	+	?
2082-1	U	3	-	-	+	-	-	?	-	?	+
2081-1	B	-	-	-	+	-	-	?	-	+	?
2081-4	U	2	-	-	+	-	+	-	-	?	+
2081-3	F	-	1	-	+	-	-	-	-	-	+
2082-2	B?	-	-	+	+	-	-	-	-	+	?
	F = 1 (14%)	7 (78%)	2 (22%)	2 (29%)	7 (100%)	0	1 (14%)	2 (29%)	7 (44%)	HH only =	0 (0%)
	B = 2 (29%)									SH only =	1 (14%)
	U = 4 (57%)									Both =	6 (86%)
	Total = 7										
Cache 26Ek3170											
4501-3	U	1	-	+	+	1	-	-	-	-	+
4501-11	U	1	-	+	+	-	-	-	-	-	+
4501-10	B?	1	1?	-	+	-	-	-	?	-	+
4501-4	U	-	-	-	+	-	-	-	-	+?	?
4501-2	B?	-	1	+	+	1	-	-	+	-	+
4501-7	U	3	-	-	+	-	-	-	-	-	+
4501-5	F	2*	-	-	+	+	-	-	-	+	+
4501-8	B?	1	-	+	+	-	+	?	?	+	?
4501-1	U	?	-	+	+	-	+	-	-	+?	+
4501-6	F	-	-	-	+	-	-	-	-	+?	-
	F = 2 (20%)	9 (83%)	2 (17%)	5 (50%)	10 (100%)	3 (30%)	2 (20%)	1 (10%)	3 (30%)	HH only =	1 (10%)
	B = 3 (30%)									SH only =	5 (50%)
	U = 5 (50%)									Both =	4 (40%)
	Total = 10										

All are present/absent except Side-by-Side and Skip-Patterned which are tabulated as number of examples per biface.

F = Flake
B = Block
U = Unidentified

APPENDIX D

Summary Data for Flake Tools

Appendix D. Summary Data for Flake Tools.

Site/Loc.	Fea.	TYPE Sc	Pt	N/D	BF	MR	Md	Ds	Fr	F/B	Ot	MATERIAL Opalite	Obs	Bas	Jas	Chal	Opal	Other	Pressure Flaked	THERMAL ALTERATION Block	Flake	Red.	Ind.	Other	HT	MOTION OF USE Scrape	Cut.	Perf.	Drill.	Groove	Bore	Chop.	Multi-Use	Indet.	Unused	Not Exam.
Subarea: **Quarry**																																				
3032/L19	1	8	-	4	-	8	-	-	2	1	-	16	-	-	-	-	7	-	1	-	-	-	-	-	23	10	3	-	-	-	-	-	-	4	-	6
3032/L20	1	1	-	-	-	2	-	-	-	-	-	3	-	-	-	-	-	-	1	-	-	-	-	-	3	1	1	-	-	-	-	-	-	1	-	-
	2	-	-	1	-	1	-	-	1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-	-	1	-	1
Total		1	-	1	-	3	-	-	1	-	-	6	-	-	-	-	-	-	1	-	-	-	-	-	6	1	2	-	-	-	-	-	-	2	-	1
3032/L21	1	-	1	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-
3032/L22	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
3032/L23	1	4	3	9	-	8	-	-	1	1	-	21	-	-	1	-	4	-	1	-	-	-	-	-	26	7	1	-	-	-	-	-	1	8	1	8
3032/L25	2	2	3	1	-	5	-	-	2	-	-	12	-	-	-	-	1	-	1	-	-	-	-	-	13	3	-	-	-	-	1	-	-	3	1	5
3032/L26	0	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
3032/L27	0	9	6	5	3	8	1	3	-	-	-	27	4	-	2	1	-	1	5	-	5	-	1	1	28	10	-	-	-	1	-	-	3	7	1	13
3032/L98	1	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
Subarea: **East**																																				
230	0	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
123	0	1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-
311	0	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	1	-	-	-	1	-	-
3170	0	5	3	1	3	8	2	2	-	-	-	14	5	1	3	-	-	1	4	-	-	1	1	-	22	6	4	-	-	-	-	-	-	8	-	6
	4	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-
	7	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	8	5	-	3	-	4	3	-	-	-	-	10	-	-	1	4	-	-	-	1	-	-	1	-	13	3	-	-	-	-	-	-	1	6	-	5
	10	-	1	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	1	-	-
	13	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	14	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
Total		12	5	6	3	13	5	2	-	-	-	29	6	1	4	5	-	1	4	1	-	1	2	1	41	12	4	-	-	-	-	-	1	18	-	11
3171	0	3	-	-	-	3	-	4	1	-	-	6	2	-	1	-	1	1	1	-	1	-	-	-	10	2	-	-	-	-	-	-	-	5	-	4
	2	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	3	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
	4	-	1	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2	-	-
	6	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Total		4	2	-	-	4	-	4	2	-	-	11	2	-	1	-	1	1	3	-	1	-	-	1	14	3	-	-	-	-	-	-	-	8	-	5
3173	0	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	1	1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	1	-	-
	3	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
Total		2	-	-	1	1	-	-	-	-	-	4	-	-	-	-	-	-	-	-	1	-	-	1	2	1	1	-	-	-	-	-	-	2	-	-
3179	1	2	-	-	-	-	-	-	1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	1	-	1
3181	1	-	-	-	-	4	-	-	1	-	-	5	-	-	-	-	-	-	-	-	1	-	-	-	4	-	2	-	-	-	-	-	-	1	-	2
3184	0	3	1	-	-	3	-	-	3	-	-	7	1	-	1	1	-	-	2	-	-	-	-	-	10	1	1	-	-	-	-	-	2	3	-	3
	2	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	3	1	-	-	-	3	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	-	-	-	-	1	-	2
	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	8	1	2	-	-	9	-	-	2	-	-	12	-	-	2	-	-	-	-	1	4	-	2	-	7	5	-	-	1	-	-	-	1	3	-	4
	10	1	2	-	-	2	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	5	3	-	-	-	-	-	-	1	1	-	-
	12	2	-	3	-	4	-	-	1	1	-	11	-	-	-	-	-	-	-	1	-	-	-	1	9	-	-	-	-	-	-	-	-	4	1	6
	14	-	-	2	-	1	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	1	1	1

Appendix D, continued.

Site/Loc.	Fea.	TYPE Sc	Pt	N/D	BF	MR	Md	Ds	Fr	F/B	Ot	MATERIAL Opalite	Obs	Bas	Jas	Chal	Opal	Other	Pressure Flaked	THERMAL ALTERATION Block	Flake	Red.	Ind.	Other	MOTION OF USE HT	Scrape	Cut.	Perf.	Drill.	Groove	Bore	Chop.	Multi-Use	Indet.	Unused	Not Exam.
3184, cont.	18	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	19	3	1	-	-	5	-	-	1	-	-	10	-	-	-	-	-	-	-	4	-	-	1	-	5	2	1	-	-	-	-	-	-	3	-	4
	20	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
	21	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	23	-	-	2	-	6	-	-	4	-	-	12	-	-	-	-	-	-	-	1	2	-	1	1	7	2	-	-	-	-	-	-	-	3	-	7
	26	1	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-	-	-	-	-	-	-	-
Total		15	6	8	-	35	-	-	11	1	-	68	2	-	3	2	-	1	2	7	6	-	4	2	57	18	3	-	1	-	-	-	4	20	2	28
3185	0	-	-	1	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-
	1	6	-	-	-	3	-	-	-	-	-	9	-	-	-	-	-	-	2	-	1	-	1	-	7	5	-	-	-	-	-	-	-	2	-	2
	6	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	2	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Total		7	-	1	2	3	-	-	-	-	-	12	-	-	-	-	-	1	2	-	3	-	1	-	9	6	3	-	-	-	-	-	-	2	-	2
3190	0	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
	1	3	3	-	-	3	-	-	3	-	-	10	1	-	-	-	-	1	1	-	4	-	1	1	6	-	1	1	-	-	-	-	-	4	-	6
	2	-	1	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	2	-	-
	5	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	6	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Total		4	4	-	-	6	-	-	3	-	-	14	2	-	-	-	-	1	2	-	5	-	2	1	9	-	2	1	-	-	-	-	1	7	-	6
3191	1	1	-	-	-	5	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	5	2	1	-	-	-	-	-	-	1	-	1
3192	0	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	1	19	4	1	-	21	-	-	5	-	1	48	1	-	-	-	-	2	4	1	6	-	1	4	37	15	7	1	-	-	-	-	3	15	1	9
	2	5	-	-	1	10	-	-	-	1	-	15	1	-	1	-	-	-	1	1	2	-	-	-	14	5	1	-	-	-	-	-	1	5	-	5
Total		25	4	1	1	31	-	-	5	1	1	64	2	-	1	-	-	2	5	2	8	-	1	4	52	21	8	1	-	-	-	-	4	20	1	14
3193	4	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
3195	0	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	2	1	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	1
Total		3	-	-	-	-	-	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	2	-	-	-	-	-	-	-	1	-	1
3196	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Total		1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-	-	-	1
3197	5	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
3198	1	2	1	-	1	5	-	-	1	-	-	10	2	-	-	-	-	-	1	1	1	-	1	-	9	1	4	-	-	-	-	-	2	3	-	2
	2	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Total		2	1	-	1	5	-	-	2	-	-	11	2	-	-	-	-	-	1	1	1	-	1	-	10	1	4	-	-	-	-	-	2	3	-	3
3200	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
3201	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
3204	0	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	-	-	-	2	1	-	-	-	-	-	-	1	-	-	-
	1	2	4	3	-	9	-	-	1	-	-	18	1	-	-	-	-	-	1	2	2	-	1	1	13	3	3	-	1	-	-	-	-	5	1	6
Total		3	5	3	-	9	-	-	1	-	-	19	1	-	-	-	-	1	2	2	2	-	1	1	15	4	3	-	1	-	-	-	1	5	1	6
Subarea: **West**																																				
3084	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	2	1	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	1	-	-
Total		1	-	-	-	2	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	1	-	2	-	-
3086	0	1	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-
3088	0	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3090	0	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Appendix D, continued.

Site/Loc.	Fea.	TYPE Sc	Pt	N/D	BF	MR	Md	Ds	Fr	F/B	Ot	MATERIAL Opalite	Obs	Bas	Jas	Chal	Opal	Other	Pressure Flaked	THERMAL ALTERATION Block	Flake	Red.	Ind.	Other	MOTION OF USE HT	Scrape	Cut.	Perf.	Drill.	Groove	Bore	Chop.	Multi-Use	Indet.	Unused	Not Exam.
3092	0	21	13	5	4	58	2	-	20	3	2	100	1	2	21	3	1	-	10	12	15	2	2	2	95	23	12	3	-	1	-	-	6	30	1	52
	2	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2
	6	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	7	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	1
	12	1	-	1	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-
	13	1	-	-	-	1	-	1	-	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	2	-	1
	14	1	-	-	-	6	-	-	1	-	-	6	-	-	2	-	-	-	-	-	-	-	1	-	7	2	-	-	-	-	-	-	1	3	-	2
	23	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1
Total		24	13	6	4	71	2	1	21	3	2	111	1	2	27	3	2	1	10	12	15	2	3	2	113	25	12	3	-	1	-	-	7	39	2	59
3093	4	-	1	-	-	2	-	-	-	-	-	3	1	-	-	-	-	-	1	-	-	-	-	3	-	-	1	1	-	-	-	-	1	-	-
3095	0	1	1	-	1	1	-	-	-	-	-	3	1	-	-	-	-	-	1	-	1	-	-	1	2	-	2	-	-	-	-	-	1	1	-
	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	5	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	6	1	-	-	-	2	-	-	-	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-	1	1	-	-	-	-	-	-	-	-	1	1
	9	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
	10	1	3	1	-	4	-	-	5	-	-	12	2	-	-	-	-	-	2	-	4	-	1	-	9	2	-	1	-	-	-	-	-	4	1	6
	11	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-
	15	-	-	-	-	4	-	-	1	-	-	4	-	-	-	1	-	-	-	1	1	-	-	-	3	1	-	-	-	-	-	-	-	1	-	3
	16	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
	19	3	1	1	-	4	-	-	-	-	-	9	-	-	-	-	-	-	1	-	1	-	-	1	7	2	3	-	-	-	-	-	2	-	2
	20	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
	22	-	2	-	-	1	-	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-	-	-	-	-	2
	24	-	-	2	-	6	2	-	3	-	-	10	1	-	1	1	-	-	-	-	1	-	-	-	12	4	-	-	-	-	-	-	1	3	-	5
	25	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Total		9	8	4	1	25	2	-	10	-	-	49	4	-	4	2	-	-	6	1	13	-	1	2	42	12	6	1	1	-	-	-	1	12	4	22
3101	0	-	2	-	-	1	-	-	-	-	-	3	-	-	-	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	2	-	-
3102	0	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
3106	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
	4	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-	-	-	1	-	-	-
Total		3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	2	-	-	-	-	1	1	-	-	-	-	-	-	2	-	-	-
3114	1	1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	1	-	-
3115	1	1	1	-	-	2	-	-	-	-	-	4	-	-	-	-	-	-	1	-	1	-	1	-	2	2	1	-	-	-	-	-	-	1	-	-
3116	1	3	2	-	-	2	-	-	1	-	-	8	-	-	-	-	-	-	1	-	-	-	-	-	8	4	-	2	-	-	-	-	-	-	-	2
3149	0	-	-	1	-	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	1	-	-
	2	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1
Total		-	-	1	-	3	-	-	-	-	-	3	-	-	-	1	-	-	-	-	1	-	-	-	3	-	-	-	-	-	-	1	1	1	-	1
3160	0	6	6	1	-	14	-	-	9	-	-	30	-	-	1	3	-	2	7	1	10	-	1	5	19	4	2	1	-	-	1	-	1	12	-	15
	1	2	1	2	1	4	-	-	2	-	1	11	2	-	-	-	-	-	4	2	-	1	-	1	9	3	1	-	-	-	-	-	-	5	-	4
	4	-	1	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2	-	-
	12	-	1	-	-	1	1	-	1	-	1	5	-	-	-	-	-	-	1	1	-	-	-	-	4	1	-	-	-	1	-	-	-	-	-	3
	17	-	1	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	1	-	1	-	1	-	-	-	-	-	-	1	-	-
	19	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
	22	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	23	2	4	1	-	6	-	-	6	-	-	17	-	-	1	1	-	-	6	2	5	-	-	1	11	2	-	-	1	-	1	-	1	3	-	11
	24	1	-	-	-	1	-	-	-	2	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	1	1	-	-	-	-	-	-	-	-	2
Total		12	15	5	2	26	1	-	18	2	2	72	2	-	2	4	-	3	19	6	15	1	2	8	51	12	5	1	1	1	2	-	2	24	-	35
3165	0	-	-	-	-	4	-	-	1	-	-	4	1	-	-	-	-	-	-	-	-	-	-	-	5	-	1	-	-	-	-	-	-	3	-	1
	1	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	2	-	1	-	-	2	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-	-	-	-	2	-	-
Total		-	2	-	-	6	1	-	1	-	-	9	1	-	-	-	-	-	-	-	-	-	-	1	9	1	3	-	-	-	-	-	-	5	-	1

Appendix D, continued.

Site/Loc.	Fea.	TYPE										MATERIAL							Pressure	THERMAL ALTERATION						MOTION OF USE									Not
		Sc	Pt	N/D	BF	MR	Md	Ds	Fr	F/B	Ot	Opalite	Obs	Bas	Jas	Chal	Opal	Other	Flaked	Block	Flake	Red.	Ind.	Other	HT	Scrape	Cut.	Perf.	Drill.	Groove	Bore	Chop.	Multi-Use	Indet.	Unused	Exam.
3208	0	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-
Total		2	-	-	-	-	-	-	1	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	1	-	1
3271	0	2	8	-	-	1	-	-	-	1	-	9	-	1	-	1	1	-	6	3	4	-	-	-	5	1	2	3	1	-	-	-	3	-	2
	1	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
	3	-	1	-	1	2	-	-	-	-	-	3	-	1	-	-	-	-	-	1	1	-	-	-	2	1	2	1	-	-	-	-	-	-	-
	4	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	8	-	-	-	-	1	-	-	1	-	-	2	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	2
	12	4	-	3	-	8	-	1	1	-	-	15	-	-	-	1	1	-	-	-	1	-	-	1	15	4	-	-	-	-	-	-	4	1	8
	14	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
	18	-	-	-	-	1	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
	19	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-
	21	1	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	1	-	-
Total		7	10	5	2	14	-	1	4	1	-	37	-	2	1	2	2	-	6	4	9	-	1	1	29	9	5	4	1	-	-	-	-	9	1	15
Subarea: **North**																																				
3237	0	6	5	2	2	6	-	5	-	-	-	23	2	-	-	-	-	1	4	-	6	1	-	-	19	2	3	-	-	-	-	-	2	12	-	7
	2	-	1	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
Total		6	6	2	2	7	-	5	-	-	-	25	2	-	-	-	-	1	4	-	6	1	-	-	21	2	3	-	-	-	-	-	2	12	-	9
3238	0	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
3239	0	-	1	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	2	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1
	1	1	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	2	-	-
Total		1	2	-	-	-	1	-	-	-	-	4	-	-	-	-	-	-	3	1	1	-	-	1	1	-	-	-	-	-	-	-	3	-	1
3251	0	1	3	-	-	1	-	-	-	-	-	4	-	-	-	1	-	-	2	1	3	-	-	-	1	1	1	2	-	-	-	-	1	-	-
	1	2	2	-	-	7	-	-	11	-	-	22	-	-	-	-	-	-	2	2	9	-	2	-	9	-	1	1	-	-	-	-	3	-	17
	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	6	-	4	1	-	-	-	-	5	-	-	8	1	1	-	-	-	-	2	1	3	-	-	-	6	-	1	2	-	-	-	-	3	-	4
Total		4	9	1	-	8	-	-	16	-	-	35	1	1	-	1	-	-	6	4	15	-	2	-	17	2	3	5	-	-	-	-	7	-	21

Key:

TYPE
- Sc = Scrapers
- Pt = Pointed tools
- N/D = Notches & Denticulars
- BF = Bifacial Flake tools
- MR = Misc. Retouched tools
- Md = Microdenticulars
- Ds = Discoids
- Fr = Fragmentary tools
- F/B = Flaked/Battered tools
- Ot = Other

MATERIAL
- Obs = Obsidian
- Bas = Basalt
- Jas = Jasper
- Chal = Chalcedony

THERMAL ALTERATION
- Block = Tool made on flake from heat treated block
- Flake = Tool made on heat treated flake
- Red. = Tool heat treated during reduction
- Ind. = Heat treatment stage indeterminate
- Other = Possibly heat treated or burned
- HT = Not heat treated

MOTION OF USE
- Scrape = Scraping
- Cut. = Cutting
- Perf. = Perforating
- Drill. = Drilling
- Groove = Grooving
- Bore = Boring
- Chop. = Chopping
- Multi-Use = Multiple Use
- Indet. = Indeterminate
- Not Exam. = Not Examined

APPENDIX E

Attributes of Projectile Points

Appendix E. Attributes of Projectile Points.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/Lt	Lt/Wm	Wb/Wm	Lm/Lt
3237	000	6740	901	CLO	OPL	1	101.6	0.0	0.0	65.4	0.0	0.0	12.8	108.7	0.0	0	0	0	0.00	0.00	0.00	0.00
0214	000	2672	001	CT	OBS	1	25.1	25.1	4.1	12.8	12.4	0.0	2.9	0.6	0.8	0	0	0	1.00	1.96	0.96	0.16
3092	000	6066	001	CT	OPL	1	26.5	24.7	0.0	13.4	13.4	0.0	2.0	0.3	0.6	0	0	0	0.90	1.98	1.00	0.00
3092	000	6104	001	CT	OPL	2	25.4	25.4	7.8	10.9	3.4	0.0	3.2	0.8	0.8	0	0	0	1.00	2.33	0.31	0.31
3092	000	6221	047	CT	OBS	1	23.1	23.1	15.7	10.6	7.5	9.2	2.3	0.4	0.7	0	0	0	1.00	1.47	0.71	0.68
3092	000	6304	004	CT	OPL	1	24.3	22.9	0.0	11.5	11.5	0.0	1.9	0.3	0.6	0	0	0	0.90	2.11	1.00	0.00
3092	000	6822	005	CT	OPL	2	20.6	20.6	0.0	14.7	14.7	0.0	2.5	0.7	0.7	0	0	0	1.00	1.40	1.00	0.00
3092	000	8263	001	CT	OPL	1	26.1	25.1	0.0	11.9	11.9	0.0	2.2	0.5	0.8	0	0	0	1.00	2.19	1.00	0.00
3095	000	0509	005	CT	OBS	2	23.0	23.0	8.5	15.5	15.1	0.0	3.4	1.5	1.5	0	0	0	1.00	1.48	0.97	0.35
3095	000	0514	001	CT	OPL	2	17.7	14.9	2.5	9.5	9.5	0.0	2.4	0.3	0.4	0	0	0	0.80	1.86	1.00	0.17
3095	000	6001	001	CT	OBS	2	22.3	22.3	10.5	8.7	3.9	0.0	3.7	0.7	0.7	0	0	0	1.00	2.56	0.45	0.47
3095	000	6041	001	CT	OBS	2	21.8	21.8	11.2	9.0	1.9	0.0	3.4	0.6	0.6	0	0	0	1.00	2.42	0.21	0.51
3095	000	6801	003	CT	OPL	1	29.8	28.9	0.0	13.5	13.5	0.0	2.8	0.6	1.0	0	0	0	1.00	2.20	1.00	0.00
3106	000	2001	004	CT	OPL	2	16.8	15.2	0.0	11.8	11.8	0.0	3.0	0.5	0.5	0	0	0	0.90	1.42	1.00	0.00
3160	000	0500	326	CT	OBS	1	24.9	24.9	0.0	17.8	17.8	0.0	4.0	1.0	1.2	0	0	0	1.00	1.39	1.00	0.00
3160	000	1003	009	CT	OPL	2	29.8	29.0	7.9	14.8	13.6	0.0	2.5	1.1	1.1	0	0	0	1.00	2.01	0.91	0.26
3160	000	6081	003	CT	OPL	2	26.4	26.4	2.5	13.6	13.6	0.0	2.7	0.9	0.9	0	0	0	1.00	1.95	1.00	0.09
3160	000	6081	004	CT	OBS	1	26.6	26.6	0.0	11.0	11.0	0.0	2.9	0.6	0.7	0	0	0	1.00	2.42	1.00	0.00
3160	000	6082	002	CT	BAS	1	28.0	28.0	7.2	13.6	13.6	0.0	2.0	0.4	1.0	0	0	0	1.00	2.06	1.00	0.26
3160	000	6541	005	CT	OPL	2	26.9	25.7	3.4	12.5	12.5	0.0	3.0	0.7	0.8	0	0	0	1.00	2.15	1.00	0.13
3160	000	8542	007	CT	OPL	1	26.9	25.9	5.0	12.1	12.1	0.0	2.8	0.6	0.8	0	0	0	1.00	2.22	1.00	0.19
3160	000	8542	010	CT	BAS	1	28.5	27.5	0.0	12.8	12.6	0.0	2.9	1.0	1.2	0	0	0	1.00	2.23	0.98	0.00
3170	000	2002	001	CT	OBS	2	21.2	20.1	0.0	16.3	16.3	0.0	2.7	0.8	0.8	0	0	0	0.90	1.30	1.00	0.00
3184	000	0503	028	CT	OPL	1	29.7	29.7	3.7	15.7	15.7	0.0	3.1	1.2	1.3	0	0	0	1.00	1.89	1.00	0.12
3185	000	0016	002	CT	OBS	1	29.7	28.7	12.6	16.6	16.6	0.0	2.9	0.3	0.6	0	0	0	1.00	1.79	1.00	0.42
3185	000	1003	002	CT	OPL	1	29.0	29.0	7.6	15.9	15.9	0.0	2.3	1.4	1.4	0	0	0	1.00	1.82	1.00	0.26
3192	000	2067	001	CT	OPL	1	28.4	27.7	8.3	17.1	15.8	0.0	2.5	1.2	1.8	0	0	0	1.00	1.66	0.92	0.29
3198	000	1017	001	CT	OPL	2	24.5	23.6	4.6	14.2	14.2	0.0	2.4	0.7	0.7	0	0	0	1.00	1.73	1.00	0.19
3198	000	1018	004	CT	OPL	1	30.0	29.3	0.0	16.0	16.0	0.0	2.3	0.7	1.2	0	0	0	1.00	1.88	1.00	0.00
3198	000	1018	901	CT	OBS	2	26.0	25.5	0.0	14.7	14.7	0.0	2.8	0.7	0.7	0	0	0	1.00	1.77	1.00	0.00
3198	000	1025	901	CT	OBS	2	23.7	26.0	11.0	13.5	12.8	0.0	3.1	0.9	0.9	0	0	0	1.00	1.97	0.94	0.44
3237	000	6820	001	CT	OPL	1	16.1	15.4	0.0	10.8	10.8	0.0	1.9	0.4	0.4	0	0	0	1.00	1.49	1.00	0.00
3251	000	1003	001	CT	OPL	1	26.5	26.5	3.5	18.3	18.3	0.0	3.2	1.1	1.3	0	0	0	1.00	1.45	1.00	0.13
3032	004	0069	012	DSN	OBS	2	27.1	26.4	10.2	15.3	13.7	9.0	4.3	1.5	1.5	187	146	41	0.90	1.77	0.90	0.38
3092	000	0001	001	DSN	OPL	2	28.9	28.1	5.4	10.4	9.1	5.6	3.0	0.7	0.7	191	170	21	1.00	2.78	0.88	0.19
3092	000	0500	002	DSN	OBS	1	32.0	29.7	3.7	14.9	14.9	7.4	3.4	1.0	1.4	180	180	0	0.90	2.14	1.00	0.12
3092	000	2024	002	DSN	OPL	2	23.5	21.1	0.0	13.8	13.8	7.2	2.8	0.7	0.8	204	186	18	0.90	1.70	1.00	0.00
3092	000	2042	014	DSN	OPL	1	25.1	19.7	0.0	12.3	12.3	5.9	2.0	0.2	0.9	179	74	5	0.80	2.04	1.00	0.00
3092	000	6285	004	DSN	OBS	1	8.8	18.3	0.0	9.0	9.0	5.1	1.9	0.1	0.5	0	157	0	1.00	2.10	1.00	0.00
3092	000	6362	001	DSN	OBS	2	14.1	14.1	5.2	9.2	7.0	4.6	2.6	0.3	0.3	190	150	40	1.00	1.53	0.76	0.37
3092	000	6362	002	DSN	OPL	1	21.7	20.4	0.0	12.4	12.4	4.3	2.4	0.4	0.4	198	160	38	0.90	1.75	1.00	0.00
3092	000	6786	001	DSN	OPL	1	26.6	23.6	7.3	13.2	12.0	5.2	3.1	0.6	1.1	179	161	18	0.90	2.02	0.91	0.27
3095	000	0510	038	DSN	OPL	2	23.4	20.5	0.0	11.7	11.7	6.2	2.6	0.5	0.5	182	168	14	0.90	2.00	1.00	0.00
3095	000	2023	001	DSN	BAS	1	31.2	27.6	0.0	12.4	12.3	6.9	2.4	0.7	0.9	185	182	3	0.90	2.53	1.00	0.00
3095	000	6480	002	DSN	OBS	1	13.5	0.0	0.0	8.3	0.0	6.2	2.3	0.2	0.5	201	0	0	0.00	0.00	0.00	0.00
3095	000	7240	001	DSN	OPL	1	20.6	17.9	0.0	13.5	13.5	8.7	2.0	0.5	0.5	200	163	37	0.90	1.53	1.00	0.00
3114	000	1010	001	DSN	OPL	2	18.8	17.3	0.0	12.8	12.8	9.5	2.3	0.5	0.6	255	144	81	0.90	1.46	1.00	0.00
3116	000	1002	001	DSN	OBS	1	24.3	21.8	0.0	14.7	14.7	9.5	3.0	0.4	1.0	202	159	43	0.90	1.65	1.00	0.00
3116	000	1007	001	DSN	OPL	2	21.3	19.1	0.0	12.7	12.7	7.5	2.5	0.5	0.8	191	179	12	0.90	1.67	1.00	0.00
3160	000	1002	003	DSN	OPL	2	21.5	18.7	0.0	13.4	13.4	9.5	2.5	0.4	0.5	206	163	43	0.90	1.60	1.00	0.00
3160	000	1003	004	DSN	OBS	1	21.6	19.6	0.0	10.8	10.8	7.8	2.3	0.2	0.6	201	171	30	0.90	2.00	1.00	0.00
3160	000	1005	007	DSN	OPL	1	23.4	19.4	0.0	13.6	13.6	9.3	2.0	0.2	0.5	191	135	56	0.80	1.72	1.00	0.00
3160	000	4049	001	DSN	OPL	1	23.3	23.3	2.1	9.1	9.1	6.5	2.6	0.4	0.5	161	148	13	1.00	2.56	1.00	0.09
3160	000	6541	006	DSN	OPL	1	18.9	17.2	0.0	13.0	13.0	6.1	1.8	0.3	0.5	200	177	23	0.90	1.46	1.00	0.00
3160	000	6541	007	DSN	OPL	1	25.8	23.9	0.0	11.9	11.9	7.3	3.0	0.6	0.8	190	181	9	0.90	2.17	1.00	0.00

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/Lt	Lt/Wm	Wb/Wm	Lm/Lt
3160	000	8522	008	DSN	OPL	1	17.1	17.1	0.0	10.5	10.5	5.1	2.2	0.4	0.5	174	141	33	1.00	1.63	1.00	0.00
3170	000	2001	001	DSN	OPL	1	28.3	25.6	0.0	15.9	15.9	10.0	2.6	1.2	1.3	169	166	3	0.90	1.78	1.00	0.00
3170	000	2001	006	DSN	OPL	1	30.8	28.1	15.4	13.2	12.4	8.7	2.5	0.6	1.2	163	155	8	0.90	2.33	0.93	0.50
3170	000	5078	001	DSN	OBS	2	19.0	17.6	1.0	11.3	11.3	8.0	3.0	0.6	0.6	206	146	60	0.90	1.68	1.00	0.05
3171	000	0505	002	DSN	BAS	1	31.2	26.9	0.0	15.0	15.0	5.6	3.1	0.8	1.0	204	175	29	0.90	2.08	1.00	0.00
3178	000	0501	007	DSN	OPL	1	30.0	26.1	0.0	16.4	16.4	7.4	2.8	0.9	1.2	178	178	0	0.90	1.83	1.00	0.00
3178	000	0502	001	DSN	OBS	1	15.4	13.7	0.0	10.6	10.6	6.1	2.9	0.4	0.4	214	168	46	0.90	1.45	1.00	0.00
3184	000	4156	001	DSN	OPL	2	25.2	22.8	3.4	12.6	11.1	9.4	3.2	1.0	1.0	214	150	64	0.90	2.00	0.88	0.13
3185	000	0016	001	DSN	OBS	1	30.1	26.9	0.0	15.6	15.6	6.4	2.9	0.7	1.0	191	171	20	0.90	1.92	1.00	0.00
3185	000	1004	002	DSN	OPL	1	32.9	28.6	0.0	16.8	16.8	7.2	3.3	1.2	1.3	207	169	38	0.90	1.96	1.00	0.00
3185	000	1015	001	DSN	OPL	1	27.8	24.6	0.0	13.4	13.4	6.7	2.8	0.6	1.0	182	164	17	0.90	2.10	1.00	0.00
3190	000	0508	002	DSN	OPL	1	27.8	24.8	0.0	11.8	11.8	6.4	2.4	0.5	0.8	191	183	8	0.90	2.34	1.00	0.00
3190	000	1003	001	DSN	OPL	1	25.9	22.8	0.0	14.2	14.2	5.3	3.2	0.5	1.0	0	150	0	0.90	1.82	1.00	0.00
3192	000	0502	008	DSN	OBS	1	22.9	18.8	0.0	13.7	13.7	7.8	3.8	0.6	1.1	0	163	0	0.80	1.67	1.00	0.00
3192	000	1054	001	DSN	OPL	1	26.0	24.8	3.4	12.4	0.0	8.3	2.7	0.6	0.8	194	160	34	1.00	2.10	0.00	0.13
3192	000	2061	006	DSN	OBS	1	19.1	17.8	0.0	13.8	13.8	9.2	3.1	0.7	0.8	254	153	101	0.90	1.38	1.00	0.00
3192	000	6522	008	DSN	OPL	1	22.1	19.5	0.0	13.0	13.0	6.1	2.6	0.2	0.6	2	151	49	0.90	1.70	1.00	0.00
3198	000	0503	007	DSN	OPL	2	28.3	24.9	0.0	12.6	12.6	7.0	3.0	0.9	0.9	178	163	15	0.90	2.25	1.00	0.00
3198	000	0508	001	DSN	OBS	1	32.0	29.6	0.0	11.8	11.8	6.0	2.4	0.5	0.7	186	181	5	0.90	2.71	1.00	0.00
3198	000	1016	001	DSN	OBS	2	21.4	17.4	0.0	14.2	14.2	8.5	2.9	0.7	0.7	210	181	29	0.80	1.51	1.00	0.00
3198	000	6101	003	DSN	OPL	2	24.3	24.3	0.0	14.0	14.0	10.3	2.2	0.7	0.7	191	163	28	1.00	1.74	1.00	0.00
3237	000	6701	001	DSN	OPL	1	17.1	15.1	0.0	11.5	11.5	8.6	1.8	0.3	0.4	192	150	42	0.90	1.49	1.00	0.00
3237	000	6721	001	DSN	OPL	1	16.7	15.8	0.0	9.1	9.1	6.8	1.9	0.2	0.3	190	166	24	1.00	1.84	1.00	0.00
3237	000	6722	001	DSN	OPL	1	19.8	17.9	0.0	11.1	11.1	7.5	2.0	0.3	0.4	163	158	5	0.90	1.78	1.00	0.00
3237	000	6741	003	DSN	OPL	2	15.5	13.8	0.0	11.9	11.9	9.0	2.2	0.3	0.3	209	158	51	0.90	1.30	1.00	0.00
3237	000	6742	001	DSN	BAS	2	11.6	9.6	0.0	10.3	10.3	7.8	1.7	0.2	0.2	205	154	51	0.80	1.13	1.00	0.00
3237	000	6761	001	DSN	OPL	2	10.4	8.6	0.0	9.8	9.8	8.2	1.9	0.2	0.2	195	152	43	0.80	1.06	1.00	0.00
3237	000	6801	004	DSN	OPL	1	21.3	17.6	9.2	11.1	10.7	8.6	1.7	0.2	0.4	208	166	42	0.80	1.92	0.96	0.43
3251	000	0500	027	DSN	OPL	1	24.8	21.5	0.0	12.4	12.4	5.5	2.1	0.4	0.6	188	171	17	0.90	2.00	1.00	0.00
3251	000	3006	005	DSN	OPL	1	27.2	27.2	2.0	12.9	12.3	5.9	3.5	0.6	1.2	148	138	10	1.00	2.11	0.95	0.07
3271	000	0500	087	DSN	OPL	2	25.2	22.2	0.0	12.0	12.0	7.2	2.8	0.7	0.7	182	178	4	1.10	2.10	1.00	0.00
3271	000	0522	001	DSN	OBS	1	16.5	13.6	0.0	13.3	13.3	7.0	2.5	0.3	0.7	241	165	77	0.80	1.24	1.00	0.00
3032	138	0053	01A	ELK	CHA	1	41.0	38.1	11.5	19.0	14.0	12.5	6.0	2.5	5.0	215	113	102	0.90	2.16	0.74	0.28
3032	107	0L1A	001	ELK	OPL	1	38.6	38.6	9.5	20.1	16.4	11.4	4.2	2.4	2.9	164	138	26	1.00	1.92	0.82	0.25
3032	020	4002	009	ELK	OPL	1	37.3	34.2	12.4	15.9	14.0	10.8	5.7	3.4	3.6	224	124	100	0.90	2.35	0.88	0.33
3095	000	0510	019	ELK	OPL	1	55.9	53.9	6.9	35.3	17.4	15.7	4.3	5.5	6.0	151	115	36	1.00	1.58	0.49	0.12
3095	000	3007	001	ELK	OPL	1	31.2	31.2	6.9	22.9	15.8	12.0	6.1	3.1	3.5	165	122	43	1.00	1.36	0.69	0.22
3123	000	0078	001	ELK	OPL	1	40.6	40.6	5.8	22.1	12.3	10.9	4.9	2.2	3.0	151	118	33	1.00	1.84	0.56	0.14
3160	000	0001	190	ELK	OPL	1	54.5	53.0	7.7	24.0	15.3	11.9	5.8	3.8	6.0	157	118	39	1.00	2.27	0.64	0.14
3160	000	0001	221	ELK	OBS	1	32.2	30.0	9.7	21.9	15.5	10.2	4.9	1.7	2.1	155	134	21	0.90	1.47	0.71	0.30
3160	000	0001	300	ELK	OPL	1	36.8	36.8	6.4	21.9	13.5	11.1	4.5	2.8	3.1	150	110	40	1.00	1.68	0.62	0.17
3160	000	0500	026	ELK	OPL	1	57.8	57.8	7.4	22.5	16.3	11.7	5.1	4.3	5.0	150	135	15	1.00	2.56	0.72	0.13
3160	000	0500	063	ELK	OPL	1	53.6	53.6	7.0	17.7	13.7	10.7	5.5	4.2	5.0	167	110	57	1.00	3.02	0.77	0.13
3160	000	0500	078	ELK	OPL	1	32.5	27.2	6.0	28.0	18.8	14.3	4.3	3.0	3.5	127	126	1	0.80	1.16	0.67	0.19
3160	000	0500	131	ELK	OPL	1	47.5	43.5	5.9	29.2	19.3	15.6	4.9	4.1	4.5	125	111	14	0.90	1.62	0.66	0.12
3160	000	0500	260	ELK	OPL	1	42.8	42.8	4.6	21.6	12.0	9.6	3.9	2.8	3.0	139	110	29	1.00	2.42	0.55	0.11
3160	000	4053	001	ELK	OPL	1	43.3	38.3	0.4	23.1	18.7	12.2	6.5	3.1	5.0	174	136	38	0.90	1.87	0.81	0.01
3160	000	6083	001	ELK	OBS	1	59.8	59.8	8.2	31.6	19.7	14.0	4.3	2.5	5.5	157	131	26	1.00	1.89	0.62	0.14
3160	000	6641	001	ELK	OBS	1	37.8	37.8	3.3	28.8	15.3	13.0	4.2	2.4	3.2	134	115	19	1.00	1.31	0.53	0.09
3184	000	0015	001	ELK	OPL	2	43.8	41.1	9.4	28.2	16.4	13.4	6.1	5.8	5.8	159	107	52	0.90	1.55	0.58	0.22
3184	000	5055	002	ELK	OPL	2	37.3	34.7	10.9	21.3	12.0	9.1	4.7	2.9	3.0	168	120	48	0.90	1.75	0.56	0.29
3237	000	0001	022	ELK	OPL	1	39.2	34.4	8.2	17.4	16.5	12.6	4.6	2.5	2.6	193	120	73	0.90	2.25	0.95	0.21
3237	000	0001	029	ELK	BAS	1	43.1	43.1	6.6	24.8	14.8	12.7	6.9	4.4	5.0	145	111	34	1.00	1.74	0.60	0.15
3237	000	4029	001	ELK	OPL	1	48.5	48.5	8.9	20.3	14.1	10.1	4.6	2.3	5.0	188	122	66	1.00	2.39	0.70	0.18
3237	000	6084	001	ELK	OBS	1	54.6.0	52.7	9.9	18.4	17.5	9.2	5.9	4.0	6.0	165	134	39	1.00	2.97	0.95	0.18

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/ Lt	Lt/ Wm	Wb/ Wm	Lm/ Lt
3237	000	6322	001	ELK	OPL	1	39.3	35.6	8.1	23.5	18.4	13.3	4.7	1.9	3.5	133	123	10	0.90	1.67	0.78	0.21
3237	000	6744	001	ELK	OBS	1	45.1	45.1	5.7	23.0	10.9	9.0	5.1	2.7	3.2	165	118	47	1.00	1.96	0.47	0.13
3237	000	6762	001	ELK	OPL	1	45.2	44.9	6.7	22.5	15.3	12.7	4.6	3.0	5.0	189	19	70	1.00	2.00	0.68	0.15
3237	000	9084	001	ELK	OPL	1	62.8	62.8	7.7	27.2	16.0	11.9	5.1	4.1	8.2	136	120	16	1.00	2.30	0.59	0.13
3239	000	0500	005	ELK	OBS	1	34.8	33.8	3.1	18.0	10.6	9.3	4.5	1.9	2.3	146	120	26	1.00	1.93	0.58	0.09
3271	000	0500	159	ELK	OPL	1	33.2	30.6	4.3	21.4	12.6	0.0	4.2	1.7	2.1	160	136	30	0.90	1.54	0.59	0.13
3516	000	0001	009	ELK	OPL	1	36.8	34.6	3.5	21.2	14.5	8.4	3.7	1.4	2.2	140	129	11	0.90	1.73	0.68	0.10
3516	000	0001	901	ELK	OBS	1	43.1	43.1	6.6	20.6	11.7	8.8	5.6	3.5	3.8	145	101	44	1.00	2.09	0.57	0.15
3032	027	0001	130	FRG	OBS	1	23.3	0.0	0.0	19.5	0.0	0.0	3.9	2.0	0.0	193	0	0	0.00	0.00	0.00	0.00
3032	072	0066	009	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	023	3001	052	FRG	OBS	1	18.8	0.0	0.0	12.4	0.0	0.0	2.9	0.6	0.0	201	0	0	0.00	0.00	0.00	0.00
3032	023	4003	009	FRG	OPL	1	9.2	0.0	0.0	20.5	0.0	0.0	3.9	0.7	0.0	201	0	0	0.00	0.00	0.00	0.00
3032	027	6001	017	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	027	6122	001	FRG	OPL	1	33.1	0.0	0.0	22.9	0.0	0.0	3.5	2.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	0500	012	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	2002	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	2024	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	2042	013	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6062	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6166	004	FRG	OPL	1	10.9	0.0	0.0	8.6	0.0	0.0	2.4	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6202	012	FRG	BAS	1	7.5	0.0	0.0	8.4	0.0	0.0	2.0	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6301	002	FRG	OPL	1	18.7	0.0	0.0	11.7	0.0	0.0	3.5	0.6	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6382	001	FRG	OPL	1	14.4	0.0	0.0	7.0	0.0	0.0	1.2	0.1	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6543	002	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6623	001	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6702	009	FRG	BAS	1	10.5	0.0	0.0	9.4	0.0	0.0	1.8	0.2	0.0	181	0	0	0.00	0.00	0.00	0.00
3092	000	6722	002	FRG	OPL	1	27.8	0.0	0.0	15.9	0.0	0.0	3.4	1.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6782	003	FRG	OBS	1	20.1	0.0	0.0	10.9	0.0	0.0	3.0	0.7	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	0500	089	FRG	OPL	0	28.5	0.0	0.0	11.6	0.0	0.0	2.5	0.7	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	0516	004	FRG	OPL	0	20.4	0.0	0.0	15.5	0.0	0.0	2.6	0.8	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	2001	006	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	3010	002	FRG	OPL	1	23.1	0.0	0.0	17.9	0.0	0.0	3.9	1.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	6021	002	FRG	OPL	1	19.9	0.0	0.0	15.9	0.0	0.0	3.7	1.1	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	6501	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	6502	001	FRG	OPL	1	22.4	0.0	0.0	15.4	0.0	0.0	3.4	0.8	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	7180	001	FRG	OPL	1	20.8	0.0	0.0	12.2	0.0	0.0	3.9	0.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	7181	002	FRG	OPL	1	25.8	0.0	0.0	18.9	0.0	0.0	4.6	2.3	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	7201	003	FRG	OPL	1	16.4	0.0	0.0	13.3	0.0	0.0	2.0	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	7281	004	FRG	OBS	1	23.1	0.0	0.0	13.0	0.0	0.0	2.5	0.7	0.0	195	0	0	0.00	0.00	0.00	0.00
3095	000	9480	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3095	000	9481	001	FRG	OPL	0	4.2	0.0	0.0	5.8	0.0	0.0	1.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3099	000	0500	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3116	000	1006	001	FRG	OPL	0	9.5	0.0	0.0	8.0	0.0	0.0	2.1	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3116	000	1010	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3116	000	1011	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3125	000	0080	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3144	000	0099	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3149	000	0500	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3149	000	1002	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3149	000	1004	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	0001	017	FRG	OBS	1	25.6	0.0	0.0	17.6	0.0	0.0	2.5	0.7	0.0	156	0	0	0.00	0.00	0.00	0.00
3160	000	0500	097	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	0500	194	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	0500	242	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	0512	009	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/ Lt	Lt/ Wm	Wb/ Wm	Lm/ Lt
3160	000	1062	001	FRG	BAS	1	31.8	30.5	9.1	14.7	14.7	0.0	4.2	2.0	2.3	0	0	0	1.00	2.16	1.00	0.29
3160	000	1103	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	2104	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	4049	007	FRG	OPL	1	9.3	0.0	0.0	7.8	0.0	0.0	2.2	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	4052	005	FRG	OPL	1	26.0	0.0	0.0	17.2	0.0	0.0	3.7	1.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	4053	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	4056	002	FRG	BAS	1	12.1	0.0	0.0	9.1	0.0	0.0	3.2	0.3	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	4062	007	FRG	OPL	1	10.9	0.0	0.0	3.6	0.0	0.0	3.0	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	6362	003	FRG	OPL	1	10.4	0.0	0.0	16.9	0.0	8.7	4.0	0.9	0.0	160	0	0	0.00	0.00	0.00	0.00
3160	000	6521	004	FRG	OPL	1	13.8	0.0	0.0	10.2	0.0	0.0	2.9	0.3	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	6641	002	FRG	OPL	1	17.8	0.0	0.0	10.3	0.0	0.0	2.2	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	6723	002	FRG	OPL	1	16.5	0.0	0.0	7.6	0.0	0.0	4.5	0.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	8522	002	FRG	BAS	1	23.4	0.0	0.0	13.1	0.0	0.0	2.6	0.7	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	8542	008	FRG	OPL	1	14.9	0.0	0.0	7.5	0.0	0.0	1.9	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3162	000	0117	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3165	000	0500	015	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3165	000	1025	001	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3165	000	4048	001	FRG	OBS	1	19.0	0.0	0.0	19.5	0.0	0.0	2.3	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3170	000	4061	001	FRG	OPL	1	14.6	0.0	0.0	14.8	0.0	0.0	2.2	0.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3170	000	6822	002	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3173	000	1010	001	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3173	000	1011	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3178	000	0501	006	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3184	000	0503	014	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3185	000	1003	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3185	000	1011	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3190	000	0510	001	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3190	000	1001	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3190	000	1002	005	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3190	000	1002	006	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3190	000	1007	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3190	000	1019	005	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3191	000	1004	001	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	0502	011	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	1055	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	2061	007	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	2061	026	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	2061	027	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	2121	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	6121	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	6201	009	FRG	OBS	1	16.0	0.0	0.0	12.7	0.0	0.0	2.4	0.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3192	000	6581	004	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	0503	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1001	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1014	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1014	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1015	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1017	003	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1017	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1017	010	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1017	011	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1018	003	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1019	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1019	003	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	1025	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/ Lt	Lt/ Wm	Wb/ Wm	Lm/ Lt
3198	000	2001	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	2001	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3198	000	2001	005	FRG	OBS	0	3.5	0.0	0.0	5.2	0.0	0.0	1.3	0.1	0.0	0	0	0	0.00	0.00	0.00	0.00
3204	000	2003	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3204	000	2005	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3204	000	6007	001	FRG	OPL	1	11.0	0.0	0.0	9.5	0.0	0.0	2.3	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	0001	023	FRG	OPL	1	22.9	0.0	0.0	22.2	0.0	0.0	4.6	2.6	0.0	123	0	0	0.00	0.00	0.00	0.00
3237	000	0001	064	FRG	OPL	0	20.8	0.0	0.0	14.8	0.0	0.0	4.1	0.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	0001	065	FRG	OPL	1	17.1	0.0	0.0	10.3	0.0	0.0	2.6	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	0500	008	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	0500	036	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	2081	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	4030	001	FRG	OPL	1	21.3	0.0	0.0	19.3	0.0	0.0	4.2	1.8	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	6744	002	FRG	OPL	1	18.8	0.0	0.0	12.0	0.0	0.0	3.6	0.6	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	6745	001	FRG	OPL	1	28.1	0.0	0.0	13.6	0.0	0.0	3.9	1.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	6763	006	FRG	OPL	1	16.8	0.0	0.0	13.1	0.0	0.0	3.7	0.7	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	6865	001	FRG	OPL	1	10.9	0.0	0.0	10.7	0.0	0.0	2.5	0.3	0.0	0	0	0	0.00	0.00	0.00	0.00
3238	000	0500	014	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	0001	006	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	0500	013	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	0501	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1004	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1004	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1010	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1021	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1022	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1027	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1030	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	1030	003	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	2003	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	2061	004	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	3003	001	FRG	OPL	1	25.4	0.0	0.0	11.8	0.0	0.0	2.0	0.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	4015	003	FRG	OPL	1	17.4	0.0	0.0	12.6	0.0	0.0	2.3	0.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	4020	001	FRG	OPL	1	21.1	0.0	0.0	11.0	0.0	0.0	2.7	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	4021	007	FRG	OPL	1	9.2	0.0	0.0	8.9	0.0	0.0	3.9	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6001	002	FRG	OPL	1	15.7	0.0	0.0	9.2	0.0	0.0	3.9	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6022	001	FRG	OPL	1	12.3	0.0	0.0	6.2	0.0	0.0	1.7	0.1	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6040	007	FRG	OPL	1	17.2	0.0	0.0	13.3	0.0	0.0	4.2	0.6	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6081	001	FRG	OPL	1	15.3	0.0	0.0	8.3	0.0	0.0	1.9	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6120	002	FRG	OBS	1	7.3	0.0	0.0	15.5	0.0	0.0	3.5	0.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6121	008	FRG	OPL	1	17.8	0.0	0.0	9.2	0.0	0.0	0.2	0.3	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6121	013	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6141	004	FRG	OPL	1	13.0	0.0	0.0	11.4	0.0	0.0	3.0	0.5	0.0	225	155	70	0.00	0.00	0.00	0.00
3251	000	6421	008	FRG	OPL	1	17.4	0.0	0.0	13.1	0.0	0.0	2.0	0.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6501	002	FRG	OPL	1	25.5	0.0	0.0	15.6	0.0	0.0	2.9	0.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6561	001	FRG	OPL	1	15.2	0.0	0.0	8.4	0.0	0.0	2.2	0.3	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	6561	002	FRG	OPL	1	15.2	0.0	0.0	18.3	0.0	0.0	2.8	0.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3251	000	9042	001	FRG	OPL	1	15.5	0.0	0.0	9.5	0.0	0.0	1.9	0.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0045	001	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0500	110	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0500	130	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0500	134	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0500	203	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0500	309	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	0511	001	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/Lt	Lt/Wm	Wb/Wm	Lm/Lt
3271	000	1045	002	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	2021	008	FRG	OBS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3271	000	2021	014	FRG	OPL	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	028	0081	01A	GAT	OPL	1	54.2	51.7	10.7	31.1	14.4	15.3	5.8	3.6	7.5	145	94	59	1.00	1.74	0.45	0.20
3032	027	6062	002	GAT	OPL	2	34.2	30.0	8.5	26.3	11.6	12.3	3.5	2.7	2.7	150	94	56	0.90	1.30	0.44	0.25
3092	000	2009	002	GAT	OBS	1	43.4	42.0	6.8	21.7	10.7	11.2	4.7	3.0	4.0	190	95	95	1.00	2.00	0.50	0.16
3092	000	6041	014	GAT	OPL	1	40.1	36.9	9.7	25.5	10.6	9.8	4.5	2.1	4.2	166	96	70	0.90	1.57	0.42	0.24
3092	000	6482	003	GAT	OPL	1	45.4	43.5	3.9	28.3	12.9	12.1	5.0	4.0	5.1	134	96	38	1.00	1.60	0.46	0.09
3095	000	0001	004	GAT	OPL	2	42.8	39.7	5.6	17.1	9.1	8.8	4.8	3.5	3.5	168	81	87	0.90	2.50	0.53	0.13
3095	000	0500	008	GAT	OPL	1	65.1	59.6	9.5	20.0	11.4	11.3	4.9	4.5	5.0	198	95	74	0.90	3.25	0.56	0.15
3095	000	0516	010	GAT	OPL	1	51.3	49.5	12.4	21.8	11.5	11.5	4.7	3.2	4.0	179	93	86	1.00	2.35	1.00	0.24
3095	000	6941	001	GAT	OPL	1	32.1	32.1	9.1	22.3	12.2	12.4	4.4	2.4	2.6	211	84	127	1.00	1.44	0.55	0.28
3142	000	0097	001	GAT	OPL	1	53.4	51.0	9.1	24.0	13.9	12.8	5.3	5.1	5.6	131	96	35	1.00	2.23	0.58	0.17
3160	000	0001	103	GAT	OPL	1	42.5	40.3	9.5	22.0	10.9	12.6	5.7	3.6	3.7	169	80	89	1.00	1.93	0.50	0.22
3160	000	0500	308	GAT	OPL	1	55.4	52.4	7.2	24.2	17.5	15.2	4.5	3.4	7.0	169	96	73	0.90	2.28	0.72	0.13
3170	000	0001	044	GAT	OBS	1	33.5	33.5	8.0	26.0	12.4	13.7	5.2	3.3	3.5	199	86	113	1.00	1.29	0.48	0.24
3198	000	0500	004	GAT	OPL	1	57.0	50.3	8.5	24.3	11.4	10.4	5.9	4.5	5.1	155	98	57	0.90	2.25	0.20	0.16
3237	000	0500	074	GAT	OPL	1	53.7	49.7	10.1	23.7	11.0	13.2	5.8	6.0	6.2	184	97	87	0.90	2.26	0.46	0.19
3237	000	6064	001	GAT	OBS	1	37.5	34.6	5.3	21.6	11.7	10.2	4.1	2.3	2.4	157	95	62	0.90	1.74	0.54	0.14
3237	000	6401	001	GAT	OPL	1	79.5	76.2	12.0	33.9	17.9	17.5	5.3	8.1	15.8	159	97	62	1.00	2.35	0.53	0.15
3237	000	6704	002	GAT	OPL	2	41.3	39.6	8.8	24.8	16.4	14.7	4.8	4.6	4.6	140	95	45	1.00	1.67	0.66	0.21
3238	000	0500	001	GAT	OPL	1	52.7	49.6	12.9	25.5	11.8	0.0	6.1	6.7	0.0	195	94	101	0.90	2.06	0.46	0.25
3251	000	8001	901	GAT	OPL	1	51.1	47.3	8.7	24.2	11.8	10.2	5.0	3.0	3.0	6	168	98	0.90	2.11	0.49	0.17
3092	000	6606	002	HUM	OPL	2	34.0	32.5	16.8	15.2	9.4	0.0	3.8	2.0	2.0	0	0	0	1.00	2.24	0.69	0.49
3092	000	6728	001	HUM	OPL	1	37.1	35.8	18.0	12.6	10.3	0.0	4.2	1.3	2.4	0	0	0	1.00	2.94	0.82	0.48
3116	000	2500	001	HUM	OBS	1	42.4	38.1	10.4	17.9	15.7	0.0	5.3	3.7	3.9	0	0	0	0.90	2.36	0.87	0.25
3160	000	0500	267	HUM	OPL	1	49.6	47.6	20.9	18.8	15.9	0.0	5.2	3.4	4.8	0	0	0	1.00	2.63	0.84	0.42
3192	000	2203	002	HUM	OPL	2	27.3	26.7	17.9	18.4	13.6	0.0	5.3	2.8	4.0	0	0	0	1.00	1.48	0.73	0.65
3198	000	1007	902	HUM	OPL	2	35.2	33.0	0.0	14.7	14.2	0.0	2.0	1.4	1.4	0	0	0	0.90	2.39	0.97	0.00
3198	000	1012	004	HUM	OPL	1	51.6	49.4	18.8	23.3	20.3	0.0	3.2	1.3	4.5	0	0	0	1.00	2.21	0.87	0.36
3237	000	0001	048	HUM	OPL	1	49.6	47.9	14.8	17.8	16.9	0.0	6.1	3.6	5.0	0	0	0	1.00	2.79	0.95	0.30
3237	000	6142	001	HUM	BAS	1	44.5	43.1	23.4	18.4	10.9	0.0	4.7	2.1	4.2	0	0	0	1.00	2.42	0.59	0.53
3237	000	6881	901	HUM	OPL	2	94.9	93.8	34.1	21.1	11.2	0.0	5.9	11.7	11.7	0	0	0	1.00	4.50	0.53	0.36
3251	000	0001	004	HUM	OPL	1	21.6	19.4	8.5	13.2	10.1	0.0	3.7	1.0	1.2	0	0	0	0.90	1.64	0.77	0.39
3251	000	0505	001	HUM	OPL	1	68.2	67.4	17.5	23.4	17.0	0.0	7.1	6.3	11.0	0	0	0	1.00	2.91	0.72	0.26
3271	000	1032	005	HUM	OPL	1	42.5	40.8	12.7	16.9	14.7	0.0	3.0	1.7	2.5	0	0	0	1.00	2.52	0.87	0.30
3093	000	0505	004	LSN	OPL	2	41.6	38.3	0.0	15.5	15.5	6.6	3.1	5.5	5.5	177	172	5	0.90	2.67	1.00	0.00
3160	000	0115	001	LSN	OBS	1	38.2	36.2	0.0	17.1	17.1	7.0	3.8	1.7	2.0	182	178	4	0.90	2.23	1.00	0.00
3184	000	0524	002	LSN	OPL	1	49.3	46.6	0.0	24.9	24.9	11.8	3.7	3.5	5.0	202	182	20	0.90	1.97	1.00	0.00
3204	000	6004	001	LSN	OBS	1	39.4	33.5	0.0	23.2	23.2	6.1	3.0	0.5	2.3	0	181	0	0.90	1.70	1.00	0.00
3237	000	0500	043	LSN	OPL	1	31.4	31.0	0.0	17.0	17.0	7.9	4.2	1.3	1.5	189	184	5	1.00	1.84	1.00	0.00
3237	000	4014	004	LSN	OBS	1	37.2	37.2	0.0	16.1	16.1	8.4	3.6	1.5	1.8	186	150	36	1.00	2.31	1.00	0.00
3237	000	6902	001	LSN	OBS	2	32.6	26.6	0.0	21.3	21.3	6.7	3.8	1.6	1.6	199	182	17	0.80	1.53	1.00	0.00
3238	000	0500	037	LSN	OPL	1	43.6	41.6	0.0	16.7	16.7	9.2	4.3	2.5	3.0	180	152	28	1.00	2.61	1.00	0.00
3271	000	0500	270	LSN	OPL	2	34.7	31.2	0.0	19.3	17.6	10.1	4.4	3.2	3.2	165	165	0	0.90	1.80	0.91	0.00
3032	158	0035	004	OOK	OBS	1	20.4	19.8	5.9	10.9	7.7	5.2	2.2	0.4	0.5	191	144	47	1.00	1.87	0.71	0.29
3032	040	0056	003	OOK	OBS	1	26.9	26.9	7.0	17.7	5.0	6.8	3.6	1.2	1.3	161	62	99	1.00	1.52	0.28	0.26
3032	023	4002	021	OOK	OBS	1	44.5	44.5	0.0	22.7	22.7	0.0	3.9	3.3	3.5	0	0	0	1.00	1.96	1.00	0.00
3032	027	6521	001	OOK	OBS	2	18.5	18.5	6.7	9.5	7.4	6.8	0.2	0.4	0.4	151	101	50	1.00	1.95	0.78	0.36
3092	000	2500	001	OOK	OBS	1	24.2	23.2	0.0	10.0	9.8	7.0	3.0	0.6	0.7	225	111	114	1.00	2.44	0.98	0.00
3093	000	0505	011	OOK	OPL	1	38.0	37.2	0.0	17.1	17.1	0.0	2.8	1.5	1.5	0	0	0	1.00	2.22	1.00	0.00
3095	000	0510	044	OOK	OPL	1	34.5	32.8	0.0	14.3	14.3	0.0	2.3	0.8	1.2	0	0	0	1.00	2.41	1.00	0.00
3095	000	0510	046	OOK	OBS	1	18.8	18.8	0.0	9.5	9.5	6.8	3.8	0.6	0.8	183	116	67	1.00	0.37	1.00	0.00
3095	000	0510	049	OOK	OPL	1	37.7	36.8	8.4	20.0	17.3	13.1	5.4	4.3	4.4	195	128	67	1.00	1.88	0.88	0.22
3095	000	0519	012	OOK	OBS	1	22.6	20.9	4.6	12.5	9.2	7.4	3.0	0.6	0.7	190	117	73	0.90	1.80	0.73	0.20

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/ Lt	Lt/ Wm	Wb/ Wm	Lm/ Lt
3095	000	3011	001	OOK	OBS	1	20.0	17.6	1.8	8.1	8.1	4.2	2.7	0.3	0.3	230	120	110	0.90	2.47	1.00	0.09
3106	000	2002	001	OOK	BAS	2	16.3	14.2	1.4	9.4	9.4	6.8	3.0	0.4	0.4	252	120	132	0.90	1.73	1.00	0.09
3148	000	0103	001	OOK	OBS	1	48.6	44.0	0.0	16.1	16.1	0.0	4.6	2.2	4.0	0	0	0	0.90	3.00	1.00	0.00
3154	000	0109	001	OOK	OBS	2	30.3	29.3	9.8	18.6	11.0	11.3	4.5	2.2	2.2	243	97	146	1.00	1.63	0.59	0.32
3160	000	0500	002	OOK	OPL	1	46.9	41.9	14.6	20.2	20.2	0.0	4.3	3.0	3.2	0	0	0	0.90	2.32	1.00	0.31
3160	000	0520	002	OOK	OPL	1	27.6	25.0	0.0	17.7	17.7	0.0	4.0	2.2	2.3	0	0	0	0.90	1.55	1.00	0.00
3170	000	4060	002	OOK	OPL	2	14.5	13.1	0.0	10.5	10.5	7.5	2.4	0.3	0.3	256	136	120	0.90	1.38	1.00	0.00
3171	000	0504	007	OOK	OBS	1	35.0	33.5	4.4	12.1	11.8	0.0	2.8	1.1	1.4	0	0	0	1.00	1.04	0.97	0.12
3177	000	2001	001	OOK	OPL	2	43.5	41.8	1.4	18.0	17.6	15.7	4.4	3.0	3.0	242	140	102	1.00	2.46	0.97	0.03
3177	000	2001	010	OOK	OPL	2	16.1	16.1	0.0	10.2	5.9	7.0	3.5	0.1	0.1	228	75	53	1.00	1.58	0.58	0.00
3184	000	4156	002	OOK	OBS	1	41.2	40.9	11.8	21.7	18.9	0.0	5.5	2.4	5.0	0	0	0	1.00	1.90	0.87	0.29
3185	000	0016	003	OOK	OPL	1	53.1	53.1	15.1	22.1	18.5	0.0	3.6	2.2	5.0	0	0	0	1.00	2.40	0.84	0.28
3190	000	1004	005	OOK	OPL	1	34.3	31.8	0.0	17.9	17.9	0.0	2.9	1.2	2.0	0	0	0	0.90	1.91	1.00	0.00
3237	000	0001	127	OOK	OPL	1	39.7	37.8	12.7	20.9	14.9	12.1	4.9	2.1	4.2	198	109	89	1.00	1.90	0.71	0.32
3237	000	0500	017	OOK	OPL	1	49.2	49.2	12.4	20.4	12.5	9.6	4.8	2.6	3.0	188	106	82	1.00	2.41	0.61	0.25
3251	000	0001	001	OOK	OPL	1	50.1	47.4	20.0	17.8	13.5	12.3	7.6	5.7	6.2	260	104	156	1.00	2.81	0.76	0.40
3251	000	3006	004	OOK	OBS	1	24.4	21.9	8.7	11.6	8.4	5.6	2.6	0.4	0.6	202	116	86	0.90	2.10	0.72	0.36
3251	000	6541	001	OOK	OPL	2	17.0	17.0	6.4	9.0	5.0	5.4	2.3	0.3	0.3	205	71	134	1.00	1.89	0.56	0.38
3075	000	0028	001	RSG	OPL	1	28.4	28.4	4.4	20.1	7.5	6.2	3.6	1.0	2.0	127	101	26	1.00	1.41	0.37	0.16
3092	000	8266	002	RSG	OPL	1	37.0	36.3	3.4	18.5	8.8	7.0	2.8	1.5	3.0	140	112	28	1.00	2.00	0.48	0.09
3092	000	8302	001	RSG	OPL	1	33.6	32.4	4.6	14.5	9.8	6.8	4.0	1.3	1.5	151	110	41	1.00	2.31	0.68	0.14
3095	000	0001	002	RSG	OPL	1	35.8	35.8	4.5	18.8	8.1	5.6	4.0	1.3	2.5	125	108	17	1.00	1.90	0.43	0.13
3095	000	0500	045	RSG	OPL	1	26.6	26.6	2.9	17.0	7.5	5.6	2.8	0.7	1.3	129	124	5	1.00	1.56	0.44	0.11
3095	000	6082	001	RSG	OPL	1	25.9	25.9	4.1	16.3	7.8	6.7	3.5	0.8	1.6	146	117	29	1.00	1.59	0.48	0.16
3102	000	0500	010	RSG	OPL	2	25.3	25.3	5.1	11.8	6.5	5.7	3.4	0.9	1.0	146	98	48	1.00	2.14	0.55	0.20
3160	000	0500	103	RSG	OPL	1	37.4	37.4	4.1	14.5	6.4	4.2	3.7	1.2	1.5	139	118	21	1.00	2.57	0.44	0.11
3160	000	0500	259	RSG	OPL	1	41.3	41.3	1.7	12.6	6.4	4.7	3.2	1.4	1.7	120	104	16	1.00	3.27	0.50	0.04
3160	000	0500	310	RSG	OPL	1	38.6	38.6	2.0	15.0	7.0	6.5	3.4	1.6	7.0	137	110	27	1.00	2.57	0.46	0.05
3160	000	0517	001	RSG	OPL	2	26.8	26.8	1.3	15.5	5.3	4.7	3.2	1.3	1.3	126	105	21	1.00	1.72	0.34	0.05
3160	000	1009	002	RSG	OPL	2	20.8	20.8	2.6	11.1	6.8	3.9	2.3	0.4	0.4	130	115	15	1.00	1.87	0.61	0.13
3160	000	4032	001	RSG	OPL	1	33.8	33.8	3.7	17.7	8.7	8.5	3.9	1.6	1.8	169	99	70	1.00	1.91	0.49	0.11
3204	000	2002	001	RSG	OPL	1	35.7	35.7	2.6	14.7	6.4	5.0	3.1	1.3	1.4	140	112	28	1.00	2.43	0.44	0.07
3204	000	6002	005	RSG	OPL	1	27.8	27.8	4.5	18.4	7.6	7.6	2.9	0.4	1.0	128	114	14	1.00	1.51	0.41	0.16
3231	000	0500	001	RSG	OPL	1	29.5	29.5	3.9	19.0	7.9	7.6	3.7	1.3	1.6	133	104	29	1.00	1.55	0.41	0.13
3237	000	0001	107	RSG	OPL	1	25.9	24.6	2.6	18.8	7.3	5.2	3.5	0.6	1.2	131	111	20	1.00	1.38	0.39	0.10
3237	000	0500	056	RSG	OPL	1	35.3	35.3	2.9	21.5	8.7	7.4	2.9	1.1	1.5	123	109	14	1.00	1.64	0.40	0.08
3237	000	1544	001	RSG	OPL	1	31.5	31.5	4.7	14.3	7.9	6.9	3.3	1.2	1.5	159	98	61	1.00	2.20	0.55	0.15
3239	000	0500	001	RSG	OBS	1	26.3	26.1	4.0	11.5	5.8	5.5	2.8	0.7	0.9	174	109	65	1.00	2.28	0.50	0.15
3251	000	0001	008	RSG	OPL	1	19.1	19.1	3.6	12.4	6.7	4.7	2.9	0.6	0.7	129	108	21	1.00	1.54	0.54	0.19
3251	000	0001	010	RSG	OBS	1	21.9	21.9	2.2	14.6	7.0	4.8	2.1	0.5	0.7	133	105	28	1.00	1.50	0.48	0.10
3251	000	1022	003	RSG	OPL	1	29.5	29.5	7.7	13.3	8.2	0.5	2.4	0.7	1.3	158	115	43	1.00	2.21	0.61	0.26
3251	000	4015	002	RSG	OPL	1	23.2	23.2	7.7	12.7	8.2	6.1	2.3	0.5	0.5	199	110	89	1.00	1.83	0.64	0.33
3251	000	4017	001	RSG	OBS	1	15.9	15.9	2.6	11.4	5.4	3.7	2.4	0.3	0.3	135	104	31	1.00	1.40	0.47	0.16
3251	000	4018	001	RSG	OPL	1	25.4	25.4	2.1	16.9	6.1	4.9	2.4	0.4	0.8	135	102	33	1.00	1.50	0.36	0.08
3271	000	0500	138	RSG	OPL	1	28.9	28.9	2.8	19.8	8.8	6.4	3.7	1.3	1.7	135	118	17	1.00	1.46	0.44	0.10
3271	000	0500	146	RSG	OPL	2	20.9	20.9	4.6	10.0	8.0	6.7	3.0	0.5	0.5	151	125	26	1.00	2.09	0.80	0.22
3271	000	0500	191	RSG	OBS	1	35.0	35.0	5.5	21.4	8.7	10.5	4.0	1.7	1.8	158	110	48	1.00	1.64	0.41	0.16
3271	000	0500	293	RSG	OPL	1	32.7	32.7	5.1	12.9	10.0	7.9	3.7	1.1	1.3	152	112	40	1.00	2.53	0.78	0.16
3271	000	0500	301	RSG	OPL	1	29.2	29.2	3.6	16.5	7.7	5.8	3.3	1.0	1.2	123	118	5	1.00	1.77	0.47	0.12
3271	000	0513	004	RSG	BAS	1	34.1	34.1	3.2	19.5	7.3	5.6	3.4	1.3	1.6	130	105	25	1.00	1.75	0.37	0.09
3271	000	1046	005	RSG	OBS	1	28.5	28.5	2.3	14.6	9.8	8.2	2.6	0.7	1.2	123	111	12	1.00	1.95	0.67	0.08
3271	000	1050	001	RSG	OPL	1	34.0	34.0	0.0	20.3	6.7	6.5	2.8	1.4	1.5	123	96	27	1.00	1.67	3.02	0.00
3032	000	0001	001	STM	OPL	1	65.1	0.0	0.0	31.3	11.0	21.8	7.9	16.2	0.0	239	85	154	0.00	0.00	0.00	0.00
3032	023	0001	501	STM	OPL	1	45.9	0.0	0.0	32.2	0.0	0.0	9.5	15.8	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	023	0001	502	STM	OBS	1	24.5	0.0	0.0	20.0	0.0	0.0	4.7	2.9	0.0	0	0	0	0.00	0.00	0.00	0.00

Appendix E, continued.

Site	Locality	Reference	Specimen	Type	Material	Condition	Lt	La	Lm	Wm	Wb	Nw	Th	Wt	Est Wt	DSA	PSA	NOI	La/Lt	Lt/Wm	Wb/Wm	Lm/Lt
3032	027	0001	045	STM	OPL	1	41.2	0.0	0.0	17.7	0.0	0.0	5.1	3.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	138	0053	01B	STM	OBS	1	36.8	0.0	0.0	25.7	0.0	0.0	7.6	7.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	152	3000	001	STM	CHA	1	38.1	0.0	0.0	0.0	37.3	0.0	9.1	20.2	0.0	0	0	0	0.00	0.00	0.00	0.00
3032	023	3001	035	STM	OBS	1	21.1	0.0	0.0	22.3	0.0	0.0	9.1	5.8	0.0	0	0	0	0.00	0.00	0.00	0.00
3092	000	6421	004	STM	OPL	1	35.9	0.0	0.0	22.6	20.7	0.0	4.7	10.0	0.0	254	0	0	0.00	0.00	0.00	0.00
3101	000	0500	007	STM	OPL	1	42.1	0.0	0.0	33.5	0.0	0.0	10.9	17.5	0.0	0	0	0	0.00	0.00	0.00	0.00
3107	000	0500	002	STM	CHA	1	52.3	0.0	0.0	18.8	0.0	0.0	7.4	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3160	000	0001	153	STM	OPL	1	32.4	0.0	0.0	23.7	0.0	0.0	6.0	5.8	0.0	249	90	150	0.00	0.00	0.00	0.00
3170	000	0500	031	STM	OBS	1	25.3	0.0	0.0	21.5	0.0	0.0	8.0	4.1	0.0	0	0	0	0.00	0.00	0.00	0.00
3170	000	0500	067	STM	OBS	1	25.4	0.0	0.0	23.1	0.0	0.0	7.1	3.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3170	000	4072	001	STM	OBS	2	32.1	16.0	18.4	15.9	6.6	11.6	4.2	2.0	2.0	230	76	154	0.50	2.02	0.42	0.57
3192	000	0502	020	STM	CHA	1	28.2	0.0	0.0	25.1	0.0	0.0	6.6	6.1	0.0	0	0	0	0.00	0.00	0.00	0.00
3208	000	0505	001	STM	CHA	1	50.0	0.0	0.0	30.3	0.0	0.0	6.5	14.9	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	0500	021	STM	OBS	1	20.2	0.0	0.0	17.3	0.0	0.0	8.5	3.4	0.0	0	0	0	0.00	0.00	0.00	0.00
3237	000	6761	002	STM	BAS	2	47.4	47.4	16.4	17.2	8.8	13.2	5.7	5.0	5.0	219	75	44	1.00	2.76	0.51	0.35
3238	000	0500	023	STM	OBS	1	25.3	0.0	0.0	19.3	0.0	0.0	7.9	4.0	0.0	0	0	0	0.00	0.00	0.00	0.00
3238	000	0500	025	STM	OBS	1	22.5	0.0	0.0	21.3	0.0	0.0	7.8	4.3	0.0	0	0	0	0.00	0.00	0.00	0.00

KEY:

TYPE
- CLO = Clovis
- CT = Cottonwood
- DSN = Desert Side-notched
- ELK = Elko
- FRG = Fragment
- GAT = Gatecliff
- HUM = Humboldt
- LSN = Large Side-notched
- RSG = Rosegate
- STM = Stemmed
- OOK = Out of Key

MATERIAL
- OPL = Opalite
- OBS = Obsidian
- BAS = Basalt
- CHA = Chalcedony

CONDITION
- 1 = Complete
- 2 = Incomplete

MEASUREMENT
- Lt = Total Length
- La = Length of Longitudinal Axis
- Lm = Length from Proximal End to Maximum Width
- Wm = Maximum Width
- Wb = Basal Width
- Nw = Neck Width
- Th = Thickness
- Wt = Weight in grams
- Est Wt = Estimated Weight
- DSA = Distal Shoulder Angle, between 90°-270°
- PSA = Proximal Shoulder Angle, between 0°-270°y
- NOI = Notch Opening Index

APPENDIX F

Summary Data for Preforms

Appendix F. Summary Data for Preforms.

Subarea	Site/Loc.	Fea.	Total	MATERIAL						STAGE					THERMAL ALTERATION						BLANK TYPE				TIP ORIENTATION			
				Opalite	Obs	Bas	Chal	Jas	Opal	2	3	4	5	Ind.	HT Block	HT Blank	HT Red.	HT Indet.	HT Stage Other	Not HT	Biface Thin.	Other	Ind.	Prox.	Dist.	Trans.	Ind.
Quarry	3032/1.23	1	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	-	-	1
	3032/1.27	0	6	5	1	-	-	-	-	3	1	2	-	-	-	1	-	1	1	3	1	1	4	-	1	2	3
East	2140	0	2	1	1	-	-	-	-	-	-	2	-	-	1	-	-	-	-	1	-	-	2	-	-	-	2
	3170	0	4	2	1	-	1	-	-	1	2	1	-	-	-	2	-	-	-	2	-	1	3	-	3	1	-
		8	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	1
	Total		5																								
	3171	0	4	2	2	-	-	-	-	3	-	1	-	-	-	-	-	-	1	3	-	-	4	2	-	1	1
	3184	0	2	1	1	-	-	-	-	-	1	1	-	-	-	1	-	-	-	1	-	-	2	-	-	1	1
		3	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1
		8	3	2	1	-	-	-	-	-	1	2	-	-	-	-	-	-	-	3	-	2	1	1	1	-	1
	Total		6																								
	3185	1	3	3	-	-	-	-	-	-	2	1	-	-	-	-	1	1	1	-	2	-	1	-	1	-	2
		6	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1
	Total		4																								
	3189	0	1	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
	3190	1	1	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	-	1	-	-	-	1
		7	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
	Total		2																								
	3192	1	3	3	-	-	-	-	-	1	-	1	1	-	1	1	-	-	-	1	-	-	3	-	2	-	1
		2	1	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1
	Total		4																								
	3198	1	15	10	4	-	1	-	-	3	3	7	1	1	-	2	-	2	2	9	1	2	12	4	5	-	6
	3204	0	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	-
		1	4	4	-	-	-	-	-	2	-	2	-	-	1	2	-	-	-	1	1	-	3	1	1	-	2
	Total		5																								
West	3092	0	28	25	1	-	-	2	-	7	7	9	-	5	2	4	-	7	6	9	2	3	23	2	2	2	22
		13	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
	Total		29																								
	3093	3	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-
		4	4	3	-	1	-	-	-	2	1	1	-	-	-	-	-	2	1	1	-	-	4	2	1	-	1
		5	1	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1
	Total		6																								
	3095	0	3	3	-	-	-	-	-	-	3	-	-	-	-	3	-	-	-	-	-	-	3	1	-	-	2
		10	8	6	1	-	1	-	-	2	4	2	-	-	-	3	-	1	2	2	1	-	7	1	3	1	3
		11	1	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	-
		15	1	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
		16	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-
		19	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-
		24	2	2	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	2	-	-	-	2
	Total		17																								

Appendix F, continued.

				MATERIAL						STAGE					THERMAL ALTERATION						BLANK TYPE			TIP ORIENTATION			
Subarea	Site/Loc.	Fea.	Total	Opalite	Obs	Bas	Chal	Jas	Opal	2	3	4	5	Ind.	HT Block	HT Blank	HT Red.	HT Stage Indet.	Other	Not HT	Biface Thin.	Other	Ind.	Prox.	Dist.	Trans.	Ind.
	3116	1	3	3	-	-	-	-	-	-	-	3	-	-	-	-	-	2	-	1	-	-	3	-	-	-	3
	3155	0	1	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1
	3160	0	17	15	-	-	-	1	1	2	7	6	1	1	-	6	-	3	2	6	-	2	15	2	3	1	11
		1	4	3	-	-	1	-	-	1	-	3	-	-	-	-	-	-	1	3	-	-	4	1	-	-	3
		2	1	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-
		6	1	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	-	-
		11	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1
		12	3	1	1	-	1	-	-	1	1	1	-	-	1	1	-	-	-	1	-	1	2	1	-	-	2
		13	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
		14	1	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1
		17	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1
		20	2	1	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	-	2	1	-	1	-
		23	17	12	-	-	4	1	-	6	8	2	1	-	2	9	-	3	2	1	1	4	12	2	3	4	8
		24	2	2	-	-	-	-	-	1	1	-	-	-	-	2	-	-	-	-	-	1	1	-	-	-	2
	Total		51																								
	3165	0	2	1	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2	-	-	2	1	-	-	1
		2	1	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	-	-	1
	Total		3																								
	3271	0	3	3	-	-	-	-	-	-	1	2	-	-	-	1	-	1	-	1	-	-	3	-	-	-	3
		3	2	2	-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	1	1	1	-	1	-	-	1
		11	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1
		12	2	2	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	1	2	-	-	1	1	-	-
		14	2	2	-	-	-	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-	2	-	-	-	2
	Total		10																								
North	3231	1	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-
	3237	0	16	14	1	-	-	-	1	3	2	8	1	2	2	3	-	7	1	3	1	2	13	1	-	-	15
		2	1	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	1
	Total		17																								
	3239	1	3	3	-	-	-	-	-	1	2	-	-	-	2	1	-	-	-	-	1	1	1	2	-	-	1
	3251	0	8	8	-	-	-	-	-	2	1	4	-	1	-	2	-	5	1	-	1	-	7	-	1	-	7
		1	31	29	2	-	-	-	-	10	5	13	-	3	2	13	1	8	3	4	2	3	26	4	2	1	24
		2	4	3	-	-	1	-	-	1	1	2	-	-	1	-	-	2	-	1	-	-	4	2	-	-	2
		3	1	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1
		6	19	17	-	-	1	1	-	7	6	6	-	-	-	8	1	6	2	2	2	4	13	2	2	2	13
	Total		63																								
	3262	0	1	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-	-	1	-

APPENDIX G

Summary Data for Cores

Appendix G. Summary Data for Cores.

				ATTRIBUTES														
				MATERIAL					BLANK TYPE					CORE TYPE				
Subarea	Site	Fea.	Total Cores	Opalite	Obsidian	Basalt	Jasper	Other	Flake	Cobble	Indet.	Assay Pc.	Block	Sphere	Split Nodule	Frag	Other	Poss. Core
Quarry	Loc. 19	0	1	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-
		1	4	4	-	-	-	-	1	-	3	-	1	-	-	1	1	1
	Total		5															
	Loc. 20	2	3	3	-	-	-	-	-	2	1	-	-	-	2	1	-	-
		3	1	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-
	Total		4															
	Loc. 21	1	8	8	-	-	-	-	1	1	6	-	4	4	-	-	-	-
	Loc. 22	0	1	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-
		1	2	2	-	-	-	-	-	1	1	1	1	-	-	-	-	-
	Total		3															
	Loc. 23	1	10	10	-	-	-	-	3	1	6	-	1	2	-	4	3	-
	Loc. 24	0	1	-	1	-	-	-	-	1	-	-	1	-	-	-	-	-
	Loc 25	2	5	5	-	-	-	-	3	1	1	-	-	1	-	1	3	-
		5	1	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-
	Total		6															
	Loc. 26	0	5	5	-	-	-	-	3	-	2	-	4	1	-	-	-	-
	Loc. 27	0	14	13	1	-	-	-	8	2	4	-	5	3	1	1	3	1
East	3170	0	3	2	1	-	-	-	-	1	2	1	-	1	-	-	1	-
	3171	0	4	3	1	-	-	-	1	2	1	-	-	-	1	-	1	2
		1	2	2	-	-	-	-	-	2	-	-	-	-	-	1	1	-
		2	1	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-
		7	1	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-
	Total		8															
	3173	1	1	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-

				ATTRIBUTES														
				MATERIAL					BLANK TYPE				CORE TYPE					
Subarea	Site	Fea.	Total Cores	Opalite	Obsidian	Basalt	Jasper	Other	Flake	Cobble	Indet.	Assay Pc.	Block	Sphere	Split Nodule	Frag	Other	Poss. Core
	3184	0	1	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-
		8	2	2	-	-	-	-	1	-	1	-	1	-	-	1	-	-
		19	1	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-
		20	3	3	-	-	-	-	1	-	2	-	1	-	1	-	1	-
		23	2	2	-	-	-	-	1	-	1	-	1	1	-	-	-	-
	Total		9															
	3191	0	1	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-
	3192	1	1	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-
		2	3	2	1	-	-	-	-	1	2	-	1	1	-	-	1	-
	Total		4															
	3198	1	7	7	-	-	-	-	7	-	-	6	-	-	-	-	-	1
	3204	0	1	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-
		1	1	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-
	Total		2															
West	3091	0	1	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-
	3092	0	11	5	1	2	2	1	4	4	3	-	6	1	-	3	1	-
		6	1	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-
		12	1	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-
	Total		13															
	3093	5	2	-	-	2	-	-	-	2	-	-	2	-	-	-	-	-
	3095	0	1	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-
		15	2	2	-	-	-	-	-	2	-	-	1	-	-	-	1	-
		19	3	2	-	1	-	-	1	1	1	-	2	-	-	-	1	-
		24	1	1	-	-	-	-	-	1	-		-	-	-	1	-	-
	Total		7															
	3099	1	1	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-
	3104	0	4	4	-	-	-	-	-	3	1	1	1	-	-	-	2	-
	3106	4	2	2	-	-	-	-	1	-	1	-	1	-	-	-	-	1

				ATTRIBUTES														
				MATERIAL					BLANK TYPE				CORE TYPE					
Subarea	Site	Fea.	Total Cores	Opalite	Obsidian	Basalt	Jasper	Other	Flake	Cobble	Indet.	Assay Pc.	Block	Sphere	Split Nodule	Frag	Other	Poss. Core
	3160	0	1	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-
		17	1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
	Total		2															
	3271	0	3	2	1	-	-	-	-	2	1	1	-	1	-	1	-	-
		12	3	1	-	2	-	-	1	2	-	-	1	-	-	1	1	-
	Total		6															
North	3232	0	1	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-
	3237	0	4	-	1	1	2	-	1	2	1	-	1	-	-	1	2	-
	3238	0	1	-	-	-	-	1	-	1	-	-	1	-	-	-	-	-

APPENDIX H

Summary Data for Modified Chunks

Appendix H. Summary Data for Modified Chunks.

Subarea	Site	Feature No.	Total Mod. Chunks	MATERIAL Opalite	Jasper	Other	CORTEX Present	Absent
Quarry	Loc. 21	0	1	1	-	-	-	1
		1	3	3	-	-	2	1
	Total		4					
	Loc. 23	1	3	3	-	-	-	3
	Loc. 25	2	2	2	-	-	-	2
East	3170	0	1	-	-	1	-	1
		1	1	1	-	-	-	1
		7	1	1	-	-	-	1
	Total		3					
	3171	0	2	2	-	-	-	2
		1	2	2	-	-	2	-
		2	1	1	-	-	1	-
		4	1	1	-	-	1	-
	Total		6					
	3178	1	1	1	-	-	-	1
	3184	8	3	3	-	-	-	3
		12	1	1	-	-	-	1
		23	1	1	-	-	-	1
	Total		5					
	3192	1	2	2	-	-	1	1
		2	2	2	-	-	-	2
	Total		4					
	3196	1	4	4	-	-	-	4
	3203	0	2	2	-	-	1	1
	3204	0	4	4	-	-	1	3
		1	2	2	-	-	-	2
	Total		6					
West	3092	0	6	6	-	-	1	5
		1	1	1	-	-	-	1
	Total		7					
	3095	0	1	1	-	-	-	1
		6	1	-	1	-	-	1
		14	1	1	-	-	-	1
		24	1	1	-	-	1	-
	Total		4					
	3096	2	1	1	-	-	-	1
	3100	1	1	1	-	-	-	1
	3101	0	1	1	-	-	1	-
	3102	1	1	1	-	-	-	1
	3104	0	1	1	-	-	1	-

Appendix H, continued.

Subarea	Site	Feature No.	Total Mod. Chunks	MATERIAL Opalite	Jasper	Other	CORTEX Present	Absent
	3106	1	1	1	-	-	-	1
	3160	0	1	1	-	-	-	1
		1	1	1	-	-	-	1
		11	1	1	-	-	-	1
		21	1	1	-	-	-	1
	Total		4					
	3165	0	1	1	-	-	1	-
	3271	0	1	1	-	-	-	1
		18	1	1	-	-	-	1
	Total		2					
North	3237	0	3	3	-	-	1	2

APPENDIX I

Summary Statistics and Results for Debitage Mass Analysis

Appendix I.

Table 1. Mass Analysis Debitage Assemblage Characterizations of Composite Site Samples.

Site (26Ek)	Material	Characterization	Total Number	Total Weight
**** Northern Corridor**				
3228	Opalite	Mixed Bif	495	356.3
3231	Opalite	Mixed Bif	254	176.6
3232	Opalite	ESB	77	179.7
3232	Jasper	N<51	1	0.7
3234	Opalite	N<51	10	3.4
3234	Jasper	N<51	1	0.2
3237	Opalite	ESB	11329	13118.8
3237	Jasper	ESB	140	213.9
3237	Basalt	N<51	12	39.2
3237	Other	NoG3	3	9.1
3238	Opalite	Mixed Bif	3229	2501.5
3238	Jasper	N<51	30	37.3
3238	Basalt	N<51	3	4.7
3238	Other	N<51	2	0.3
3239	Opalite	Mixed Bif	1519	1473.4
3239	Jasper	N<51	6	2.7
3251	Opalite	Mixed Bif	19803	10239.4
3251	Jasper	Mixed Bif	65	53.1
3251	Basalt	N<51	3	0.4
3251	Other	Mixed Bif	59	51.5
**** Eastern Periphery**				
3170	Opalite	ESB	31038	62392.4
3170	Jasper	Core Red	465	440.0
3170	Basalt	N<51	26	91.7
3170	Other	N<51	36	162.1
3171	Opalite	Core Red	19180	180734.1
3171	Jasper	ESB	57	117.7
3171	Basalt	N<51	6	9.5
3171	Other	N<51	26	485.3
3172	Opalite	ESB	1250	1967.2
3172	Jasper	N<51	7	2.2
3172	Other	N<51	1	0.5
3173	Opalite	ESB	3452	8671.9
3173	Jasper	N<51	3	1.1
3177	Opalite	ESB	370	570.6
3178	Opalite	ESB	3736	6443.4
3178	Jasper	NoG3	1	20.3
3179	Opalite	Mixed Bif	1218	1420.9
3179	Jasper	N<51	1	0.6
3181	Opalite	ESB	3030	6248.7
3181	Jasper	N<51	24	16.6
3183	Opalite	Mixed Bif	2169	2453.2
3183	Jasper	N<51	2	0.3
3184	Opalite	ESB	53428	155807.4
3184	Jasper	Core Red	95	382.8
3184	Basalt	N<51	4	1.2
3184	Other	N<51	2	21.2
3185	Opalite	ESB	1959	3183.0
3185	Jasper	NoG3	1	8.4
3185	Other	N<51	2	0.9
3190	Opalite	ESB	8051	11098.7
3190	Jasper	N<51	13	14.9
3190	Basalt	N<51	1	0.1

Table 1 (continued)

Site (26Ek)	Material	Characterization	Total Number	Total Weight
3191	Opalite	N<51	21	71.5
3191	Other	NoG3	1	7.0
3192	Opalite	ESB	35724	67903.0
3192	Jasper	Core Red	236	1063.1
3192	Basalt	N<51	18	60.5
3192	Other	N<51	5	40.4
3193	Opalite	Core Red	3296	12204.2
3195	Opalite	Core Red	623	3983.7
3196	Opalite	Core Red	4480	21035.6
3196	Other	N<51	6	341.1
3197	Opalite	Core Red	1171	6738.0
3198	Opalite	Core Red	7129	26186.6
3198	Other	N<51	1	0.3
3200	Opalite	Core Red	240	1012.1
3201	Opalite	ESB	4061	6076.4
3202	Opalite	ESB	1060	2013.5
3203	Opalite	Core Red	388	1745.5
3204	Opalite	ESB	39171	69305.6
3204	Jasper	N<51	37	28.2
3204	Basalt	N<51	2	0.7
3204	Other	N<51	6	28.2
**** Western Periphery**				
3082	Opalite	N<51	4	17.9
3084	Opalite	Core Red	55	279.7
3084	Jasper	Core Red	244	2425.6
3090	Opalite	Core Red	95	612.4
3090	Jasper	N<51	2	2.8
3092	Opalite	ESB	98189	159677.8
3092	Jasper	ESB	6455	13464.1
3092	Basalt	Core Red	371	2585.4
3092	Other	ESB	59	88.3
3093	Opalite	ESB	2532	2911.3
3093	Jasper	N<51	1	1.8
3095	Opalite	ESB	65286	74928.0
3095	Jasper	Mixed Bif	254	172.4
3095	Basalt	N<51	35	113.3
3095	Other	N<51	2	3.8
3096	Opalite	ESB	790	996.9
3100	Opalite	Core Red	845	2883.3
3101	Opalite	ESB	925	1709.8
3101	Jasper	N<51	27	34.5
3102	Opalite	Core Red	1364	6669.8
3102	Jasper	N<51	5	7.2
3104	Opalite	Core Red	541	3807.4
3106	Opalite	ESB	10940	26236.1
3106	Jasper	N<51	15	12.7
3106	Basalt	N<51	12	28.9
3106	Other	NoG3	2	43.3
3107	Opalite	ESB	1446	4683.4
3107	Jasper	ESB	58	133.0
3114	Opalite	ESB	3772	5024.9
3115	Opalite	Mixed Bif	1785	1886.8
3115	Basalt	N<51	1	0.8
3116	Opalite	ESB	2377	3495.1
3116	Basalt	N<51	1	0.4
3116	Other	N<51	4	1.4

Table 1 (continued)

Site (26Ek)	Material	Characterization	Total Number	Total Weight
3149	Opalite	ESB	360	530.2
3149	Jasper	N<51	32	26.5
3160	Opalite	ESB	45742	61506.7
3160	Jasper	Mixed Bif	330	321.3
3160	Basalt	Core Red	57	586.1
3160	Other	N<51	9	21.2
3165	Opalite	ESB	12426	16218.2
3165	Jasper	Mixed Bif	64	81.6
3165	Basalt	N<51	9	20.2
3207	Opalite	NoG3	7	184.5
3271	Opalite	ESB	47073	63579.3
3271	Jasper	Mixed Bif	55	63.1
3271	Basalt	Core Red	238	3302.0
3271	Other	N<51	6	12.1
**** 26EK3032 Localities**				
Loc.19	Opalite	Core Red	14665	73009.6
Loc.19	Jasper	N<51	7	7.5
Loc.19	Other	N<51	1	0.7
Loc.20	Opalite	Core Red	8633	32594.7
Loc.20	Jasper	N<51	2	9.5
Loc.20	Other	ESB	168	286.6
Loc.21	Opalite	Core Red	1793	39885.1
Loc.21	Other	NoG3	1	11.4
Loc.22	Opalite	Core Red	2066	13681.1
Loc.22	Jasper	N<51	1	0.5
Loc.23	Opalite	Core Red	12828	75726.8
Loc.25	Opalite	Core Red	23315	80951.0
Loc.25	Basalt	N<51	9	63.1
Loc.25	Other	N<51	11	33.2
Loc.98	Opalite	Core Red	1286	12250.6
Loc.98	Other	NoG3	15	2.7

Characterizations:
Mixed Bif = Mixed biface
Core Red = Core reduction
ESB = Early biface, Stage 1 to Stage 3.5
LSB = Late biface, Stage 3.5+
NoG3 = Not classified, no G3 size grade items
N<51 = not classified, n<51.

Table 2. Mass Analysis Characterizations of Composite Feature Samples.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total sample wt.	n	% Fea. Sample	Est. Total Weight	Stage 3
**** Northern Corridor**										
3228	0	1	Red. locus	Opalite	LSB	48.3	135	66.67	72.4	0
3228	0	2	Red. locus	Opalite	Mixed Bif	308.0	360	100.00	308.0	0
3231	0	1	Red. locus	Opalite	Mixed Bif	176.6	254	66.67	264.9	0
3232	0	1	Red. locus	Opalite	ESB	179.7	77	80.00	224.6	0
3232	0	1	Unknown	Jasper	N<51	0.7	1	80.00	0.9	0
3234	0		Nonfeat.	Opalite	N<51	3.4	10	0.05	6800.0	5
3234	0		Nonfeat.	Jasper	N<51	0.2	1	0.05	400.0	0
3237	A		Nonfeat.	Opalite	ESB	10967.3	9553	0.00	10967.3	8
3237	C		Nonfeat.	Jasper	ESB	206.1	133	0.00	206.1	0
3237	C		Nonfeat.	Obsid.	N<51	19.0	28	0.00	19.0	0
3237	C		Nonfeat.	Basalt	N<51	38.3	8	0.00	38.3	0
3237	C		Nonfeat.	Other	NoG3	9.1	3	0.00	9.1	0
3237	C	2	Other	Opalite	ESB	2144.9	1769	69.70	3077.3	2
3237	C	2	Unknown	Jasper	N<51	7.8	7	69.70	11.2	0
3237	C	2	Unknown	Obsid.	N<51	0.2	2	69.70	0.3	0
3237	C	2	Unknown	Basalt	N<51	0.9	4	69.70	1.3	0
3237	C	3	Other	Opalite	N<51	2.3	6	0.00	2.3	0
3237	C	5	Unknown	Opalite	NoG3	4.3	1	0.00	4.3	0
3238	A		Nonfeat.	Opalite	Mixed Bif	298.9	397	0.00	298.9	0
3238	A		Nonfeat.	Jasper	N<51	10.8	13	0.00	10.8	
3238	0		Nonfeat.	Obsid.	N<51	0.4	3	0.00	0.4	0
3238	A		Nonfeat.	Other	N<51	0.3	2	0.00	0.3	0
3238	0	1	Red. locus	Opalite	Mixed Bif	2202.6	2832	57.14	3854.7	3
3238	0	1	Unknown	Jasper	N<51	26.5	17	57.14	46.4	0
3238	0	1	Unknown	Obsid.	N<51	0.4	3	57.14	0.7	0
3238	0	1	Unknown	Basalt	N<51	4.7	3	57.14	8.2	0
3239	0	1	Red. locus	Opalite	Mixed Bif	1473.4	1519	10.53	13992.4	11
3239	0	1	Unknown	Jasper	N<51	2.7	6	10.53	25.6	0
3239	0	1	Unknown	Obsid.	N<51	0.3	1	10.53	2.8	0
3251	0		Nonfeat.	Opalite	Mixed Bif	244.9	308	0.00	244.9	0
3251	0		Nonfeat.	Obsid.	N<51	1.2	3	0.00	1.2	0
3251	0	1	Other	Opalite	Mixed Bif	3986.8	8097	33.33	11961.6	9
3251	0	1	Unknown	Jasper	N<51	8.0	10	33.33	24.0	0
3251	0	1	Unknown	Obsid.	N<51	7.0	12	33.33	21.0	0
3251	0	1	Unknown	Basalt	N<51	0.4	3	33.33	1.2	0
3251	0	1	Unknown	Other	N<51	7.9	5	33.33	23.7	0
3251	0	2	Other	Opalite	Mixed Bif	3901.9	8024	16.67	23406.7	18
3251	0	6	Other		Mixed Bif	84.4	117	0.00	84.4	0
3251	0	6	Unknown	Opalite	Mixed Bif	2105.8	3374	0.00	2105.8	2
3251	0	6	Unknown	Jasper	Mixed Bif	45.1	55	0.00	45.1	0
3251	0	6	Unknown	Obsid.	N<51	14.5	41	0.00	14.5	0
3251	0	6	Unknown	Other	Mixed Bif	43.6	54	0.00	43.6	0
**** Eastern Periphery**										
3170	0		Nonfeat.	Opalite	ESB	20435.3	9919	0.00	20435.3	15
3170	0		Nonfeat.	Jasper	Core Red	374.9	453	0.00	374.9	0
3170	0		Nonfeat.	Obsid.	N<51	3.2	5	0.00	3.2	0
3170	0		Nonfeat.	Basalt	N<51	91.7	26	0.00	91.7	0
3170	0		Nonfeat.	Other	N<51	135.3	22	0.00	135.3	0
3170	0	1	Quarry fea	Opalite	Core Red	4155.0	886	0.52	799038.5	601
3170	0	1	Unknown	Jasper	N<51	60.2	9	0.52	11576.9	9

Table 2, continued.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total sample wt.	n	% Fea. Sample	Est. Total Weight	Stage 3
3170	A	8	Unknown	Opalite	ESB	31840.8	17458	40.51	78599.9	59
3170	A	8	Red. locus	Obsid.	N<51	4.0	4	40.51	9.9	0
3170	A	8	Unknown	Other	N<51	26.8	14	40.51	66.2	0
3170	0	9	Unknown	Opalite	ESB	5779.1	2659	100.00	5779.1	4
3170	0	9	Red. locus	Jasper	N<51	4.9	3	100.00	4.9	0
3170	0	9	Unknown	Obsid.	N<51	0.6	2	100.00	0.6	0
3170	0	14	Other	Opalite	ESB	182.2	116	100.00	182.2	0
3171	0		Nonfeat.	Opalite	ESB	24285.2	6705	0.00	24285.2	18
3171	0		Nonfeat.	Jasper	ESB	114.7	56	0.00	114.7	0
3171	0		Nonfeat.	Obsid.	N<51	0.7	1	0.00	0.7	0
3171	0		Nonfeat.	Basalt	N<51	9.5	6	0.00	9.5	0
3171	0		Nonfeat.	Other	N<51	4.5	1	0.00	4.5	0
3171	0	1	Red. locus	Opalite	Core Red	23661.8	1694	100.00	23661.8	18
3171	0	1	Unknown	Jasper	NoG3	3.0	1	100.00	3.0	0
3171	0	1	Unknown	Obsid.	N<51	0.1	1	100.00	0.1	0
3171	0	1	Unknown	Other	N<51	73.3	8	100.00	73.3	0
3171	0	2	Unknown	Opalite	Core Red	123799.3	8848	1.03	12019350.0	9037
3171	0	2	Quarry fea	Other	N<51	407.5	17	1.03	39563.1	30
3171	0	3	Red. locus	Opalite	Core Red	8987.8	1933	0.00	8987.8	7
3172	0	1	Red. locus	Opalite	ESB	1967.2	1250	100.00	1967.2	1
3172	0	1	Unknown	Jasper	N<51	2.2	7	100.00	2.2	0
3172	0	1	Unknown	Other	N<51	0.5	1	100.00	0.5	0
3173	0	1	Red. locus	Opalite	ESB	8671.9	3452	100.00	8671.9	7
3173	0	1	Unknown	Jasper	N<51	1.1	3	100.00	1.1	0
3173	0	1	Unknown	Obsid.	N<51	1.2	1	100.00	1.2	0
3177	0	1	Red. locus	Opalite	ESB	570.6	370	0.70	81514.3	61
3178	0	1	Red. locus	Opalite	ESB	6443.4	3736	11.36	56720.1	43
3178	0	1	Unknown	Jasper	NoG3	20.3	1	11.36	178.7	0
3179	0	1	Red. locus	Opalite	Mixed Bif	1420.9	1218	100.00	1420.9	1
3179	0	1	Unknown	Jasper	N<51	0.6	1	100.00	0.6	0
3181	0	1	Unknown	Opalite	ESB	6248.7	3030	100.00	6248.7	5
3181	0	1	Red. locus	Jasper	N<51	16.6	24	100.00	16.6	0
3181	0	1	Unknown	Obsid.	N<51	0.2	2	100.00	0.2	0
3183	0	1	Red. locus	Opalite	Mixed Bif	2453.2	2169	100.00	2453.2	2
3183	0	1	Unknown	Jasper	N<51	0.3	2	100.00	0.3	0
3183	0	1	Unknown	Obsid.	N<51	0.5	4	100.00	0.5	0
3184	0		Nonfeat.	Opalite	ESB	7258.3	3084	0.00	7258.3	5
3184	0		Nonfeat.	Jasper	N<51	16.9	17	0.00	16.9	0
3184	0		Nonfeat.	Obsid.	N<51	5.1	2	0.00	5.1	0
3184	0	1	Unknown	Opalite	N<51	16.9	9	100.00	16.9	0
3184	0	1	Other	Obsid.	N<51	15.1	2	100.00	15.1	0
3184	0	2	Red. locus	Opalite	Core Red	8797.3	1988	100.00	8797.3	7
3184	0	2	Unknown	Obsid.	N<51	0.1	1	100.00	0.1	0
3184	0	3	Red. locus	Opalite	ESB	2102.8	1096	1.39	151280.6	114
3184	0	3	Unknown	Jasper	N<51	0.5	2	1.39	36.0	0
3184	0	3	Unknown	Obsid.	N<51	6.7	3	1.39	482.0	0
3184	0	8	Red. locus	Opalite	ESB	26250.3	12617	65.63	39997.4	30
3184	0	8	Unknown	Jasper	Core Red	343.2	59	65.63	522.9	0
3184	0	8	Unknown	Obsid.	N<51	34.1	20	65.63	52.0	0
3184	0	8	Unknown	Other	NoG3	20.8	1	65.63	31.7	0
3184	0	12	Unknown	Opalite	Core Red	26325.0	6353	81.82	32174.3	24
3184	0	12	Unknown	Jasper	N<51	0.2	1	81.82	0.2	0
3184	0	12	Red. locus	Obsid.	N<51	3.8	6	81.82	4.6	0
3184	0	14	Red. locus	Opalite	ESB	3332.4	2015	100.00	3332.4	3

Table 2, continued.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total sample wt.	n	% Fea. Sample	Est. Total Weight	Stage 3
3184	0	14	Unknown	Jasper	N<51	0.3	1	100.00	0.3	0
3184	0	19	Unknown	Opalite	ESB	18016.6	9021	100.00	18016.6	14
3184	0	19	Red. locus	Jasper	N<51	9.5	13	100.00	9.5	0
3184	0	19	Unknown	Obsid.	Mixed Bif	61.6	67	100.00	61.6	0
3184	0	19	Unknown	Basalt	N<51	1.2	4	100.00	1.2	0
3184	0	19	Unknown	Other	N<51	0.4	1	100.00	0.4	0
3184	0	20	Red. locus	Opalite	Core Red	43587.9	5378	0.00	43587.9	33
3184	0	20	Unknown	Jasper	NoG3	12.2	2	0.00	12.2	0
3184	0	23	Red. locus	Opalite	ESB	20119.9	11867	39.68	50705.4	38
3184	0	23	Unknown	Obsid.	N<51	0.1	1	39.68	0.3	0
3185	0	1	Red. locus	Opalite	ESB	3183.0	1959	100.00	3183.0	2
3185	0	1	Unknown	Jasper	NoG3	8.4	1	100.00	8.4	0
3185	0	1	Unknown	Obsid.	N<51	0.2	1	100.00	0.2	0
3185	0	1	Unknown	Other	N<51	0.9	2	100.00	0.9	0
3190	0	1	Unknown	Opalite	ESB	6644.4	5054	90.32	7356.5	6
3190	0	1	Unknown	Jasper	N<51	4.3	11	90.32	4.8	0
3190	0	1	Red. locus	Obsid.	N<51	54.6	41	90.32	60.5	0
3190	0	1	Unknown	Basalt	N<51	0.1	1	90.32	0.1	0
3190	0	2	Red. locus	Opalite	ESB	4454.3	2997	100.00	4454.3	3
3190	0	2	Unknown	Jasper	NoG3	10.6	2	100.00	10.6	0
3190	0	2	Unknown	Obsid.	NoG3	2.1	3	100.00	2.1	0
3191	0	1	Red. locus	Opalite	N<51	71.5	21	25.00	286.0	0
3191	0	1	Unknown	Obsid.	N<51	0.8	1	25.00	3.2	0
3191	0	1	Unknown	Other	NoG3	7.0	1	25.00	28.0	0
3192	0	1	Unknown	Opalite	ESB	43778.7	20823	100.00	43778.7	33
3192	0	1	Unknown	Jasper	Core Red	988.1	209	100.00	988.1	1
3192	0	1	Other	Obsid.	N<51	6.3	12	100.00	6.3	0
3192	0	1	Unknown	Basalt	N<51	54.3	10	100.00	54.3	0
3192	0	1	Unknown	Other	N<51	0.5	2	100.00	0.5	0
3192	0	2	Unknown	Opalite	ESB	24124.3	14901	1.39	1735561.2	1305
3192	0	2	Unknown	Jasper	N<51	75.0	27	1.39	5395.7	4
3192	0	2	Other	Obsid.	N<51	20.2	28	1.39	1453.2	1
3192	0	2	Unknown	Basalt	N<51	6.2	8	1.39	446.0	0
3192	0	2	Unknown	Other	N<51	39.9	3	1.39	2870.5	2
3193	0	1	Quarry fea	Opalite	Core Red	1615.3	290	0.44	367113.6	276
3193	0	4	Red. locus	Opalite	ESB	10588.9	3006	66.67	15882.6	12
3195	0	1	Quarry fea	Opalite	Core Red	1011.6	171	0.13	778153.8	585
3195	0	2	Quarry fea	Opalite	Core Red	2972.1	452	0.57	521421.1	392
3196	0	1	Other	Opalite	Core Red	11564.1	3035	0.39	2965153.8	2229
3196	0	1	Unknown	Other	N<51	341.1	6	0.39	87461.5	66
3196	0	2	Quarry fea	Opalite	Core Red	9471.5	1445	0.12	7892916.7	5935
3197	0		Nonfeat.	Opalite	Core Red	1282.4	267	0.00	1282.4	1
3197	0	1	Quarry fea	Opalite	Core Red	3029.4	499	1.76	172125.0	129
3197	0	5	Other	Opalite	Core Red	1694.4	144	0.00	1694.4	1
3197	0	10	Red. locus	Opalite	Core Red	731.8	261	0.00	731.8	1
3198	0	1	Unknown	Opalite	Core Red	17859.6	5717	100.00	17859.6	13
3198	0	1	Red. locus	Obsid.	N<51	38.8	39	100.00	38.8	0
3198	0	1	Unknown	Other	N<51	0.3	1	100.00	0.3	0
3198	0	2	Red. locus	Opalite	Core Red	1939.1	598	100.00	1939.1	1
3198	0	9	Red. locus	Opalite	ESB	247.2	107	0.84	29428.6	22
3198	0	14	Quarry fea	Opalite	Core Red	6140.7	707	1.82	337401.1	254
3200	0	1	Quarry fea	Opalite	Core Red	1012.1	240	0.31	326483.9	245
3201	0	1	Red. locus	Opalite	Mixed Bif	1517.2	1257	1.96	77408.2	58
3201	0	1	Unknown	Obsid.	N<51	12.2	23	1.96	622.4	0

Table 2, continued.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total sample wt.	n	% Fea. Sample	Est. Total Weight	Stage 3
3201	0	2	Red. locus	Opalite	Mixed Bif	2760.0	2616	4.64	59482.8	45
3201	0	3	Red. locus	Opalite	N<51	43.3	24	0.00	43.3	0
3201	0	4	Quarry fea	Opalite	Core Red	1755.9	164	0.22	798136.4	600
3202	0	1	Red. locus	Opalite	ESB	2013.5	1060	6.25	32216.0	24
3203	0		Nonfeat.	Opalite	Core Red	1745.5	388	0.05	3491000.0	2625
3204	0	1	Unknown	Opalite	ESB	69305.6	39171	6.25	1108889.6	834
3204	0	1	Red. locus	Jasper	N<51	28.2	37	6.25	451.2	0
3204	0	1	Unknown	Obsid.	N<51	1.2	7	6.25	19.2	0
3204	0	1	Unknown	Basalt	N<51	0.7	2	6.25	11.2	0
3204	0	1	Unknown	Other	N<51	28.2	6	6.25	451.2	0
**** Western Periphery**										
3082	0	2	Red. locus	Opalite	N<51	17.9	4	3.75	477.3	0
3084	0	1	Quarry fea	Opalite	N<51	34.2	32	0.68	5029.4	4
3084	0	1	Unknown	Jasper	Core Red	758.3	120	0.68	111514.7	84
3084	0	2	Unknown	Opalite	N<51	245.5	23	2.08	11802.9	9
3084	0	2	Unknown	Jasper	Core Red	1667.3	124	2.08	80158.7	60
3090	0		Nonfeat.	Opalite	Core Red	612.4	95	0.00	612.4	0
3090	0		Nonfeat.	Jasper	N<51	2.8	2	0.00	2.8	0
3092	0		Nonfeat.	Opalite	ESB	142812.1	92356	0.00	142812.1	107
3092	0		Nonfeat.	Jasper	ESB	11657.3	5922	0.00	11657.3	9
3092	0		Nonfeat.	Obsid.	Mixed Bif	61.0	69	0.00	61.0	0
3092	0		Nonfeat.	Basalt	Core Red	2153.8	346	0.00	2153.8	2
3092	0		Nonfeat.	Other	Mixed Bif	62.2	58	0.00	62.2	0
3092	0	6	Quarry fea	Opalite	ESB	749.5	202	0.00	749.5	1
3092	0	6	Unknown	Jasper	N<51	21.5	10	0.00	21.5	0
3092	0	7	Unknown	Opalite	Core Red	4019.1	880	0.00	4019.1	3
3092	0	7	Unknown	Jasper	N<51	188.3	42	0.00	188.3	0
3092	0	7	Red. locus	Basalt	N<51	288.9	4	0.00	288.9	0
3092	0	9	Other	Opalite	ESB	107.7	65	0.00	107.7	0
3092	0	9	Unknown	Jasper	N<51	0.7	2	0.00	0.7	0
3092	0	9	Unknown	Basalt	N<51	1.8	1	0.00	1.8	0
3092	0	12	Other	Opalite	ESB	2136.0	56	0.00	2136.0	2
3092	0	12	Unknown	Jasper	NoG3	428.4	8	0.00	428.4	0
3092	0	12	Unknown	Basalt	NoG3	65.2	1	0.00	65.2	0
3092	0	13	Red. locus	Opalite	Mixed Bif	2398.5	61	0.00	2398.5	2
3092	0	13	Unknown	Jasper	N<51	446.9	19	0.00	446.9	0
3092	0	13	Unknown	Basalt	NoG3	42.1	1	0.00	42.1	0
3092	0	13	Unknown	Other	NoG3	26.1	1	0.00	26.1	0
3092	0	14	Red. locus	Opalite	ESB	3001.9	2067	0.00	3001.9	2
3092	0	14	Unknown	Jasper	ESB	366.1	238	0.00	366.1	0
3092	0	14	Unknown	Basalt	N<51	1.3	5	0.00	1.3	0
3092	0	15	Red. locus	Opalite	ESB	124.5	84	0.00	124.5	0
3092	0	15	Unknown	Jasper	N<51	127.2	50	0.00	127.2	0
3092	0	16	Unknown	Opalite	Mixed Bif	96.9	102	0.00	96.9	0
3092	0	16	Unknown	Jasper	N<51	0.6	2	0.00	0.6	0
3092	0	17	Unknown	Opalite	N<51	22.3	31	0.00	22.3	0
3092	0	17	Unknown	Jasper	N<51	2.1	2	0.00	2.1	0
3092	0	18	Unknown	Opalite	N<51	197.4	35	0.00	197.4	0
3092	0	18	Unknown	Jasper	N<51	0.6	1	0.00	0.6	0
3092	0	20	Unknown	Opalite	ESB	194.7	105	0.00	194.7	0
3092	0	20	Other	Jasper	N<51	5.2	6	0.00	5.2	0
3092	0	21	Red. locus	Opalite	ESB	1203.8	802	0.00	1203.8	1
3092	0	21	Unknown	Jasper	N<51	58.8	41	0.00	58.8	0
3092	0	21	Unknown	Basalt	NoG3	9.6	1	0.00	9.6	0
3092	0	23	Red. locus	Opalite	ESB	2410.9	1249	0.00	2410.9	2

Table 2, continued.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total sample wt.	n	% Fea. Sample	Est. Total Weight	Stage 3
3092	0	23	Unknown	Jasper	ESB	160.1	110	0.00	160.1	0
3092	0	23	Unknown	Obsid.	N<51	0.7	2	0.00	0.7	0
3092	0	23	Unknown	Basalt	N<51	22.3	10	0.00	22.3	0
3092	0	24	Quarry fea	Opalite	ESB	202.5	94	0.00	202.5	0
3092	0	24	Unknown	Jasper	N<51	0.3	2	0.00	0.3	0
3092	0	24	Unknown	Basalt	N<51	0.4	2	0.00	0.4	0
3093	0	4	Unknown	Opalite	ESB	2911.3	2532	100.00	2911.3	2
3093	0	4	Unknown	Jasper	N<51	1.8	1	100.00	1.8	0
3093	0	4	Unknown	Obsid.	N<51	9.1	18	100.00	9.1	0
3095	0	6	Red. locus	Opalite	ESB	4533.8	3977	0.00	4533.8	3
3095	0	6	Unknown	Obsid.	N<51	0.8	2	0.00	0.8	0
3095	0	10	Unknown	Opalite	ESB	8717.6	5231	0.38	2294105.3	1725
3095	0	10	Unknown	Jasper	N<51	0.3	1	0.38	78.9	0
3095	0	10	Unknown	Obsid.	N<51	8.5	7	0.38	2236.8	2
3095	0	10	Unknown	Other	NoG3	3.6	1	0.38	947.4	1
3095	0	15	Unknown		N<51	5.5	6	25.00	22.0	0
3095	0	15	Unknown	Opalite	Mixed Bif	7673.1	7119	25.00	30692.4	23
3095	0	15	Unknown	Obsid.	N<51	9.1	14	25.00	36.4	0
3095	0	15	Unknown	Basalt	NoG3	0.0	0	25.00	0.0	0
3095	0	15	Unknown	Other	N<51	0.2	1	25.00	0.8	0
3095	0	19	Unknown	Opalite	ESB	18218.8	15057	8.75	208214.9	157
3095	0	19	Unknown	Jasper	N<51	21.3	17	8.75	243.4	0
3095	0	19	Unknown	Obsid.	N<51	17.9	18	8.75	204.6	0
3095	0	19	Unknown	Basalt	N<51	112.9	34	8.75	1290.3	1
3095	0	22	Unknown	Opalite	Mixed Bif	17364.3	15716	40.00	43410.8	33
3095	0	22	Unknown	Jasper	N<51	36.6	38	40.00	91.5	0
3095	0	22	Unknown	Obsid.	Mixed Bif	41.9	64	40.00	104.8	0
3095	0	22	Unknown	Basalt	N<51	0.4	1	40.00	1.0	0
3095	0	24	Other	Opalite	Mixed Bif	18420.4	18186	33.33	55266.7	42
3095	0	24	Unknown	Jasper	Mixed Bif	114.2	198	33.33	342.6	0
3095	0	24	Unknown	Obsid.	N<51	14.9	33	33.33	44.7	0
3096	0	1	Red. locus	Opalite	ESB	996.9	790	100.00	996.9	1
3100	0	1	Red. locus	Opalite	Core Red	2883.3	845	100.00	2883.3	2
3101	0		Nonfeat.	Opalite	ESB	1709.8	925	0.03	5699333.3	4285
3101	1		Nonfeat.	Jasper	N<51	34.5	27	0.03	115000.0	86
3101	1		Nonfeat.	Obsid.	NoG3	0.0	0	0.03	0.0	0
3102	0	1	Unknown	Opalite	Core Red	6669.8	1364	100.00	6669.8	5
3102	0	1	Red. locus	Jasper	N<51	7.2	5	100.00	7.2	0
3104	0		Nonfeat.	Opalite	Core Red	3807.4	541	0.00	3807.4	3
3106	0	1	Red. locus	Opalite	ESB	14139.3	4430	37.50	37704.8	28
3106	0	1	Unknown	Basalt	NoG3	1.6	1	37.50	4.3	0
3106	0	4	Unknown	Opalite	ESB	11206.8	6269	100.00	11206.8	8
3106	0	4	Other	Jasper	N<51	11.3	13	100.00	11.3	0
3106	0	4	Unknown	Obsid.	N<51	6.7	7	100.00	6.7	0
3106	0	4	Unknown	Basalt	N<51	26.2	10	100.00	26.2	0
3106	0	4	Unknown	Other	NoG3	43.3	2	100.00	43.3	0
3106	0	700	Unknown	Opalite	ESB	890.0	241	999.99	890.0	1
3106	0	700	Unknown	Jasper	N<51	1.4	2	999.99	1.4	0
3106	0	700	Unknown	Basalt	NoG3	1.1	1	999.99	1.1	0
3107	0		Nonfeat.	Opalite	ESB	100.5	53	0.00	100.5	0
3107	0		Nonfeat.	Jasper	ESB	131.9	54	0.00	131.9	0
3107	0	1	Red. locus	Opalite	Core Red	4582.9	1393	100.00	4582.9	3
3107	0	1	Unknown	Jasper	N<51	1.1	4	100.00	1.1	0

Table 2, continued.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total wt.	sample n	% Fea. Sample	Est. Total Weight	Stage 3
3114	0	1	Red. locus	Opalite	ESB	5024.9	3772	90.91	5527.3	4
3115	0	1	Red. locus	Opalite	Mixed Bif	1886.8	1785	62.50	3018.9	2
3115	0	1	Unknown	Obsid.	N<51	0.1	1	62.50	0.2	0
3115	0	1	Unknown	Basalt	N<51	0.8	1	62.50	1.3	0
3116	0	1	Red. locus	Opalite	ESB	3495.1	2377	100.00	3495.1	3
3116	0	1	Unknown	Basalt	N<51	0.4	1	100.00	0.4	0
3116	0	1	Unknown	Other	N<51	1.4	4	100.00	1.4	0
3149	0		Nonfeat.	Opalite	ESB	286.1	86	0.00	286.1	0
3149	0		Nonfeat.	Jasper	N<51	25.9	31	0.00	25.9	0
3149	0	2	Other	Opalite	Mixed Bif	244.1	274	100.00	244.1	0
3149	0	2	Unknown	Jasper	N<51	0.6	1	100.00	0.6	0
3149	0	2	Unknown	Obsid.	N<51	0.7	1	100.00	0.7	0
3160	A		Nonfeat.	Opalite E	B	9524.5	7715	0.00	9524.5	7
3160	A		Nonfeat.	Jasper	Mixed Bif	157.3	145	0.00	157.3	0
3160	A		Nonfeat.	Obsid.	N<51	1.1	4	0.00	1.1	0
3160	C		Nonfeat.	Basalt	N<51	15.0	17	0.00	15.0	0
3160	C	1	Unknown	Opalite	ESB	27048.7	19384	43.00	62904.0	47
3160	C	1	Unknown	Jasper	N<51	16.8	46	43.00	39.1	0
3160	C	1	Unknown	Obsid.	ESB	72.1	55	43.00	167.7	0
3160	C	1	Unknown	Basalt	N<51	551.6	32	43.00	1282.8	1
3160	C	1	Unknown	Other	N<51	10.3	6	43.00	24.0	0
3160	C	2	Red. locus	Opalite	Mixed Bif	843.1	1150	85.11	990.6	1
3160	C	3	Red. locus	Opalite	ESB	4621.1	2247	100.00	4621.1	3
3160	C	3	Unknown	Jasper	N<51	1.5	3	100.00	1.5	0
3160	C	11	Red. locus	Opalite	Core Red	3869.4	1238	0.00	3869.4	3
3160	C	11	Unknown	Jasper	NoG3	6.6	2	0.00	6.6	0
3160	C	11	Unknown	Basalt	N<51	14.6	4	0.00	14.6	0
3160	C	11	Unknown	Other	N<51	10.9	3	0.00	10.9	0
3160	C	12	Red. locus	Opalite	ESB	4177.9	3340	12.86	32487.6	24
3160	C	12	Unknown	Jasper	N<51	67.7	46	12.86	526.4	0
3160	C	12	Unknown	Obsid.	N<51	0.3	2	12.86	2.3	0
3160	C	12	Unknown	Basalt	N<51	4.4	2	12.86	34.2	0
3160	C	14	Red. locus	Opalite	Mixed Bif	2271.4	2841	6.30	36054.0	27
3160	C	14	Unknown	Jasper	N<51	2.0	7	6.30	31.7	0
3160	C	14	Unknown	Obsid.	N<51	4.6	16	6.30	73.0	0
3160	A	17	Red. locus	Opalite	Mixed Bif	1816.5	2411	2.72	66783.1	50
3160	A	17	Unknown	Jasper	N<51	2.6	27	2.72	95.6	0
3160	B	20	Unknown	Opalite	Mixed Bif	1055.1	886	2.70	39077.8	29
3160	B	20	Unknown	Jasper	N<51	7.8	7	2.70	288.9	0
3160	A	23	Unknown	Opalite	ESB	4540.1	3945	100.00	4540.1	3
3160	A	23	Unknown	Jasper	N<51	47.2	38	100.00	47.2	0
3160	A	23	Unknown	Basalt	N<51	0.5	2	100.00	0.5	0
3160	A	24	Other	Opalite	ESB	1131.9	475	0.00	1131.9	1
3160	A	24	Unknown	Jasper	N<51	11.8	9	0.00	11.8	0
3160	C	25	Other	Opalite	Core Red	607.0	110	0.00	607.0	0
3165	0		Nonfeat.	Opalite	ESB	4892.8	3745	0.00	4892.8	4
3165	A		Nonfeat.	Jasper	N<51	56.9	50	0.00	56.9	0
3165	A		Nonfeat.	Obsid.	N<51	3.5	11	0.00	3.5	0
3165	A		Nonfeat.	Basalt	N<51	20.0	8	0.00	20.0	0
3165	0	1	Other	Opalite	Mixed Bif	1561.7	1710	80.00	1952.1	1
3165	0	2	Unknown	Opalite	ESB	9763.7	6971	100.00	9763.7	7
3165	0	2	Other	Jasper	N<51	24.7	14	100.00	24.7	0
3165	0	2	Unknown	Basalt	N<51	0.2	1	100.00	0.2	0
3207	0		Nonfeat.	Opalite	NoG3	184.5	7	0.05	369000.0	277
3271	A		Nonfeat.	Opalite	ESB	2566.0	1626	0.00	2566.0	2
3271	A		Nonfeat.	Jasper	N<51	40.8	39	0.00	40.8	0
3271	A		Nonfeat.	Obsid.	N<51	5.5	8	0.00	5.5	0

Table 2, continued.

Site (26Ek)	Locus	Fea. No.	Type	Material	Character-ization	Total sample wt.	n	% Fea. Sample	Est. Total Weight	Stage 3
3271	A		Nonfeat.	Basalt	N<51	20.6	8	0.00	20.6	0
3271	C	2	Unknown	Opalite	ESB	1542.2	1214	100.00	1542.2	1
3271	C	2	Red. locus	Obsid.	N<51	2.4	4	100.00	2.4	0
3271	B	12	Unknown	Opalite	ESB	50019.3	36214	100.00	50019.3	38
3271	B	12	Unknown	Jasper	NoG3	6.9	2	100.00	6.9	0
3271	B	12	Unknown	Obsid.	N<51	23.3	32	100.00	23.3	0
3271	B	12	Unknown	Basalt	Core Red	3267.5	214	100.00	3267.5	2
3271	B	12	Unknown	Other	N<51	3.4	2	100.00	3.4	0
3271	B	18	Other	Opalite	Mixed Bif	2153.8	2874	40.00	5384.5	4
3271	B	18	Unknown	Jasper	N<51	12.5	9	40.00	31.3	0
3271	B	18	Unknown	Obsid.	NoG3	2.1	1	40.00	5.3	0
3271	A	19	Unknown	Opalite	ESB	856.8	582	0.00	856.8	1
3271	A	19	Unknown	Jasper	N<51	2.7	4	0.00	2.7	0
3271	A	19	Unknown	Obsid.	NoG3	0.0	0	0.00	0.0	0
3271	A	19	Red. locus	Basalt	N<51	9.0	10	0.00	9.0	0
3271	A	21	Unknown	Opalite	ESB	6441.2	4563	83.33	7729.7	6
3271	A	21	Unknown	Jasper	N<51	0.2	1	83.33	0.2	0
3271	A	21	Red. locus	Obsid.	N<51	2.5	4	83.33	3.0	0
3271	A	21	Unknown	Basalt	N<51	4.9	6	83.33	5.9	0
3271	A	21	Unknown	Other	N<51	8.7	4	83.33	10.4	0
**** 26EK3032 Localities**										
Loc.19	0	1	Quarry fea	Opalite	Core Red	73009.6	14665	3.14	2325146.5	1748
Loc.19	0	1	Unknown	Jasper	N<51	7.5	7	3.14	238.9	0
Loc.19	0	1	Unknown	Other	N<51	0.7	1	3.14	22.3	0
Loc.20	0	1	Red. locus	Opalite	ESB	21172.6	5752	57.14	37053.9	28
Loc.20	0	1	Unknown	Jasper	N<51	1.4	1	57.14	2.5	0
Loc.20	0	1	Unknown	Other	ESB	286.6	168	57.14	501.6	0
Loc.20	0	2	Red. locus	Opalite	Core Red	4306.7	1023	40.00	10766.8	8
Loc.20	0	3	Red. locus	Opalite	Core Red	7115.4	1858	7.69	92528.0	70
Loc.20	0	3	Unknown	Jasper	NoG3	8.1	1	7.69	105.3	0
Loc.21	0	1	Red. locus	Opalite	Core Red	39885.1	1793	100.00	39885.1	30
Loc.21	0	1	Unknown	Other	NoG3	11.4	1	100.00	11.4	0
Loc.22	0	1	Red. locus	Opalite	Core Red	13681.1	2066	66.67	20520.6	15
Loc.22	0	1	Unknown	Jasper	N<51	0.5	1	66.67	0.7	0
Loc.23	0	1	Unknown	Opalite	Core Red	75726.8	12828	10.00	757268.0	569
Loc.23	0	1	Red. locus	Obsid.	N<51	8.8	5	10.00	88.0	0
Loc.25	0	2	Red. locus	Opalite	ESB	57984.3	20678	100.00	57984.3	44
Loc.25	0	2	Unknown	Basalt	N<51	63.1	9	100.00	63.1	0
Loc.25	0	2	Unknown	Other	N<51	20.3	8	100.00	20.3	0
Loc.25	0	5	Red. locus	Opalite	Core Red	22966.7	2637	17.39	132068.4	99
Loc.25	0	5	Unknown	Other	N<51	12.9	3	17.39	74.2	0
Loc.98	0	1	Quarry fea	Opalite	Core Red	12250.6	1286	1.11	1103657.7	830
Loc.98	0	1	Unknown	Other	NoG3	52.7	1	1.11	4747.7	4

Feature Type:
- Red. locus = reduction locus/lithic scatter
- Quarry fea = quarry pit, bedrock outcrop quarry, cobble quarry
- Unknown = various, not recorded in field data
- Other = hearth, living surface, presumed non-reduction features
- Nonfeat. = non-feature context (general site or locality area)

Characterizations:
- Core Red = Core reduction
- ESB = Early biface, Stage 1 to Stage 3.5
- LSB = Late biface, Stage 3.5+
- EdgeMain = Edge maintenance and resharpening
- NoG3 = not classified, no G3 size grade items
- Mixed Bif = Mixed biface, Stage 1 to Stage 4+
- N<51 = not classified, n<51

Appendix I.

Table 3. Mass Analysis Debitage Sample Characterizations of Feature Strata.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
****Site 26Ek3032, Locality 23**								
1	1	1	2599	74	Opalite	Core Red	595	1243.4
1	1	1	2599	080	Opalite	Core Red	1063	1379.4
1	1	1	2599	086	Opalite	Core Red	954	1724.7
1	1	8	2599	073	Opalite	ESB	888	848.0
1	1	1	2599	078	Opalite	ESB	1684	1876.4
1	1	1	2599	102	Opalite	Core Red	646	2077.4
1	1	1	2599	103	Opalite	Core Red	727	751.1
1	1	2	2599	085	Opalite	Core Red	1679	1115.0
1	1	2	2599	083	Opalite	Core Red	357	609.3
1	1	2	2599	101	Opalite	ESB	645	851.2
1	1	2	2599	082	Opalite	Core Red	253	2333.0
1	1	3	2599	079	Opalite	ESB	1049	508.1
1	1	3	2599	092	Opalite	Core Red	1494	1632.2
1	1	3	2599	087	Opalite	Core Red	276	1399.1
1	1	3	2599	094	Opalite	Core Red	1317	1705.6
1	1	3	2599	088	Opalite	Core Red	910	1043.1
1	1	3	2599	095	Opalite	Core Red	785	2890.3
1	1	4	2599	090	Opalite	ESB	2215	2822.3
1	1	4	2599	089	Opalite	Core Red	3710	2083.1
1	1	1	2599	102	Other	NoG3	2	0.5
1	1	1	2599	103	Other	NoG3	2	0.1
1	1	2	2599	085	Other	NoG3	5	5.5
1	1	2	2599	083	Other	NoG3	1	0.0
1	1	3	2599	087	Other	NoG3	1	0.0
**** 26Ek3084**								
1	2	1	2599	910	Opalite	NoG3	1	665.1
1	2	1	2599	920	Opalite	NoG3	5	8.6
1	2	6	2599	917	Jasper	Core Red	91	3356.6
1	2	1	2599	915	Jasper	Core Red	137	1032.1
1	2	1	2599	905	Jasper	Core Red	325	1573.7
1	2	1	2599	920	Jasper	Core Red	1264	3457.5
1	2	1	2599	914	Jasper	Core Red	785	1035.8
1	2	2	2599	904	Jasper	Core Red	921	3598.6
1	2	2	2599	903	Jasper	Core Red	1964	2261.1
1	2	3	2599	900	Jasper	NoG3	2068	799.8
1	2	3	2599	921	Jasper	Core Red	610	3414.1
1	2	3	2599	922	Jasper	NoG3	1	82.7
1	2	6	2599	916	Basalt	NoG3	1	1595.3
1	2	3	2599	921	Basalt	NoG3	4	65.1
**** 26Ek3170**								
1	1	1	2599	100	Opalite	Core Red	761	1347.1
1	1	2	2599	098	Opalite	Core Red	1193	1953.5
1	1	2	2599	107	Opalite	Mixed Bif	424	109.9
1	1	2	2599	108	Opalite	Core Red	880	2007.0
1	1	2	2599	110	Opalite	Core Red	1289	3611.5
1	1	3	2599	099	Opalite	Core Red	644	1796.3
1	1	3	2599	109	Opalite	Core Red	354	2613.6
1	1	3	2599	112	Opalite	Core Red	950	1327.0
1	1	7	2599	111	Opalite	Core Red	79	335.0
1	1	1	2599	100	Jasper	N<51	7	4.9

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
1	1	2	2599	110	Jasper	NoG3	2	0.3
1	1	3	2599	099	Jasper	NoG3	15	1.1
1	1	1	2599	100	Basalt	NoG3	2	0.1
1	1	2	2599	110	Basalt	NoG3	1	0.1
**** 26Ek3171**								
2	1	2	2599	113	Opalite	Core Red	253	2907.4
2	1	2	2599	115	Opalite	Core Red	671	2250.2
2	1	2	2599	117	Opalite	Core Red	107	114.0
2	1	2	2599	118	Opalite	ESB	548	363.7
2	1	2	2599	121	Opalite	Core Red	290	639.8
2	1	3	2599	114	Opalite	N<51	20	2.1
2	1	5	2599	125	Opalite	ESB	173	96.5
2	1	7	2599	119	Opalite	Core Red	244	1742.2
2	1	8	2599	116	Opalite	Core Red	381	1236.0
2	1	9	2599	126	Opalite	ESB	259	115.3
2	1	1	2599	124	Opalite	Core Red	51	24.8
2	1	1	2599	122	Opalite	Core Red	2249	953.7
2	1	1	2599	123	Opalite	Core Red	146	195.6
2	1	1	2599	120	Opalite	ESB	143	175.7
2	1	2	2599	113	Obsidian	NoG3	1	0.1
2	1	1	2599	123	Other	NoG3	1	11.6
**** 26Ek3195**								
2	1	1	2599	505	Opalite	N<51	28	5.6
2	1	2	2599	506	Opalite	ESB	632	300.3
2	1	3	2599	507	Opalite	Core Red	291	632.6
2	1	4	2599	508	Opalite	ESB	346	181.5
2	1	6	2599	509	Opalite	Mixed Bif	1019	300.9
2	1	7	2599	510	Opalite	Core Red	354	558.2
2	1	8	2599	511	Opalite	Core Red	1329	1191.8
2	1	9	2599	512	Opalite	ESB	1543	441.1
2	1	1	2599	513	Opalite	ESB	3938	832.6
2	1	1	2599	514	Opalite	Core Red	817	2861.9
2	1	1	2599	515	Opalite	Core Red	1506	1431.7
2	1	1	2599	516	Opalite	ESB	1142	593.9
2	1	1	2599	518	Opalite	ESB	3215	1029.9
2	1	1	2599	517	Opalite	ESB	5170	2021.0
2	2	1	2599	521	Opalite	ESB	2256	1307.1
2	1	2	2599	519	Opalite	Mixed Bif	946	185.9
2	2	2	2599	520	Opalite	Core Red	1661	2491.5
2	2	2	2599	525	Opalite	ESB	1422	391.0
2	2	2	2599	526	Opalite	Core Red	3152	1365.7
2	2	2	2599	522	Opalite	Core Red	459	2090.5
2	2	3	2599	527	Opalite	Core Red	1373	3490.9
2	2	3	2599	524	Opalite	Core Red	1770	2725.9
2	2	3	2599	523	Opalite	ESB	843	637.4
2	2	3	2599	533	Opalite	Core Red	852	1539.5
2	2	3	2599	532	Opalite	Mixed Bif	1706	439.8
2	2	4	2599	531	Opalite	Core Red	410	1951.5
2	2	4	2599	530	Opalite	ESB	442	256.2
2	2	4	2599	528	Opalite	ESB	1828	2027.6
2	2	4	2599	529	Opalite	Core Red	1067	1017.4
2	2	4	2599	534	Opalite	ESB	755	931.5
2	1	2	2599	506	Other	NoG3	1	8.0
2	1	1	2599	513	Other	ESB	232	55.3

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
2	1	1	2599	515	Other	N<51	1	0.5
2	1	1	2599	518	Other	NoG3	7	3.2
2	1	1	2599	517	Other	NoG3	11	2.1
2	2	1	2599	521	Other	N<51	24	4.5
2	2	2	2599	520	Other	N<51	4	1.3
2	2	2	2599	525	Other	N<51	4	1.5
2	2	2	2599	526	Other	EdgeMain	90	12.0
2	2	3	2599	524	Other	N<51	1	0.4
2	2	3	2599	533	Other	NoG3	1	74.8
2	2	4	2599	528	Other	N<51	6	32.9
2	2	4	2599	529	Other	N<51	4	1.6
4	1	1	2599	504	Opalite	Core Red	357	1706.7
4	1	2	2599	502	Opalite	ESB	337	224.7
4	1	3	2599	503	Opalite	Core Red	248	664.3
4	1	4	2599	501	Opalite	Core Red	335	319.6
4	1	5	2599	500	Opalite	ESB	294	238.5
**** 26Ek3208**								
3	1	u	2599	157	Opalite	Core Red	2581	2597.4
3	1	u	2599	158	Opalite	Core Red	1001	3303.3
3	1	u	2599	173	Opalite	Core Red	3798	5958.5
3	2	1	2599	039	Opalite	ESB	1619	1738.9
3	2	2	2599	040	Opalite	Core Red	852	2178.9
3	2	3	2599	056	Opalite	ESB	1045	1321.2
3	1	3	2599	199	Opalite	Core Red	2915	1712.1
3	3	3	2599	204	Opalite	Core Red	999	2078.8
3	2	4	2599	057	Opalite	ESB	2967	1982.8
3	2	4	2599	149	Opalite	Core Red	1549	3530.4
3	1	4	2599	192	Opalite	Core Red	1759	3382.2
3	1	4	2599	200	Opalite	Core Red	2114	2023.6
3	3	4	2599	233	Opalite	Core Red	648	3103.7
3	2	5	2599	058	Opalite	Core Red	995	2241.7
3	3	5	2599	203	Opalite	Core Red	1568	1322.0
3	2	6	2599	041	Opalite	Core Red	2261	2056.0
3	3	6	2599	202	Opalite	Core Red	815	1690.0
3	2	7	2599	042	Opalite	Core Red	1868	1593.1
3	3	7	2599	201	Opalite	NoG3	8	65.1
3	2	8	2599	043	Opalite	Core Red	3508	2152.6
3	3	9	2599	230	Opalite	Core Red	599	2267.3
3	2	1	2599	045	Opalite	Core Red	844	3515.9
3	2	1	2599	046	Opalite	Core Red	1238	2852.0
3	3	1	2599	228	Opalite	Core Red	837	1980.4
3	2	1	2599	059	Opalite	Core Red	2155	2201.6
3	1	1	2599	188	Opalite	Core Red	2507	3067.3
3	3	1	2599	227	Opalite	Core Red	2486	1943.9
3	2	1	2599	060	Opalite	Core Red	1140	1950.5
3	3	1	2599	226	Opalite	Core Red	785	1924.1
3	2	1	2599	061	Opalite	ESB	2323	1411.5
3	3	1	2599	210	Opalite	Core Red	2117	2382.9
3	3	1	2599	215	Opalite	Core Red	905	2234.9
3	3	1	2599	225	Opalite	Core Red	2093	2941.3
3	2	1	2599	044	Opalite	Core Red	1531	2339.8
3	3	1	2599	224	Opalite	ESB	3737	1567.7
3	3	1	2599	223	Opalite	Core Red	592	468.7
3	2	1	2599	047	Opalite	Core Red	519	2884.1
3	3	1	2599	205	Opalite	Core Red	2692	1270.8

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
3	2	1	2599	048	Opalite	ESB	2372	917.1
3	1	1	2599	216	Opalite	Core Red	2732	4907.1
3	3	1	2599	221	Opalite	Core Red	985	2401.7
3	2	1	2599	050	Opalite	Core Red	3031	2096.6
3	2	2	2599	049	Opalite	Core Red	2932	2203.3
3	2	2	2599	051	Opalite	Core Red	228	1413.4
3	1	2	2599	174	Opalite	Core Red	1007	2966.2
3	1	2	2599	175	Opalite	Core Red	1015	3395.2
3	1	2	2599	156	Opalite	Core Red	604	1756.8
3	2	2	2599	064	Opalite	Core Red	1623	3704.9
3	1	2	2599	155	Opalite	Core Red	251	1160.0
3	1	2	2599	163	Opalite	Core Red	1774	1631.9
3	1	2	2599	165	Opalite	Core Red	1585	4455.6
3	2	2	2599	063	Opalite	Core Red	1410	2583.4
3	2	2	2599	062	Opalite	Core Red	1126	1006.6
3	1	2	2599	164	Opalite	Core Red	2075	3615.0
3	1	2	2599	171	Opalite	Core Red	769	2262.5
3	1	2	2599	168	Opalite	Core Red	2809	2975.9
3	1	2	2599	167	Opalite	Core Red	2739	2789.1
3	1	2	2599	189	Opalite	Core Red	1055	2326.3
3	2	3	2599	053	Opalite	Core Red	1493	1528.5
3	1	3	2599	166	Opalite	Core Red	2587	2542.5
3	2	3	2599	055	Opalite	Core Red	3805	3173.8
3	1	3	2599	169	Opalite	Core Red	1413	5438.3
3	1	3	2599	191	Opalite	Core Red	959	963.6
3	1	3	2599	190	Opalite	Core Red	1562	1570.3
3	2	3	2599	052	Opalite	Core Red	4321	1729.5
3	1	3	2599	170	Opalite	Core Red	961	1631.1
3	2	3	2599	054	Opalite	Core Red	1227	1140.4
3	2	3	2599	142	Opalite	Core Red	650	828.6
3	1	3	2599	159	Opalite	Core Red	2555	2503.6
3	3	3	2599	212	Opalite	Core Red	1684	3087.5
3	1	3	2599	162	Opalite	Core Red	2520	2759.4
3	3	3	2599	211	Opalite	Core Red	1317	3334.8
3	3	3	2599	214	Opalite	Core Red	537	3488.2
3	1	3	2599	161	Opalite	Core Red	1655	2262.2
3	3	3	2599	213	Opalite	Core Red	1368	2036.0
3	2	3	2599	148	Opalite	Core Red	2568	1910.2
3	1	3	2599	160	Opalite	Core Red	916	1784.1
3	3	3	2599	209	Opalite	Core Red	1294	1804.5
3	2	3	2599	068	Opalite	Core Red	1114	2091.7
3	1	3	2599	172	Opalite	Core Red	571	1317.0
3	3	3	2599	207	Opalite	Core Red	658	1626.1
3	2	4	2599	147	Opalite	Core Red	502	2625.9
3	1	4	2599	176	Opalite	Core Red	1685	3112.3
3	2	4	2599	150	Opalite	Core Red	806	1573.3
3	1	4	2599	193	Opalite	Core Red	334	2473.1
3	3	4	2599	206	Opalite	ESB	1624	939.4
3	2	4	2599	067	Opalite	Core Red	968	1427.7
3	2	4	2599	146	Opalite	Core Red	1734	1607.0
3	1	4	2599	194	Opalite	Core Red	1531	2286.4
3	3	4	2599	263	Opalite	Core Red	1441	1709.9
3	2	4	2599	145	Opalite	Core Red	1249	2065.6
3	1	4	2599	198	Opalite	Core Red	344	705.7
3	3	4	2599	260	Opalite	Core Red	422	2556.3
3	3	4	2599	261	Opalite	Core Red	1388	1926.5
3	2	4	2599	144	Opalite	Core Red	740	2092.8
3	1	4	2599	186	Opalite	Core Red	1511	1657.9

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
3	2	4	2599	066	Opalite	Core Red	1139	1420.4
3	2	4	2599	143	Opalite	Core Red	2076	2875.6
3	1	4	2599	185	Opalite	Mixed Bif	495	129.8
3	2	4	2599	065	Opalite	Core Red	727	514.6
3	1	4	2599	178	Opalite	Core Red	1138	1772.8
3	1	4	2599	184	Opalite	Core Red	1361	1251.2
3	1	4	2599	187	Opalite	ESB	4411	1830.4
3	1	5	2599	177	Opalite	Core Red	1485	2135.7
3	1	5	2599	183	Opalite	ESB	2945	1834.6
3	1	5	2599	182	Opalite	Core Red	1222	1268.6
3	1	5	2599	181	Opalite	Core Red	1763	2173.9
3	1	5	2599	180	Opalite	ESB	366	224.8
3	1	5	2599	179	Opalite	Core Red	524	418.0
3	1	5	2599	152	Opalite	Core Red	1117	1777.0
3	1	5	2599	154	Opalite	Core Red	705	740.1
3	1	5	2599	151	Opalite	Core Red	1042	1799.8
3	1	5	2599	153	Opalite	Core Red	772	2451.1
3	2	3	2599	056	Jasper	NoG3	1	0.1
3	1	3	2599	199	Jasper	NoG3	3	0.1
3	2	4	2599	057	Jasper	NoG3	1	0.2
3	2	5	2599	058	Jasper	NoG3	3	0.6
3	3	1	2599	224	Jasper	NoG3	3	0.6
3	2	2	2599	064	Jasper	NoG3	1	0.1
3	3	3	2599	213	Jasper	NoG3	1	0.1
3	2	3	2599	148	Jasper	NoG3	2	0.2
3	2	4	2599	147	Jasper	NoG3	1	0.1
3	2	4	2599	067	Jasper	NoG3	1	0.1
3	2	4	2599	066	Jasper	NoG3	2	1.4
3	2	4	2599	143	Jasper	NoG3	1	0.1
3	1	u	2599	157	Basalt	NoG3	6	33.5
3	2	2	2599	040	Basalt	NoG3	4	5.3
3	2	3	2599	056	Basalt	NoG3	15	26.0
3	1	3	2599	199	Basalt	NoG3	19	11.8
3	3	3	2599	204	Basalt	NoG3	4	6.9
3	2	4	2599	057	Basalt	NoG3	21	2.2
3	2	4	2599	149	Basalt	NoG3	15	50.9
3	3	4	2599	233	Basalt	NoG3	1	0.2
3	2	5	2599	058	Basalt	NoG3	5	2.3
3	3	5	2599	203	Basalt	NoG3	14	1.9
3	2	6	2599	041	Basalt	NoG3	16	74.1
3	3	6	2599	202	Basalt	NoG3	4	0.7
3	2	7	2599	042	Basalt	NoG3	16	4.5
3	2	8	2599	043	Basalt	NoG3	38	43.4
3	3	9	2599	230	Basalt	NoG3	4	0.5
3	2	1	2599	046	Basalt	NoG3	5	0.7
3	3	1	2599	228	Basalt	NoG3	1	0.4
3	2	1	2599	059	Basalt	NoG3	7	34.3
3	1	1	2599	188	Basalt	NoG3	9	2.5
3	3	1	2599	227	Basalt	NoG3	15	3.2
3	2	1	2599	061	Basalt	NoG3	19	1.8
3	3	1	2599	210	Basalt	NoG3	19	40.0
3	3	1	2599	215	Basalt	NoG3	10	2.9
3	3	1	2599	225	Basalt	NoG3	21	2.9
3	2	1	2599	044	Basalt	NoG3	10	4.5
3	3	1	2599	224	Basalt	NoG3	15	2.1
3	3	1	2599	223	Basalt	NoG3	5	2.7
3	2	1	2599	047	Basalt	NoG3	2	0.3
3	3	1	2599	205	Basalt	NoG3	8	0.9

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
3	3	1	2599	221	Basalt	NoG3	4	2.0
3	2	1	2599	050	Basalt	NoG3	19	9.9
3	2	2	2599	049	Basalt	NoG3	31	15.8
3	2	2	2599	051	Basalt	NoG3	15	7.7
3	1	2	2599	174	Basalt	NoG3	7	10.8
3	1	2	2599	175	Basalt	NoG3	6	383.8
3	1	2	2599	155	Basalt	NoG3	1	3.7
3	1	2	2599	163	Basalt	NoG3	14	34.1
3	1	2	2599	165	Basalt	NoG3	11	1.2
3	2	2	2599	063	Basalt	NoG3	29	12.2
3	2	2	2599	062	Basalt	NoG3	17	8.1
3	1	2	2599	164	Basalt	NoG3	11	5.9
3	1	2	2599	171	Basalt	NoG3	1	1.9
3	1	2	2599	168	Basalt	NoG3	16	12.6
3	1	2	2599	167	Basalt	NoG3	27	27.0
3	1	2	2599	189	Basalt	NoG3	4	19.8
3	2	3	2599	053	Basalt	NoG3	4	148.9
3	1	3	2599	166	Basalt	NoG3	25	18.2
3	2	3	2599	055	Basalt	NoG3	8	1.3
3	1	3	2599	190	Basalt	NoG3	6	56.0
3	2	3	2599	052	Basalt	NoG3	1	17.8
3	1	3	2599	170	Basalt	NoG3	5	1.7
3	2	3	2599	054	Basalt	NoG3	7	21.6
3	2	3	2599	142	Basalt	NoG3	4	0.6
3	1	3	2599	159	Basalt	NoG3	34	7.5
3	3	3	2599	212	Basalt	NoG3	13	3.0
3	1	3	2599	162	Basalt	NoG3	21	24.4
3	3	3	2599	211	Basalt	NoG3	13	27.6
3	3	3	2599	214	Basalt	NoG3	3	0.2
3	1	3	2599	161	Basalt	NoG3	10	11.7
3	3	3	2599	213	Basalt	NoG3	13	6.6
3	2	3	2599	148	Basalt	NoG3	37	9.5
3	1	3	2599	160	Basalt	NoG3	4	1.2
3	3	3	2599	209	Basalt	NoG3	16	1.2
3	2	3	2599	068	Basalt	NoG3	16	4.8
3	1	3	2599	172	Basalt	NoG3	2	3.8
3	2	4	2599	147	Basalt	NoG3	3	1.6
3	1	4	2599	176	Basalt	NoG3	9	2.9
3	2	4	2599	150	Basalt	NoG3	6	0.8
3	1	4	2599	193	Basalt	NoG3	1	5.3
3	3	4	2599	206	Basalt	NoG3	44	27.4
3	2	4	2599	146	Basalt	NoG3	22	109.5
3	1	4	2599	194	Basalt	NoG3	8	35.1
3	3	4	2599	263	Basalt	NoG3	5	1.3
3	2	4	2599	145	Basalt	NoG3	26	3.7
3	3	4	2599	260	Basalt	NoG3	2	3.5
3	3	4	2599	261	Basalt	NoG3	3	15.9
3	2	4	2599	144	Basalt	NoG3	6	0.6
3	2	4	2599	066	Basalt	NoG3	10	5.6
3	2	4	2599	143	Basalt	NoG3	15	6.0
3	1	4	2599	184	Basalt	NoG3	12	1.5
3	1	4	2599	187	Basalt	NoG3	15	3.2
3	1	5	2599	177	Basalt	NoG3	1	224.7
3	1	5	2599	183	Basalt	NoG3	10	2.9
3	1	5	2599	182	Basalt	NoG3	12	13.3
3	1	5	2599	181	Basalt	NoG3	5	4.9
3	1	5	2599	180	Basalt	NoG3	2	8.6
3	1	5	2599	154	Basalt	NoG3	2	292.3

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
3	1	5	2599	153	Basalt	NoG3	8	68.1
3	1	unk	2599	157	Other	NoG3	23	15.5
3	1	unk	2599	158	Other	NoG3	5	25.7
3	1	unk	2599	173	Other	NoG3	56	125.1
3	2	3	2599	056	Other	NoG3	6	14.4
3	1	3	2599	199	Other	NoG3	29	28.3
3	3	3	2599	204	Other	NoG3	3	0.5
3	2	4	2599	057	Other	NoG3	7	22.6
3	2	4	2599	149	Other	NoG3	7	4.3
3	3	4	2599	233	Other	NoG3	1	0.5
3	2	5	2599	058	Other	NoG3	3	0.5
3	3	5	2599	203	Other	NoG3	7	11.7
3	2	8	2599	043	Other	NoG3	11	6.7
3	3	9	2599	230	Other	NoG3	1	0.1
3	2	1	2599	046	Other	NoG3	5	6.8
3	3	1	2599	228	Other	NoG3	10	45.1
3	2	1	2599	059	Other	NoG3	7	1.3
3	1	1	2599	188	Other	NoG3	32	4.3
3	3	1	2599	227	Other	NoG3	19	56.8
3	3	1	2599	226	Other	NoG3	3	9.2
3	2	1	2599	061	Other	NoG3	15	10.1
3	3	1	2599	215	Other	NoG3	9	31.5
3	3	1	2599	225	Other	NoG3	19	4.0
3	2	1	2599	044	Other	NoG3	20	84.9
3	3	1	2599	224	Other	NoG3	25	7.8
3	3	1	2599	223	Other	NoG3	5	1.2
3	2	1	2599	047	Other	NoG3	1	17.1
3	3	1	2599	205	Other	NoG3	3	0.3
3	2	1	2599	048	Other	NoG3	21	3.4
3	3	1	2599	221	Other	NoG3	25	6.4
3	2	2	2599	049	Other	NoG3	15	8.9
3	2	2	2599	051	Other	NoG3	8	9.1
3	1	2	2599	174	Other	NoG3	13	3.2
3	1	2	2599	175	Other	NoG3	12	52.4
3	1	2	2599	156	Other	NoG3	9	38.4
3	2	2	2599	064	Other	NoG3	14	152.9
3	1	2	2599	155	Other	NoG3	1	1.3
3	1	2	2599	165	Other	NoG3	2	32.6
3	2	2	2599	063	Other	NoG3	19	5.2
3	2	2	2599	062	Other	NoG3	7	11.9
3	1	2	2599	164	Other	NoG3	1	265.4
3	1	2	2599	168	Other	NoG3	51	21.0
3	1	2	2599	167	Other	NoG3	15	126.4
3	1	2	2599	189	Other	NoG3	18	4.9
3	2	3	2599	053	Other	NoG3	15	59.4
3	1	3	2599	166	Other	NoG3	8	3.1
3	2	3	2599	055	Other	NoG3	32	8.7
3	1	3	2599	191	Other	NoG3	7	39.5
3	1	3	2599	190	Other	NoG3	8	16.2
3	2	3	2599	052	Other	NoG3	25	8.8
3	1	3	2599	170	Other	NoG3	16	104.7
3	2	3	2599	054	Other	NoG3	9	20.0
3	2	3	2599	142	Other	NoG3	5	0.8
3	1	3	2599	159	Other	NoG3	24	28.7
3	3	3	2599	212	Other	NoG3	3	28.9
3	1	3	2599	162	Other	NoG3	11	4.4
3	3	3	2599	211	Other	NoG3	10	2.7
3	3	3	2599	214	Other	NoG3	4	2.6

Table 3, continued.

Feature Number	Trench Number	Stratum Number	Reference Number	Specimen Number	Material	Character-ization	Total No.	Weight
3	1	3	2599	161	Other	NoG3	11	7.5
3	3	3	2599	213	Other	NoG3	2	0.2
3	2	3	2599	148	Other	NoG3	20	2.9
3	1	3	2599	160	Other	NoG3	5	1.9
3	3	3	2599	209	Other	NoG3	2	0.2
3	2	3	2599	068	Other	NoG3	4	0.3
3	1	3	2599	172	Other	NoG3	7	8.2
3	2	4	2599	147	Other	NoG3	8	2.5
3	1	4	2599	176	Other	NoG3	3	23.2
3	3	4	2599	206	Other	NoG3	1	29.7
3	2	4	2599	067	Other	NoG3	5	1.2
3	2	4	2599	146	Other	NoG3	5	2.7
3	1	4	2599	194	Other	NoG3	9	22.3
3	2	4	2599	145	Other	NoG3	7	6.6
3	2	4	2599	144	Other	NoG3	5	1.3
3	1	4	2599	186	Other	N<51	11	5.9
3	2	4	2599	066	Other	NoG3	1	33.3
3	2	4	2599	143	Other	NoG3	35	2.6
3	1	4	2599	185	Other	N<51	4	3.7
3	2	4	2599	065	Other	NoG3	3	2.7
3	1	4	2599	184	Other	NoG3	7	1.6
3	1	5	2599	183	Other	NoG3	12	8.3
3	1	5	2599	182	Other	NoG3	5	3.7
3	1	5	2599	181	Other	NoG3	12	16.0
3	1	5	2599	180	Other	NoG3	3	34.0
3	1	5	2599	152	Other	NoG3	3	27.0
3	1	5	2599	154	Other	NoG3	1	0.4

Characterizations:
Core Red = Core reduction
ESB = Early biface, Stage 1 to Stage 3.5
LSB = Late biface, Stage 3.5+
Mixed Bif = Mixed biface, Stage 1 to Stage 4+
EdgeMain = Edge maintenance and resharpening
NoG3 = not classified, no G3 size grade items
N<51 = not classified, n<51

APPENDIX J

Attributes of Hammerstones and Cobble Tools

APPENDIX J

Attributes of Hammerstones and Cobble Tools.
(ALL MEASUREMENTS IN CENTIMETERS)

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thick-ness	Weight (gms)	Type	Shaped	Complete
3032, Loc. 19	01-6	-	QZ	13.3	9.8	6.2	1142.6	HM	-	+
	01-11	-	QZ	12.4	11.6	4.2	835.1	HM	+	+
3032, Loc. 23	3001-23	1	QZ	8.5	5.3	4.6	251.0	HM	-	+
	3001-25	1	JA	10.0	6.8	4.6	407.0	HM	-	+
3032, Loc. 25	01-5	-	QZ	6.0	5.4	4.3	186.7	HM	-	+
	01-11	-	QZ	6.2	5.5	4.5	203.8	HM	-	+
	01-12	-	QZ	6.7	8.5	3.6	289.3	HM	+	-
	4003-1	5	OP	8.7	6.6	4.1	299.1	HM	-	+
	4009-21	2	OP	8.4	8.3	3.8	347.8	CH	+	?
3032, Loc. 98	3001-2	1	QZ	6.8	7.8	3.2	259.7	HM	-	-
3084	502-1	2	MB	12.3	11.5	6.8	1253.2	HM	-	-
	502-2	2	RH	13.2	6.6	6.9	756.2	HM	?	-
	502-3	2	MB	10.2	3.4	3.8	163.2	HM	+	-
	502-4	2	MB	13.1	11.6	6.0	1032.9	HM	?	+
	1021-1	2	OP	16.0	10.5	4.8	813.1	SV	+	+
3085	508-1	8	MB	8.1	6.4	5.5	427.3	HM	-	+
	508-2	8	TB	13.9	9.6	4.0	452.9	CH	+	-
3092	2041-1	-	OP	6.4	5.4	3.5	159.5	HM	+	+
	6062-11	-	TB	6.7	8.4	3.3	253.9	HM	-	-
	6063-6	-	QZ	7.3	6.3	5.4	335.8	HM	-	+
	6083-2	-	QZ	11.0	5.7	4.8	478.4	HM	-	+
	6122-6	-	TB	11.2	8.2	4.2	349.0	CH	?	-
	6161-1	-	QZ	5.8	9.7	4.0	28.2	HM	-	-
	6242-1	-	OQ	7.0	5.7	4.2	245.1	HM	-	+
	6525-2	-	MB	10.4	8.7	5.5	538.5	HM	-	+
	6562-5	-	MB	15.8	11.3	3.6	911.8	CH	+	+
	6562-6	-	MB	6.6	6.6	5.8	416.1	HM	-	-
	6642-2	-	MB	10.3	12.5	4.2	755.6	CH	+	+
	8283-2	7	MB	10.0	6.9	3.0	296.7	HM	-	+
	8290-2	24	MB	7.1	5.9	5.3	312.6	HM	-	+
	8302-4	7	MB	9.7	7.4	7.0	602.2	HM	-	-
	8364-1	13	TB	10.9	13.7	2.8	653.1	CH	?	?
	8382-5	13	MB	5.9	5.3	5.2	220.8	HM	-	+
	8403-3	13	RH	6.0	6.0	1.8	60.5	HM	-	-
	8403-4	13	QZ	9.9	7.6	3.8	357.2	HM	-	+
	8482-1	13	MB	6.4	5.7	4.2	201.4	HM	-	-
	8522-6	13	MB	11.1	8.3	4.8	511.6	HM	-	-
	8644-1	9	TB	13.7	9.7	4.0	918.1	CH	?	-
	9263-1	14	RH	4.8	4.5	3.7	106.7	HM	-	+
3093	505-9	5	QZ	11.8	7.8	3.6	401.2	CH	+	+
3095	500-21	-	OP	10.8	7.2	6.8	523.3	CH	+	+
	500-49	-	QZ	10.4	9.7	7.3	925.1	HM	-	+
	500-57	-	RH	10.0	7.9	2.6	252.0	SS	-	-
	505-5	5	OP	8.6	6.6	4.7	348.8	HM	?	+
	511-3	11	MB	17.5	13.3	6.4	3000.0	HM	-	-
	513-1	13	QZ	8.3	6.2	5.9	433.5	HM	-	+
	514-3	14	MB	8.6	7.3	4.8	283.9	HM	+	-
	514-4	14	MB	7.5	2.8	3.2	80.7	HM	+	-

Appendix J, continued.

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thick-ness	Weight (gms)	Type	Shaped	Complete
	1004-3	19	MB	10.3	8.1	5.1	484.6	HM	-	+
	1006-1	19	MB	8.7	8.6	4.7	589.6	HM	-	-
	3015-4	15	MB	7.0	5.6	5.2	247.6	HM	-	+
	3019-8	19	MB	10.9	5.8	5.2	572.9	HM	-	+
	6660-1	10	TB	11.0	9.3	3.2	629.3	CH	?	+
3096	500-3	-	QZ	8.4	6.6	2.6	190.8	HM	-	+
	502-3	2	MB	10.4	7.8	5.5	568.0	CH	+	+
	504-1	4	MB	6.7	5.2	3.8	221.0	HM	-	+
3099	501-1	1	OP	9.2	8.0	3.6	28.0	HM	+	+
	502-1	2	OP	8.0	8.0	3.1	161.9	CH	+	+
3101	500-2	-	OP	10.2	6.0	2.9	211.5	CH	+	+
3104	500-5	-	MB	11.2	10.5	8.0	2000.0	CH	+	+
	500-10	-	QZ	10.8	8.9	8.2	889.2	HM	-	+
3106	1050-1	4	TB	12.1	7.1	3.5	280.8	SS	-	-
	2021-4	5	MB	12.0	9.7	6.1	751.0	HM	+	+
3107	1002-1	1	TF	13.6	10.4	4.7	663.0	CH	+	+
3114	1007-5	1	TB	10.9	10.0	3.2	447.8	SS	?	+
3149	500-11	-	OP	9.7	7.0	3.7	269.4	CH	+	+
3160	01-9	-	MB	9.3	5.9	3.2	250.2	HM	+	-
	500-67	-	RH	7.6	6.9	3.3	227.6	CH	+	+
	500-118	-	MB	14.6	8.7	6.1	778.5	PL	+	+
	501-1	1	TB	30.5	25.6	2.6	2600.0	SV	+	-
	501-15	1	MB	11.4	8.5	4.4	441.9	PL	+	+
	507-4	7	RH	6.7	6.0	5.5	280.2	HM	-	+
	1001-1	1	MB	14.4	8.8	5.7	752.5	PL	+	+
	1005-4	1	TB	11.4	9.7	1.9	430.3	HM	?	-
	1007-4	1	TB	8.0	4.3	2.4	115.7	SS	-	?
	2001-1	1	MB	9.4	6.6	2.6	162.0	HM	-	-
	6341-2	-	QZ	6.9	5.6	2.9	156.6	HM	-	+
	6862-3	-	OP	10.2	9.5	6.2	691.0	HM	?	+
3170	01-25	-	RH	10.7	10.3	6.2	1046.3	PL	+	+
	500-11	-	QZ	6.3	2.7	2.6	51.7	HM	?	-
	500-50	-	MB	8.6	6.5	5.9	326.1	HM	-	-
	500-52	-	OP	7.9	6.3	4.9	244.1	CH	+	-
3171	500-4	-	TF	11.6	12.9	3.0	447.6	SS	?	+
	6365-1	-	QZ	9.5	9.0	4.8	553.2	HM	-	+
	6907-7	2	QZ	12.8	5.2	5.2	635.7	HM	-	?
3177	501-1	1	RH	13.2	8.3	5.6	746.9	HM	-	+
3184	503-3	3	OP	10.8	8.9	5.2	382.7	CH	+	?
	2021-13	13	QZ	6.8	5.7	4.4	207.0	HM	-	+
	4125-2	8	OP	8.6	7.6	6.2	415.5	HM	+	+
	6001-4	12	JA	9.2	5.4	3.5	219.8	HM	-	+
3185	504-1	4	QZ	9.5	4.3	5.8	349.9	HM	-	+
	1010-1	1	TF	14.0	12.4	3.9	731.8	SS	+	+
	1012-1	1	QZ	9.2	9.1	8.0	832.2	HM	-	+

Appendix J, continued.

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thick-ness	Weight (gms)	Type	Shaped	Complete
3192	2062-1	2	TF	11.4	9.6	4.6	615.6	HM	-	+
	2064-1	2	QZ	10.9	9.8	5.6	639.7	HM	-	+
	2122-1	1	QZ	8.0	7.4	6.5	390.5	HM	-	+
	6063-1	1	QZ	11.6	8.0	5.9	563.4	HM	-	-
	6322-1	2	HE	17.9	9.3	8.1	847.7	SS	-	+
	6602-3	1	TF	2.7	1.7	0.8	4.2	SS	-	-
3193	506-1	6	TF	4.3	3.2	0.9	14.6	SS	-	+
3195	502-1	2	RH	25.0	14.0	6.8	3600.0	HM	-	+
	502-2	2	RH	25.0	14.5	9.3	2440.0	HM	-	-
	503-1	3	QZ	6.1	4.8	1.9	73.4	HM	-	-
	507-1	7	QZ	5.7	5.8	3.6	155.4	HM	-	+
	507-2	7	QZ	10.6	7.1	6.0	627.5	HM	-	+
	507-6	7	MB	8.1	7.5	6.4	469.7	HM	-	+
3196	501-2	1	QZ	9.2	6.8	3.4	196.8	HM	-	-
	502-1	2	QZ	9.2	7.7	2.6	126.6	HM	-	-
	502-8	2	QZ	10.7	10.0	6.7	755.1	HM	-	+
	502-0	2	QZ	18.5	13.0	5.8	1497.1	HM	-	+
	1007-1	1	QZ	8.6	7.5	5.2	391.4	HM	-	+
	1033-1	2	QZ	9.5	9.3	4.3	354.3	HM	-	-
	2002-1	1	OP	12.2	8.9	7.1	816.7	HM	-	+
	2002-3	1	QZ	8.8	7.3	3.6	338.1	HM	-	-
3197	504-2	4	QZ	9.4	6.9	5.7	320.1	HM	?	-
	504-4	4	QZ	8.0	5.5	1.7	53.9	HM	-	-
	506-1	6	MB	6.8	6.6	3.9	191.4	HM	?	-
	506-2	6	OQ	7.6	6.0	3.4	158.4	HM	-	-
	507-2	7	QZ	11.9	6.8	4.4	361.0	HM	-	-
	509-5	9	QZ	9.0	8.4	3.8	263.1	HM	-	+
3198	514-5	14	QZ	6.7	5.1	3.1	104.3	HM	-	-
	514-6	14	QZ	4.7	5.1	1.2	38.5	HM	-	-
3200	501-2	1	QZ	16.8	14.4	3.0	1328.8	SV	+	-
	2500-1	-	QZ	9.1	8.8	5.1	500.4	HM	-	+
3201	500-1	-	QZ	11.4	7.0	6.9	827.4	HM	-	+
	502-14	2	QZ	8.1	8.2	4.3	382.7	HM	?	+
	503-4	3	QZ	13.8	9.7	5.0	928.5	HM	-	-
	504-1	4	MB	5.9	4.6	4.9	139.3	HM	-	-
	1002-1	1	TF	13.0	10.9	3.5	387.8	SS	?	-
3204	500-22	-	QZ	13.0	9.9	2.5	501.4	HM	-	-
	500-23	-	RH	10.1	8.1	2.6	326.7	SS	-	-
	500-26	-	QZ	10.9	10.4	4.9	529.0	HM	-	+
	500-32	-	QZ	7.8	6.4	4.0	208.2	HM	-	+
	500-33	-	QZ	12.1	8.8	5.0	708.6	HM	-	+
	2005-12	-	OP	5.9	3.6	3.2	51.4	HM	-	-
	2500-7	-	MB	9.8	8.2	5.2	495.2	HM	-	+
	2599-1	1	MB	4.3	4.2	3.5	88.4	HM	+	+
	9001-1	1	RH	7.7	5.9	5.1	268.7	HM	-	+
3208	501-1	1	MB	13.9	11.4	5.0	818.4	HC	+	-
	501-2	1	MB	18.6	12.3	11.0	2500.0	HM	-	+
	508-1	8	QZ	15.5	8.5	6.7	1259.0	HM	-	-
	2500-3	-	MB	8.3	6.8	5.9	413.3	HM	+	+
	2599-17	3	TF	10.1	7.4	3.7	194.9	SS	-	+
	2599-244	3	QZ	15.3	13.2	5.5	1600.0	HM	?	+

Appendix J, continued.

Site No. (26Ek)	Specimen No.	Fea.	Material	Length	Width	Thick-ness	Weight (gms)	Type	Shaped	Complete
3237	01-6	-	QZ	6.7	5.7	4.4	234.7	HM	-	+
	01-28	-	JA	12.4	9.5	5.2	756.8	CH	+	?
	500-6	-	OP	9.4	6.7	4.9	361.9	HM	-	+
	2599-3	-	OP	11.2	7.4	4.1	341.0	CH	+	+
	6702-1	2	RN	11.0	8.7	2.8	445.7	CH	+	?
	6723-6	2	OP	7.7	5.5	5.0	268.7	HM	?	+
	6881-2	-	OT	7.9	5.5	4.5	234.3	HM	-	+
3238	500-33	-	QZ	18.1	12.7	4.2	1282.4	CH	+	-
3239	500-22	-	TB	11.2	7.1	5.8	576.1	CH	+	+
	500-23	-	QZ	16.0	8.5	7.7	1109.7	HM	-	+
	500-24	-	MB	5.3	5.7	5.1	227.4	HM	-	+
	500-27	-	OQ	5.9	4.8	3.4	77.1	CH	+	+
	500-29	-	OP	10.4	10.2	3.6	412.9	CH	+	+
3251	500-20	-	QZ	9.9	6.9	3.5	293.5	CH	+	+
	1009-1	1	TB	12.4	7.7	3.3	449.0	CH	+	+
	6063-2	6	QZ	6.4	5.8	3.1	179.0	HM	-	-
3271	500-4	-	TB	13.5	8.5	3.4	601.9	CH	+	+
	500-18	-	QZ	7.8	5.4	3.2	188.2	HM	-	+
	500-21	-	MB	13.8	9.5	2.8	494.8	CH	+	?
	500-62	-	TF	7.7	7.2	3.4	137.8	SS	+	+
	500-82	-	RH	7.5	5.9	3.6	184.0	HM	-	+
	500-163	-	OQ	6.1	4.5	2.1	58.5	CH	+	-
	500-261	-	MB	10.7	9.2	4.2	560.1	HM	-	+
	500-311	-	QZ	7.7	9.0	4.8	467.4	HM	-	-
	505-2	5	OP	8.2	6.0	3.6	201.0	CH	+	+
	506-5	6	QZ	7.6	5.9	2.6	172.6	HM	-	-
	516-1	16	MB	20.0	17.0	11.9	4000.0	HM	-	+
	516-2	16	OP	7.1	6.8	3.4	148.6	CH	+	-
	519-3	19	MB	11.3	8.7	6.2	745.4	CH	+	+
	1022-3	12	OP	11.1	7.5	4.7	344.9	CH	+	+
	1023-2	12	OP	11.9	8.0	4.9	525.2	CH	+	+
	1026-1	12	OQ	7.5	6.0	5.0	379.4	HM	?	+
	1038-1	12	MB	8.3	5.2	3.1	155.0	CH	+	?
	1047-2	12	TB	12.6	7.0	2.7	410.5	SS	-	-

Key:

Material
- MB = Mass Basalt
- TB = Tabular Basalt
- QZ = Quartzite
- OP = Opalite
- OQ = Opalite w/Quartzite
- JA = Jasper
- RH = Rhyolite
- TF = Tuff
- HE = Hematite
- OT = Other

Type
- HM = Hammerstones
- CH = Chopper
- PL = Scraper Plane
- SS = Scratched Stone
- HC = Hammer/Chopper
- SV = Shovel

APPENDIX K

Attributes of Ground Stone Artifacts

(Attributes of stone beads and ornaments are presented in Chapter 11)

APPENDIX K

Attributes of Groundstone Artifacts.
(ALL MEASUREMENTS IN CENTIMETERS)

Site No. (26Ek)	Specimen No.	Fea.	No. Frags.	Material	% Complete-ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Use Wear	Type	Length	Width	Thick-ness	Weight (gms)	Fire Affected
3032, Loc. 19	01-9	-	1	TB	50	SR	-	U	PL	M	ME	16.5	11.9	3.5	1,122.3	-
3032, Loc. 93	01-1	-	1	RH	75	SR	-	U	CN	L	ME	40.2	15.8	7.3	>400.0	-
3092	01-2	-	1	TB	?	SR	-	B	PL	M	ME	10.4	7.4	3.1	542.9	-
	500-3	-	1	TF	100	SR	+	M	PL	H	AB	4.5	1.4	1.4	8.4	-
	2599-12	-	1	TB	90	SR	+	U	PL	H	AB	4.5	1.4	1.4	8.4	-
	6165-2	-	1	MB	100	IR	-	U	CN	L	MR	24.5	18.4	22.4	13,600.0	-
	6170-1	-	2	TB	60	OV	-	U	PL	L	ME	(22.2)	(19.4)	4.6	3,000.0	-
	6222-4	-	1	MB	75	SR	+	U	CN	L	ME	16.4	15.0	4.6	2,200.0	-
	6462-1	-	1	TB	75	IR	-	U	PL	M	ME	20.3	10.7	4.7	1,800.0	-
	6545-1	-	1	TB	90	SR	-	U	PL	M	ME	20.3	15.0	2.2	1,275.3	-
	8402-7	12	1	TB	20	IN	?	U	PL	L	ME	13.5	7.7	3.2	411.0	+
3095	01-3	-	1	TB	20	IN	-	U	CN	M	ME	20.8	7.2	10.0	3,000.0	-
	500-22	-	1	RH	50	SR	+	U	CV	L	PE	9.9	6.8	4.7	470.5	-
	500-31	-	1	TB	?	IN	-	U	CN	L	ME	7.9	5.9	1.6	101.6	-
	500-26	-	1	TB	50	IR	-	U	CN	L	ME	9.0	15.8	2.8	998.1	-
	510-10	10	1	RH	50	OV	+	U	CV	L	MO	6.0	9.1	4.2	232.5	-
	515-9	15	1	MB	25	IN	-	U	PL	M	ME	8.0	15.0	12.2	4,200.0	-
	519-20	19	1	SS	20	OV	+	B	CV	H	ME	19.0	12.5	1.2	535.1	-
	525-3	24/25	2	TB	25	SR	-	U	PL	M	ME	(19.0)	(10.2)	2.7	879.7	+
	1002-2	15/19	14	IG	?	OV	+	B	PL	M	ME	?	?	3.1	1,810.3	?
	1002-7	19	1	SS	25	SR	+	U	GV	H	SA	3.2	4.1	1.9	27.6	-
	1023-1	15	36	TF	95	OV	+	B	ML	L/H	ME	(40.5)	(20.2)	1.8	2,242.7	-
	1025-1	15	1	SS	75	OV	+	U	GV	H	SA	11.7	6.6	2.0	203.1	-
	1029-1	15	4	TB	60	IN	-	B	PL	L	ME	(34.0)	(30.0)	2.9	3,458.4	-
	1032-5	15	1	TB	?	SR	-	U	PL	M	ME	15.4	10.0	3.0	955.7	-
	1044-1	22	6	TB	60	IN	-	U	PL	M	ME	(33.35)	(20.5)	5.9	4,930.4	+
	6381-4	19	1	TF	50	SR	+	M	M	M	AB	3.7	3.6	1.9	28.2	-
3096	1002-2	1	1	MB	100	OV	-	U	CV	L	MO	13.2	8.4	5.5	782.1	-
3106	1037-1	4	1	TB	?	IN	?	U	PL	L	ME	6.6	5.1	3.6	227.6	-
3149	500-6	-	1	MB	95	OV	?	U	PL	M	ME	30.0	24.5	14.0	9,500.0	-
	500-7	-	1	RH	40	OV	?	B	CV	L	MO	5.9	8.7	4.3	220.2	-

Appendix K, continued.

Site No. (26Ek)	Specimen No.	Fea.	No. Frags.	Material	% Complete-ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Use Wear	Type	Length	Width	Thick-ness	Weight (gms)	Fire Affected
3160	01-30	-	1	MB	75	OV	-	U	CN	L	MR	19.7	17.6	9.7	5,000.0	-
	01-33	-	1	MB	100	SR	-	U	PL	L	ME	29.6	20.8	18.0	14,600.0	-
	01-63	-	1	MB	75	IR	-	U	PL	M	ME	27.9	25.4	9.4	8,600.0	-
	01-115	-	1	TB	100	SR	-	U	CN	L	MR	31.8	22.0	16.6	15,000.0	-
	01-119	-	1	TB	100	SR	-	U	CV	M	ME	25.0	22.6	4.2	4,800.0	-
	01-208	-	1	TB	100	OV	+	M	M	M	PE	18.0	6.0	5.6	992.3	-
	01-210	-	1	MB	100	OV	-	U	CN	L	ME	31.5	21.7	17.5	16,400.0	-
	01-219	-	1	TB	25	IN	-	U	CV	M	ME	14.7	14.2	5.4	1,552.8	-
	500-53	-	2	TB	100	SR	+	M	ML	M	PE	(19.5)	(6.8)	6.7	1,431.2	-
	500-74	-	1	SS	10	OV	+	B	PL	L	ME	7.0	5.0	2.5	75.9	-
	500-110	-	1	TB	?	IR	-	U	PL	L	ME	21.2	12.0	2.0	682.1	-
	501-2	1	1	RH	100	SR	+	B	CV	L	MO	13.1	8.8	4.9	747.5	-
	515-1	15	1	TF	50	OV	+	U	GV	H	SA	4.6	2.8	2.2	17.6	-
	520-7	20	1	TB	50	IR	-	U	CN	M	ME	28.1	19.0	3.0	2,140.1	-
	519-8	19	1	TB	100	SR	-	U	PL	L	MR	28.5	15.0	9.5	6,400.0	-
	523-14	23	1	TB	50	OV	-	U	CN	L	MR	20.5	12.3	9.9	3,600.0	-
	1005-2	1	1	RH	40	SR	+	U	CV	M	MO	6.8	8.0	4.7	358.4	-
	2041-1	-	1	RH	75	OV	+	U	CV	M	MO	13.1	7.4	4.6	612.4	-
	4019-1	1	1	MB	90	IR	-	U	ML	L	ME	43.5	23.5	16.0	19,800.0	-
3165	01-4	-	1	TB	100	IR	-	U	PL	L	ME	47.5	30.0	3.0	6,800.0	-
	501-1	1	1	TB	100	IR	+	U	CN	L	ME	41.4	26.9	2.5	4,000.0	-
	502-1	2	1	TB	?	IR	-	U	CN	M	ME	24.7	20.0	3.4	3,900.0	-
	6181-2	-	1	TB	25	IR	-	U	PL	L	ME	16.4	11.5	2.0	675.1	-
3170	500-5	-	1	QZ	50	OV	+	U	CV	L	MO	10.4	8.3	3.8	402.0	-
	2023-1	-	1	TB	25	IN	?	B	PL	M	ME	18.9	13.0	2.7	975.8	-
3171	2022-1	-	1	RH	75	SR	?	B	CV	L	MO	15.2	9.1	4.3	628.7	-
3181	1015-1	1	1	RH	100	OV	?	B	CV	L	MO	18.2	11.0	7.4	1,627.0	+
3184	503-27	3	1	SS	100	OV	+	U	CV	H	SA	9.9	5.0	4.0	177.0	-
	3010-3	10	1	TF	75	OV	+	B	ML	L	MO	11.7	7.5	4.5	406.5	-
3185	1010-2	1	1	RH	50	OV	+	U	CV	L	MO	12.5	8.9	4.8	500.9	-
3190	505-4	5	3	TF	25	IN	+	U	PL	L	ME	(14.3)	(8.9)	6.7	835.6	-
	1006-3	1	1	TF	100	IR	-	M	ML	M	AB	4.2	2.6	1.9	19.2	-

Appendix K, continued.

Site No. (26Ek)	Specimen No.	Fea.	No. Frags.	Material	% Complete-ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Use Wear	Type	Length	Width	Thick-ness	Weight (gms)	Fire Affected
3192	01-1	-	1	TF	100	OV	+	U	PL	M	MO	16.4	9.5	3.5	752.3	-
	1015-3	1	1	TB	?	IN	?	U	PL	L	ME	8.4	4.3	1.5	73.3	-
	2061-1	2	1	QZ	100	OV	+	B	ML	L	MO	6.3	9.9	3.4	327.9	-
	2599-2	1	1	TF	50	IN	-	U	PL	L	ME	17.5	14.5	2.6	849.3	-
	6141-3	1	1	TF	40	SR	+	U	PL	L	ME	14.6	14.2	2.3	753.2	-
	6121-5	-	1	RH	20	IN	?	U	PL	L	ME	14.1	10.8	5.2	1,239.9	-
	6581-1	1	1	MB	10	IN	?	U	PL	M	ME	8.9	5.2	2.3	129.8	-
3196	502-5	2	1	TF	100	SR	-	U	PL	L	ME	7.0	4.1	3.6	60.7	-
3198	1003-1	1	1	SS	100	SR	+	M	GV	H	SA	5.5	2.6	1.7	33.9	-
3201	502-15	2	1	RH	100	OV	?	U	CV	L	MO	13.2	9.0	5.8	956.6	-
	503-5	3	17	RH	50	IN	+	U	PL	L	ME	(36.0)	(22.5)	5.3	4,077.4	+
3204	2500-8	-	1	QZ	50	OV	?	U	CV	L	MO	7.6	7.4	2.9	238.0	+
3228	1001-1	1	2	TB	95	IR	-	U	PL	L	ME	(22.7)	(19.6)	4.9	2,1911.3	-
3237	01-3	-	1	RH	25	IR	-	U	CV	L	ME	22.3	9.9	12.7	3,300.0	-
	01-4	-	1	MB	25	?	?	U	PL	M	ME	17.4	12.5	5.8	1,295.1	-
	01-27	-	2	TF	20	OV	+	B	PL	L	ME	(11.0)	(8.4)	2.3	320.7	-
	01-123	-	1	RH	100	IR	-	U	PL	L	ME	28.0	23.5	5.4	5,000.0	-
	500-81	-	1	RH	10	IN	?	U	CN	L	ME	9.0	5.4	4.3	232.8	-
	6200-1	-	1	TF	5	OV	+	B	PL	L	ME	7.7	6.7	2.3	142.7	-
	6401-2	-	1	TF	?	?	?	U	PL	M	ME	7.2	5.7	3.2	176.1	+
	6700-2	-	1	RH	?	IR	-	U	PL	L	ME	10.4	8.3	4.1	443.3	-
3238	500-16	-	1	RH	?	SR	+	U	CN	L	ME	9.1	8.2	4.6	541.7	-
3251	01-16	-	1	RH	10	IN	?	U	PL	M	ME	6.5	5.7	5.4	278.1	-
	500-4	-	1	RH	25	OV	+	U	CN	M	ME	19.0	19.0	5.2	2,108.9	-
	500-6	-	1	QZ	20	IN	?	U	CN	M	ME	10.8	9.3	5.9	558.4	-
	500-8	-	1	TF	?	IN	?	U	PL	L	ME	8.6	7.9	5.1	365.0	-
	500-11	-	1	TF	?	IN	?	U	PL	L	ME	4.8	5.3	2.1	62.1	-
	500-14	-	1	RH	20	SR	+	U	CN	L	ME	11.6	9.6	2.6	480.2	-
	500-15	-	1	TF	100	OV	+	U	CV	L	MO	14.4	8.4	6.7	1,146.0	-
	501-1	1	1	RH	25	OV	+	U	CN	M	ME	15.0	17.0	3.3	1,006.4	-
	501-4	1	1	RH	40	OV	-	U	CV	L	MO	9.8	6.5	4.4	384.7	+

Appendix K, continued.

Site No. (26Ek)	Specimen No.	Fea.	No. Frags.	Material	% Complete-ness	Plan Outline	Shaped	Facial Use	Use Surface Profile	Use Wear	Type	Length	Width	Thick-ness	Weight (gms)	Fire Affected
3251, continued	506-1	6	1	TF	?	IN	?	B	PL	L	ME	13.6	7.6	3.3	402.5	-
	506-5	6	1	RH	?	IN	?	U	PL	L	ME	12.2	5.8	2.6	211.0	-
	1006-5	1	1	TF	5	OV	+	B	PL	L	ME	5.8	4.6	3.7	123.8	+
	3006-2	6	1	RH	50	OV	-	U	CV	M	AB	8.5	8.6	3.3	386.8	-
	3006-6	6	1	QZ	10	?	-	U	PL	M	ME	6.6	6.2	2.3	74.2	-
	3006-9	6	1	TF	20	SR	+	B	ML	M	MO	5.2	5.2	2.6	90.8	-
	6462-1	1	1	QZ	50	IR	-	U	PL	L	MO	9.2	7.4	4.5	401.3	+
	6501-1	1	1	TF	60	SR	+	U	CV	L	MO	9.9	6.4	3.5	326.0	-
	6502-1	1	1	TF	20	SR	+	U	PL	M	MO	3.7	4.9	4.3	80.8	+
3271	500-73	-	1	RH	75	SR	+	M	CV	L	MO	12.0	6.2	3.8	532.0	+
	500-133	-	1	TB	?	IN	?	U	PL	M	ME	11.0	10.3	2.9	481.0	+
	500-150	-	1	RH	40	SR	+	M	ML	L	PE	7.1	7.4	5.6	501.1	-
	500-273	-	2	TB	?	SR	?	U	PL	L	ME	(17.0)	(10.8)	2.8	882.8	-
	1008-1	2	1	RH	25	OV	?	U	CV	L	MO	7.4	5.1	2.4	108.3	-
	1101-2	18	1	MB	100	OV	-	U	PL	M	MR	22.0	18.5	11.0	2,600.0	-

Key:

Material
- IG = Ignimbrite
- MB = Mass Basalt
- TB = Tabular Basalt
- QZ = Quartzite
- RH = Rhyolite
- SS = Sandstone
- TF = Tuff

Plan Outline
- SR = Sub-rectangular
- OV = Ovoid
- IR = Irregular
- IN = Indeterminant

Parentheses denote measurement of two or more refitted pieces.

Facial Use
- U = Unifacial
- B = Bifacial
- M = Multiple

Use Surface Profile
- CN = Concave
- CV = Convex
- PL = Planar
- ML = Multiple

Use Wear
- L = Light use; polished facets only on elevated areas of surface; retains characteristics of original surface.
- M = Moderate use; thin layer of original surface of stone is removed by grinding; polished facets cover ca. 50% of surface area.
- H = Heavy use; perceptible trough developed below original surface; ground facets over entire surface; often resharpened by pecking.

Type
- MO = Mano
- ME = Metate
- PE = Pestle
- MR = Mortar
- AB = Abrader
- SA = Shaft Abrader/ Smoother

APPENDIX L

Radiocarbon Analysis Results

Beta Analytic, Inc.

BETA ANALYTIC INC.

MURRY A. TAMERS, PH. D.
JERRY J. STIPP, PH. D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A.

May 5, 1990

Mr. Steven G. Botkin
Intermountain Research
Drawer A
Silver City, Nevada 89428

Dear Mr. Botkin:

Please find enclosed the results on your nineteen charcoal samples recently submitted for radiocarbon dating analyses. We trust these dates will be interesting for your work.

As before, the charcoals were pretreated by first examining for rootlets. They were then given our acid, alkali, acid series of soakings to remove carbonates and humic acids. The following benzene syntheses and counting went normally. The pouch B portion was used only in the case of Beta-36984.

Two of the samples were small, as indicated on the date report sheet. They were given extended counting time (four times the normal amount) to reduce the statistical errors as much as practical.

We are enclosing our invoice. As always, if there are any questions or if you would like to discuss the dates, call us at any time.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / BITNET: XNRBET22@SERVAX

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Steven G. Botkin
Intermountain Research

DATE RECEIVED: April 12, 1990
DATE REPORTED: May 5, 1990
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	
Beta-36976	3092-8584-5 (Sample #21)	750 +/- 70 BP	(charcoal)
Beta-36977	3092-8645-1 (Sample #36)	650 +/- 50 BP	(charcoal)
Beta-36978	3171-2599-5	410 +/- 70 BP	(charcoal)
Beta-36979	3195-2599-129	320 +/- 50 BP	(charcoal)
Beta-36980	3195-2599-130	500 +/- 80 BP	(charcoal)
Beta-36981	3195-2599-131	360 +/- 60 BP	(charcoal)
Beta-36982	3198-8462-6 (Sample #10)	300 +/- 60 BP	(charcoal)
Beta-36983	3208-2599-15	900 +/- 80 BP	(charcoal)
Beta-36984	3208-2599-21 (0.43 gram carbon)	870 +/- 80 BP	(charcoal)
Beta-36985	3208-2599-22	650 +/- 100 BP	(charcoal)
Beta-36986	3208-2599-23	570 +/- 80 BP	(charcoal)
Beta-36987	3208-2599-24	480 +/- 60 BP	(charcoal)
Beta-36988	3208-2599-25 (0.69 gram carbon)	840 +/- 60 BP	(charcoal)
Beta-36989	3208-2599-28	560 +/- 70 BP	(charcoal)

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: _____

DATE RECEIVED: _____

DATE REPORTED: _____

SUBMITTER'S PURCHASE ORDER # _____

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	
Beta-36990	3208-2599-31	770 +/- 80 BP	(charcoal)
Beta-36991	3208-2599-33	740 +/- 80 BP	(charcoal)
Beta-36992	3208-2599-36	590 +/- 80 BP	(charcoal)
Beta-36993	3237-8802-4 (Sample #3)	970 +/- 60 BP	(charcoal)
Beta-36994	3237-8845-1 (Sample #9)	1860 +/- 70 BP	(charcoal)

Note: the small samples Beta-36984 and 36988 were given extended counting time

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

RADIOCARBON DATING, STABLE ISOTOPE RATIOS
P.O. BOX 248113 CORAL GABLES, FLORIDA 33124 - (305) 667-5167
BITNET XNRBET22@SERVAX

August 10, 1988

Dr. Robert G. Elston
Intermountain Research
Drawer A
Silver City, Nevada 89428

Dear Dr. Elston:

Please find enclosed the results on the two charcoal samples recently submitted for radiocarbon dating analyses. We hope these dates will be useful in your research.

Your charcoals were pretreated by first examining for rootlets. The samples were then given a hot acid wash to eliminate carbonates. They were repeatedly rinsed to neutrality and subsequently given a hot alkali soaking to take out humic acids. After rinsing to neutrality, another acid wash followed and another rinsing to neutrality. The following benzene syntheses and counting proceeded normally.

A sample date (Beta-26828) came out to be very young. However, as stated on the date report sheet, this has not been adjusted using the dendrochronology (tree ring calibration) tables. There are ambiguities in the curves for very young samples due to both heliomagnetic and fossil fuel burning effects. In your case the age could be between cal 272 BP (cal AD 1678) and 0 BP on the two sigma basis.

We are enclosing our invoice. If there are any questions or if you would like to confer on the dates, my direct telephone number is listed above. Please don't hesitate to call us if we can be of help.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Robert G. Elston
Intermountain Research

DATE RECEIVED: July 21, 1988
DATE REPORTED: August 10, 1988
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ
Beta-26827	26Ek3106-2021-1	300 +/- 70 BP
Beta-26828	26Ek3204-2003-13	40 +/- 50 BP

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

RADIOCARBON DATING, STABLE ISOTOPE RATIOS
P.O. BOX 248113 CORAL GABLES, FLORIDA 33124 - (305) 667-5167
BITNET XNRBET22@SERVAX

July 30, 1988

Dr. Robert G. Elston
Intermountain Research
Drawer A
Silver City, Nevada 89428

Dear Dr. Elston:

Please find enclosed the results on the two charcoal samples recently submitted for radiocarbon dating analyses. We hope these dates will be useful in your studies.

Your charcoals were pretreated the same as the other materials of this sort submitted previously. They were first examined for rootlets. The samples were then given our acid, alkali, acid soakings to get out carbonates and humic acids. The following benzene syntheses and counting proceeded normally.

The Beta-26754 sample was small, as shown on the date report sheet. It was given extended counting time (four times the normal amount) to reduce the statistical error as much as practical.

We are enclosing our invoice. Would you forward this to the appropriate office for payment. If there are any questions or if you would like to confer on the dates, please call us.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Robert G. Elston
Intermountain Research

DATE RECEIVED: July 15, 1988
DATE REPORTED: July 30, 1988
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	
Beta-26754	26Ek3208 2500-2/Sample #4 (sorted fraction)	800 +/- 60 BP	(0.7 gram carbon)
Beta-26755	26Ek3208 2500-4/Sample #5 (sorted and unsorted fractions)	650 +/- 60 BP	

Note: the small sample Beta-26754 was given extended counting time.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

APPENDIX M

Obsidian Hydration Analysis

Thomas M. Origer

SONOMA STATE UNIVERSITY
ACADEMIC FOUNDATION, INC.

ANTHROPOLOGICAL STUDIES CENTER
CULTURAL RESOURCES FACILITY
707 664-2381

Steve Botkin
Intermountain Research
Drawer A
Silver City, NV 89428

January 9, 1991

Dear Steve:

This letter reports hydration band measurements obtained from specimens from Tosawihi Quarry and vicinity, northcentral Nevada. This work was completed per your letter dated November 29, 1990. The specimens were returned to you in December 1990.

The analysis was completed at the Sonoma State University Obsidian Hydration Laboratory, an adjunct of the Anthropological Studies Center, Department of Anthropology. Procedures used by our hydration lab for thin section preparation and hydration band measurement are described below.

Each specimen was examined in order to find two or more surfaces that would yield edges which would be perpendicular to the microslide when preparation of the thin section was completed. Two small parallel cuts were made at an appropriate location along the edge of each specimen with a 4 inch diameter circular saw blade mounted on a lapidary trimsaw. The cuts resulted in the isolation of a small sample with a thicknesses of approximately one millimeter. Each sample was removed from its specimen and mounted with Lakeside Cement onto permanently etched petrographic microslide.

The thickness of the samples was reduced by manual grinding with a slurry of #500 silicon carbide abrasive on a glass plate. The grinding was completed in two steps. The first grinding was terminated when the sample's thickness was reduced by approximate 1/2, thus eliminating any micro-chips created by the saw blade during the cutting process. The slides were then reheated, which liquified the Lakeside Cement, and the samples inverted. The newly exposed surfaces were then ground until the proper thickness was attained.

The correct thin section thickness was determined by the "touch" technique. A finger was rubbed across the slide, onto the sample, and the difference (sample thickness) was "felt." The second technique employed for arriving at proper thin section thickness is termed the "transparency" test. The microslide was held up to a strong source of light and the translucency of the thin section observed. The sample was sufficiently reduced in thickness when the thin section readily allowed the passage of light.

A protective coverslip was affixed over the thin sections when all grinding was completed. The completed microslides are curated at our hydration lab under File No. 90-H979.

1801 East Cotati Avenue Rohnert Park, California 9492

The hydration bands were measured with a strainfree 40 power objective and a Bausch and Lomb 12.5 power filar micrometer eyepiece on a Nikon petrographic microscope. Six measurements were taken at several locations along the edge of the thin section. The mean of the measurements was calculated and listed on the enclosed table with other information. These hydration measurements have a range of +/- 0.2 due to normal limitations of the equipment.

The abbreviation "NVB" under the "Mean" column on the enclosed tables marks specimens which had no visible hydration band. Under the same column, "DH" indicates specimens with diffuse hydration, which was not measureable. The abbreviations used under the "Remarks" column include "w," and "Band 1" and "Band 2." The "w" indicates the specimen had surfaces which were weathered, and "Band 1" means that this is the smaller hydration band measurement of a specimen with multiple bands. "Band 2" marks the larger band measurement from a particular specimen.

If you have questions or comments about this hydration work, please don't hesitate to contact us.

Cordially,

Thomas M. Origer, Director
Obsidian Hydration Laboratory

NV-Misc. **Steve Botkin - Intermountain Research** **December 1990**

Lab#	Catalog#	Description	Provenience	Remarks	Readings	Mean	Source
01	4067-1	Preform (3170)	67/surface(0-2)	none	1.0 1.1 1.1 1.1 1.2 1.2	1.1	
02	5077-1	Preform (3170)	77/surface	none	1.3 1.3 1.3 1.3 1.4 1.4	1.3	
03	500-11	Preform (3171)	IA/surface	none	1.1 1.2 1.2 1.3 1.3 1.3	1.2	
04	1-9	Preform (3171)	IA/surface	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	
05	1-2	Preform (3184)	IA/surface	none	1.3 1.4 1.4 1.4 1.6 1.6	1.5	
06	508-5	Preform (3184)	IA/surface	none	1.2 1.3 1.3 1.3 1.3 1.3	1.3	
07	500-1	Preform (3189)	IA/surface	none		NVB	
08	507-1	Preform (3190)	IA/surface	none	3.1 3.1 3.2 3.2 3.2 3.2	3.2	
09	1004-1	Point (3191)	4/surface(0-2)	none	1.3 1.4 1.4 1.4 1.4 1.4	1.4	
10	1003-2	Preform (3198)	3/surface	none	1.7 1.7 1.7 1.7 1.7 1.8	1.7	
11	1007-1	Preform (3198)	7/surface	none	1.6 1.7 1.7 1.8 1.8 1.8	1.7	
12	1017-2	Preform (3198)	17/surface	none	1.6 1.6 1.6 1.6 1.7 1.7	1.6	
13	1018-2	Preform (3198)	18/surface	none	1.9 2.0 2.1 2.1 2.3 2.3	2.1	
14	500-74	Preform (3204)	IA/surface	none	1.4 1.6 1.6 1.6 1.6 1.6	1.6	
15	510-3	Preform (3095)	IA/surface	none	1.4 1.4 1.6 1.6 1.6 1.7	1.6	
16	501-1	Preform (3116)	SF/IF/surface	none	3.8 3.8 3.8 3.9 4.1 4.1	3.9	
17	500-1	Preform (3165)	IA/surface	none	4.1 4.2 4.2 4.2 4.3 4.4	4.2	
18	512-13	Preform (3160)	IF/surface	none	4.9 4.9 5.0 5.0 5.1 5.3	5.0	
19	1084-1	Preform (3160)	4/surface	none		DH	
20	1001-1	Preform (3231)	1/surface	none	2.3 2.3 2.3 2.4 2.4 2.4	2.4	
21	6422-5	Preform (3251)	13/10-20	none		NVB	
22	6543-1	Preform (3251)	18/20-30	Band 1	1.2 1.2 1.3 1.3 1.4 1.4	1.3	
22	6543-1	Preform (3251)	18/20-30	Band 2	4.7 4.7 4.8 4.8 4.8 4.9	4.8	
23	2141-1	Preform (3237)	5/0-10	none	4.1 4.1 4.2 4.2 4.3 4.3	4.2	
24	6903-3	Preform (3237)	66/20-30	none	3.0 3.1 3.1 3.2 3.2 3.2	3.1	
25	501-1	Preform (3239)	IF/surface	Band 1	1.4 1.6 1.6 1.7 1.7 1.8	1.6	
25	501-1	Preform (3239)	IF/surface	Band 2	4.1 4.1 4.1 4.1 4.2 4.4	4.2	
26	500-30	Core (3170)	ISO/surface	none		NVB	
27	500-3	Core (3184)	IA/surface	none	1.3 1.4 1.4 1.6 1.6 1.6	1.5	
28	2065-7	Core (3192)	4/40-50	none	4.2 4.2 4.3 4.4 4.4 4.5	4.3	
29	6222-1	Core (3092)	15/10-20	none	1.2 1.3 1.3 1.3 1.3 1.4	1.3	
30	1045-1	Core (3095)	5/surface	none	1.2 1.2 1.2 1.2 1.3 1.3	1.2	
31	2021-1	Core (3271)	2/0-10	none	2.1 2.1 2.3 2.3 2.3 2.4	2.3	
32	1-26	Core (3237)	IA/surface	none	1.7 1.7 1.7 1.7 1.7 1.8	1.7	
33	1-1	Core (3032)	Locus 24/surface	none	5.8 5.8 6.0 6.1 6.1 6.1	6.0	
34	500-44	Biface (3170)	ISO/surface	none		NVB	
35	500-43	Biface (3170)	IA/surface	none	2.9 2.9 3.0 3.0 3.0 3.0	3.0	
36	500-59	Biface (3170)	IA/surface	none	1.6 1.6 1.6 1.7 1.7 1.7	1.7	
37	508-3	Biface (3170)	IF/surface	Band 1	2.7 2.7 2.9 2.9 3.0 3.0	2.9	
37	508-3	Biface (3170)	IF/surface	Band 2	8.4 8.4 8.5 8.6 8.6 8.7	8.5	
38	1001-9	Biface (3184)	SFC/surface	none	1.4 1.4 1.4 1.6 1.6 1.7	1.5	
39	1019-1	Biface (3190)	SFC/surface	none	7.8 7.9 8.0 8.0 8.0 8.1	8.0	
40	1045-1	Biface (3190)	5/surface 0-2	none	3.1 3.3 3.3 3.3 3.3 3.3	3.3	
41	501-14	Biface (3191)	IFSA/surface	none	3.8 3.8 3.9 4.1 4.1 4.1	4.0	
42	501-12	Biface (3191)	IFSA/surface	none	3.0 3.1 3.1 3.1 3.2 3.3	3.1	
43	501-13	Biface (3191)	IFSA/surface	none	3.2 3.2 3.3 3.5 3.5 3.5	3.4	
44	6205-1	Biface (3092)	14/40-50	none		DH	
45	2599-13	Biface (3092)	--/surface	none	3.9 3.9 4.1 4.1 4.2 4.3	4.1	
46	500-107	Biface (3160)	IA/surface	none	7.3 7.3 7.3 7.4 7.4 7.5	7.4	
47	500-27	Biface (3271)	IA/---	none	7.3 7.3 7.4 7.5 7.5 7.6	7.4	
48	500-3	Biface (3234)	IA SC/surface	none	11.7 11.7 11.9 11.9 11.9 11.9	11.8	
49	500-22	Biface Cut 1 (3237)	IA SC/surface	none	6.1 6.1 6.1 6.1 6.2 6.2	6.1	
50	500-22	Biface Cut 2 (3237)	IA SC/surface	none	6.2 6.3 6.4 6.4 6.6 6.6	6.4	
51	500-22	Biface Cut 3 (3237)	IA SC/surface	none	3.3 3.5 3.6 3.6 3.6 3.7	3.6	
52	500-33	Biface (3237)	IA/surface	none	5.6 5.6 5.6 5.7 5.7 5.7	5.7	
53	500-24	Biface (3238)	IA/surface	none	4.5 4.7 4.7 4.9 5.0 5.0	4.8	
54	3001-8	Biface (3032)	IF/surface	none		NVB	
55	500-7	Debitage (3172)	IA/surface	none	1.3 1.3 1.4 1.6 1.6 1.6	1.5	
56	500-6	Debitage (3172)	IA/surface	w	1.7 1.8 1.8 1.8 1.8 1.8	1.5	
57	501-25	Debitage (3191)	IFSA/surface	none	3.0 3.1 3.1 3.2 3.3 3.3	3.2	
58	501-23	Debitage (3191)	IFSA/surface	none	3.0 3.0 3.0 3.1 3.3 3.3	3.1	
59	501-24	Debitage (3191)	IFSA/surface	none		NVB	
60	6264-3	Debitage (3192)	29/30-40	none	6.1 6.2 6.2 6.3 6.4 6.4	6.3	

Lab Accession No.: 90-H979 Technician: Thomas M. Origer

NV-Misc. **Steve Botkin - Intermountain Research** **December 1990**

Lab#	Catalog#	Description	Provenience	Remarks	Readings	Mean	Source
61	500-264	Debitage (3160)	IA/surface	none	5.0 5.0 5.0 5.0 5.1 5.3	5.1	
62	6744-7	Debitage (3237)	58/30-40	none	3.6 3.6 3.6 3.6 3.6 3.6	3.6	
63	6065-1	Debitage (3251)	28/40-50	none	5.7 5.7 5.7 5.8 6.0 6.0	5.8	
64	2001-2	Debitage (3238)	1/0-10	none	6.0 6.0 6.0 6.0 6.1 6.1	6.0	
65	1001-5	Debitage (3239)	1/surface	none	5.7 5.8 6.0 6.0 6.1 6.2	6.0	
66	6063-1	Debitage (3237)	34/20-30	none	3.1 3.1 3.0 3.2 3.3 3.5	3.2	
67	6185-2	Debitage (3251)	34/40-50	none	7.2 7.2 7.3 7.4 7.4 7.5	7.3	
68	6183-3	Debitage (3251)	3/20-30	none	6.3 6.3 6.4 6.4 6.6 6.6	6.4	
69	6481-2	Debitage (3251)	21/2-10	none	4.2 4.2 4.2 4.2 4.3 4.3	4.2	
70	3001-55	Debitage (3032)	IF Locus 23/surface	none	1.6 1.6 1.7 1.7 1.7 1.8	1.7	
71	509-5	Point (3095)	IF Locus 23/surface	none	1.6 1.6 1.7 1.7 1.7 1.8	1.7	
72	6001-1	Point (3095)	5/2-10	none	1.7 1.8 1.8 1.8 1.8 1.8	1.8	
73	6041-1	Point (3095)	7/2-10	Band 1	2.3 2.4 2.4 2.5 2.5 2.5	2.4	
73	6041-1	Point (3095)	7/2-10	Band 2	5.0 5.0 5.1 5.3 5.3 5.4	5.2	
74	2672-1	Point (DSC)	1/surface	none		NVB	
75	500-326	Point (3160)	IA/surface	none	3.5 3.5 3.5 3.5 3.6 3.7	3.6	
76	6081-4	Point (3160)	52/2-10	none	1.2 1.2 1.2 1.2 1.2 1.2	1.2	
77	2002-1	Point (3170)	1/10-20	none	1.1 1.2 1.2 1.3 1.4 1.4	1.3	
78	1025-1	Point (3198)	25/surface 0-2	none	2.1 2.3 2.4 2.4 2.4 2.5	2.4	
79	1018-1	Point (3198)	18/surface 0-2	none	2.5 2.6 2.6 2.6 2.7 2.7	2.6	
80	16-2	Point (3185)	--/surface 0-2	none	2.5 2.5 2.6 2.6 2.6 2.6	2.6	
81	500-2	Point (3092)	150/surface 0-2	none		NVB	
82	6285-4	Point (3092)	18/20 cm	none	1.2 1.2 1.2 1.2 1.2 1.3	1.2	
83	6362-1	Point (3092)	22/10-20	none	1.6 1.6 1.7 1.7 1.8 1.8	1.7	
84	6480-2	Point (3095)	29/0-2	none	1.7 1.7 1.7 1.8 1.8 1.8	1.8	
85	1002-1	Point (3116)	2/0-2	none	1.2 1.2 1.2 1.2 1.3 1.3	1.2	
86	1003-4	Point (3160)	3/0-2	none	1.2 1.2 1.2 1.3 1.3 1.3	1.3	
87	5078-1	Point (3170)	78/0-2	none	1.0 1.0 1.0 1.0 1.0 1.0	1.0	
88	502-1	Point (3178)	IFSA/surface	none	1.2 1.2 1.2 1.2 1.3 1.3	1.2	
89	502-8	Point (3192)	IFSA/surface	none	1.0 1.1 1.1 1.2 1.2 1.2	1.1	
90	2061-6	Point (3192)	4/0-10	none	1.3 1.3 1.3 1.3 1.3 1.3	1.3	
91	508-1	Point (3198)	IFSA/surface	none	1.7 1.7 1.8 1.8 1.8 1.8	1.8	
92	1016-1	Point (3198)	18/0-2	none	1.7 1.8 1.8 1.8 1.8 1.9	1.8	
93	522-1	Point (3271)	IF/0	none	1.7 1.7 1.8 1.8 1.9 1.9	1.8	
94	16-1	Point (3185)	--/surface	none	2.1 2.3 2.4 2.4 2.4 2.4	2.3	
95	500-1	Point (3239)	IASC/surface	none	2.4 2.4 2.5 2.5 2.5 2.5	2.5	
96	01-10	Point (3251)	IA/surface	none	3.3 3.5 3.5 3.6 3.6 3.7	3.5	
97	4017-1	Point (3251)	17/0-2	none	2.1 2.1 2.3 2.3 2.4 2.4	2.3	
98	500-191	Point (3271)	IA/0-2	none	4.8 4.8 4.9 4.9 4.9 5.1	4.9	
99	1046-5	Point (3271)	26/0-2	none		NVB	
100	01-221	Point (3160)	IA/5	none	3.3 3.3 3.5 3.6 3.6 3.7	3.5	
101	6083-1	Point (3160)	52/20-30	none	3.3 3.5 3.5 3.6 3.6 3.6	3.5	
102	6641-1	Point (3160)	86/2-10	none	3.8 3.9 3.9 3.9 4.1 4.1	4.0	
103	6084-1	Point (3237)	35/30-40	none	3.9 4.1 4.2 4.2 4.3 4.3	4.2	
104	6744-1	Point (3237)	5/30-40	none	3.2 3.2 3.2 3.2 3.3 3.5	3.3	
105	2009-2	Point (3092)	1/80-90	none	4.5 4.5 4.7 4.7 4.7 4.8	4.7	
106	1-44	Point (3170)	IA/surface	none	4.5 4.7 4.7 4.8 4.8 4.9	4.7	
107	6064-1	Point (3237)	34/30-40	none	2.7 2.7 2.7 2.9 3.0 3.0	2.8	
108	2500-1	Point (3116)	--/surface	none	6.7 6.7 6.7 6.8 6.9 6.9	6.8	
109	115-1	Point (3160)	--/surface	none	6.2 6.2 6.2 6.3 6.4 6.4	6.3	
110	6004-1	Point (3204)	3/30-40	none	1.2 1.2 1.2 1.2 1.3 1.3	1.2	
111	4014-4	Point (3237)	14/surface	none	3.9 3.9 3.9 3.9 4.1 4.2	4.0	
112	6902-1	Point (3237)	66/10-20	none		DH	
113	01-502	Point (3032)	--/surface	none	5.4 5.4 5.4 5.5 5.6 5.6	5.5	
114	500-31	Point (3170)	--/surface	none	4.1 4.2 4.2 4.2 4.3 4.3	4.2	
115	500-67	Point (3170)	--/surface	none		NVB	
116	4072-1	Point (3170)	U72/surface	none	7.4 7.4 7.4 7.5 7.6 7.6	7.5	
117	500-21	Point (3237)	--/surface	none		NVB	
118	500-23	Point (3238)	--/surface	none		NVB	
119	500-25	Point (3238)	--/surface	none		NVB	
120	1019-5	Point (3190)	U19/surface	none	3.3 3.3 3.3 3.3 3.5 3.5	3.4	
121	4002-21	Point (3032)	U2/	none	1.3 1.3 1.4 1.4 1.4 1.4	1.4	
122	2500-1	Point (3092)	-----	none	1.0 1.0 1.0 1.1 1.1 1.2	1.1	

Lab Accession No.: 90-H979 Technician: Thomas M. Origer

NV-Misc. **Steve Botkin - Intermountain Research** **December 1990**

Lab#	Catalog#	Description	Provenience	Remarks	Readings	Mean	Source
123	510-46	Point (3095)	surface	none	1.3 1.3 1.4 1.4 1.6 1.6	1.4	
124	3011-1	Point (3095)	surface	none	1.3 1.4 1.4 1.6 1.6 1.6	1.5	
125	504-7	Point (3171)	surface	none	1.6 1.6 1.6 1.7 1.7 1.8	1.7	
126	4156-2	Point (3184)	U156/surface	none	1.2 1.2 1.2 1.2 1.3 1.4	1.3	
127	519-12	Point (3095)	surface	none	1.7 1.7 1.7 1.8 1.8 1.9	1.8	
128	103-1	Point (3148)	surface	none	1.7 1.7 1.8 1.8 1.9 1.9	1.8	
129	3006-4	Point (3251)	surface	none	2.4 2.4 2.5 2.5 2.5 2.5	2.5	
130	1018-3	Point (3198)	U18/surface	none	1.8 1.8 1.9 1.9 1.9 1.9	1.9	
131	500-8	Point (3237)	surface	none	4.8 4.9 4.9 5.0 5.0 5.0	4.9	
132	109-1	Point (3154)	surface	none	5.0 5.0 5.1 5.1 5.1 5.3	5.1	
133	500-5	Point (3239)	surface	none	5.3 5.3 5.3 5.3 5.4 5.4	5.3	
134	510-6	Flake Tool (3170)	surface	none	2.4 2.5 2.6 2.6 2.6 2.7	2.6	
135	500-33	Flake Tool (3170)	surface	none		NVB	
136	5069-1	Flake Tool (3184)	U69/surface	none	1.3 1.4 1.4 1.4 1.6 1.6	1.5	
137	3026-1	Flake Tool (3184)	surface	none	3.9 3.9 4.1 4.1 4.2 4.2	4.1	
138	506-2	Flake Tool (3190)	surface	none	7.4 7.4 7.4 7.5 7.6 7.8	7.5	
139	501-17	Flake Tool (3191)	surface	none		NVB	
140	501-7	Flake Tool (3191)	surface	none		NVB	
141	1021-1	Flake Tool (3192)	U21/surface	none	1.0 1.0 1.0 1.0 1.1 1.1	1.0	
142	1001-1	Flake Tool (3201)	U1/surface	none		NVB	
143	510-2	Flake Tool (3095)	surface	none	3.0 3.1 3.2 3.3 3.3 3.3	3.2	
144	6581-3	Flake Tool (3165)	U38/2-10	none	1.2 1.3 1.3 1.3 1.3 1.4	1.3	
145	500-32	Flake Tool (3237)	surface	none	6.4 6.6 6.6 6.6 6.7 6.7	6.6	

Lab Accession No.: 90-H979 Technician: Thomas M. Origer

APPENDIX N

Obsidian Source Characterizations

Richard E. Hughes

February 14, 1991

Dr. Robert G. Elston
Intermountain Research
Drawer 'A'
Silver City, NV 89428

Dear Bob:

Enclosed with this letter you will find copies of ten tables presenting x-ray fluorescence data generated from the analysis of 148 artifacts from the Tosawihi quarries and other sites in the immediate vicinity, Elko County, Nevada. The analyses were conducted pursuant to letter requests from Steve Botkin for IMR project 638-46.

Laboratory investigations were performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a Rh x-ray tube, a 50 kV x-ray generator, 1251 pulse processor (amplifier), 1236 bias/protection module, a 100 mHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30 mm^2 area. The x-ray tube was operated at 35.0 kV, .30 mA, using a .127 mm rhodium (Rh) primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity data for the trace elements zinc (Zn Kα), gallium (Ga Kα), rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα) and niobium (Nb Kα). Titanium (Ti Kα), manganese (Mn Kα), and total iron ($Fe_2O_3^T$) intensities were generated by operating the x-ray tube at 15.0 kV, .32 mA, with a .127 mm aluminum (Al) filter in an air path at 300 seconds livetime. Iron vs. manganese (Fe Kα/Mn Kα) ratios were computed from data generated by operating the x-ray tube at 12.0 kV, .30 mA, with a .127 mm Al filter in an air path at 300 seconds livetime. Data processing is executed by a Hewlett Packard Vectra™ microcomputer with operating software and analytical results stored on a Hewlett Packard 20 megabyte fixed disk. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from analysis of up to 26 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology (formerly National Bureau of Standards), the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France). Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988).

Trace element values on the enclosed tables are expressed in quantitative units (i.e. parts per million [ppm] by weight), and these were compared directly to values for known obsidian sources that appear in Hughes (1985, 1986, 1990), Jack and Carmichael (1969), Nelson (1984) and Skinner (1983, 1986), and unpublished data in my possession on certain other Nevada obsidians. Artifacts were matched to the profiles of known chemical types of obsidian on the basis of correspondences (at the 2-sigma level) in diagnostic trace element concentration values (i.e., ppm values for Rb, Sr, Y, Zr and, when necessary, Ba, Ti, Mn and $Fe_2O_3^T$ compositions) and/or Fe Kα/Mn Kα ratios. Artifact-to-source (geochemical type) correspondences were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards. The term "diagnostic" is used to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations show low intra-source variability

and marked variability across sources. Diagnostic elements, then, are those whose concentration values allow one to draw the clearest geochemical distinctions between sources (Hughes 1990). Although Ga and Nb ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they don't usually vary significantly across obsidian sources (see Hughes 1982, 1984). This is particularly true of Ga, which occurs in concentrations between 10-30 ppm in nearly all sources in the study area. Zn ppm values are infrequently diagnostic; they are always high in Zr-rich, Sr-poor peralkaline volcanic glasses, but otherwise they do not usually vary significantly between non-peralkaline sources.

The trace elemental composition measurements presented in the enclosed tables are reported to the nearest ppm to relect the resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. The resolution limits of the present x-ray fluorescence instrument for measurement of all elements appears in Hughes (1988) and Hughes and Lees (1991). When counting and fitting error uncertainty estimates (the "±" value in the tables) for a sample are greater than calibration-imposed limits of resolution, the larger number is preferred as a more conservative, robust reflection of elemental composition and measurement error due to variations in sample size, surface and x-ray reflection geometry (see Hughes 1988).

The enclosed data tables present the source attribution for each specimen, so I will not repeat individual artifact-to-source assignments. The majority of samples (71 of 146 [two samples were not obsidian]) match the trace element signature of parent obsidians of the Paradise Valley geochemical type, while 37 samples correspond with the trace element profiles of Browns Bench volcanic glass. As I discussed with you over the telephone, the Browns Bench obsidian is somewhat variable in trace element composition due to the fact that it was formed in a large ash-flow tuff sheet. Such sheets can produce artifact-quality glasses that vary in geochemical composition both horizontally and vertically. I am currently writing a paper with Bob Smith (due to be published later this year in the GSA Special Papers series) which deals with ash-flow tuff glasses (Browns Bench in paricular) from the standpoint of geochemistry and sourcing studies. Other glass types also are represented in the collection, albeit in smaller numbers. Pinto Peak, Bordwell Spring, Fox Mountain and Double H Mountains obsidians occur to the west of Tosawihi while Majuba Mountain and Malad are located, respectively, to the southwest and northeast of the Tosawihi sites. Several "Unknown" chemical types were identified employing supplementary xrf analyses but despite the geochemical coherence of the groupings, I know of no parent source locations for any of them.

Supplementary xrf analyses were conducted on 49 samples to generate barium (Ba), Fe/Mn ratios and Ti, Mn and $Fe_2O_3^T$ data. Ba ppm values appear on the data tables and the other measurements, by sample, follow. 3032.1.502, Fe/Mn =74; 3092.6205.1, Fe/Mn = 66; 3160.1084.1, Fe/Mn = 35; 3170.500.31, Fe/Mn = 60; 3170.510.6, Fe/Mn = 50; 3171.504.7, Fe/Mn = 67; 3198.508.1, Fe/Mn = 71 and 3251.1.10, Fe/Mn = 72. Sample 3092.6285.4: Ti = 467 ± 28 ppm, Mn = 206 ± 24 ppm, $Fe_2O_3^T$ = 1.03 ± .09 %; 3095.6041.1: Ti = 364 ± 24 ppm, Mn = 209 ± 23 ppm, $Fe_2O_3^T$ = 1.07 ± .09 %; 3170.508.3: Ti = 601 ± 23 ppm, Mn = 211 ± 23 ppm, $Fe_2O_3^T$ = 1.25 ± .09 %; 3172.500.7: Ti = 407 ± 23 ppm, Mn = 208 ± 23 ppm, $Fe_2O_3^T$ = 1.18 ± .09 %; 3237.6063.1: Ti = 405 ± 24 ppm, Mn = 198 ± 23 ppm, $Fe_2O_3^T$ = 1.02 ± .09%; 3238.2001.2: Ti = 395 ± 24 ppm, Mn = 193 ± 23 ppm; $Fe_2O_3^T$ = 1.05 ± .09%; 3251.4017.1: Ti = 559 ± 24 ppm, Mn = 197 ± 23 ppm, $Fe_2O_3^T$ = 1.02 ± .09 %; 3251.6183.3: Ti = 405 ± 25 ppm, Mn = 183 ± 23 ppm, $Fe_2O_3^T$ = 1.10 ± .09%; 3251.6422.5: Ti = 697 ± 26 ppm, Mn = 216 ± 23 ppm, $Fe_2O_3^T$ = 1.26 ± .09 %; and 3251.6481.2: Ti = 496 ± 26 ppm, Mn = 219 ± 23 ppm, $Fe_2O_3^T$ = 1.30 ± .09 %.

Overall I am struck by the large number of geochemically distinct obsidians represented in the Tosawihi project-- particularly when compared with the much more limited number represented at James Creek Shelter, a mere 50 km to the southeast. Some (much?) of this might be attributable to differences in sample sizes, site function, and/or time but the differences are noteworthy. Once these Tosawihi data are ordered by artifact class and time period some very interesting patterns may emerge.

Let me know if I can provide further assistance. I will return the samples to you under separate cover.

Sincerely,

Richard

Richard E. Hughes, Ph.D.

encl.

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Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
2672.1	72 ±6	21 ±3	225 ±5	46 ±3	64 ±2	443 ±5	46 ±4	---	Browns Bench
3032.23.1.502	200 ±6	25 ±3	208 ±5	0 ±3	96 ±2	532 ±5	32 ±3	---	Pinto Peak or Double H Mtns.
3032.24.01.1	66 ±5	20 ±3	344 ±5	0 ±3	74 ±2	72 ±4	15 ±3	---	Paradise Valley
3032.23.3001.8	46 ±5	19 ±3	252 ±5	21 ±3	67 ±2	365 ±5	46 ±3	---	Browns Bench
3032.23.3001.55	35 ±6	17 ±3	118 ±5	63 ±3	34 ±2	85 ±4	16 ±3	1457 ±15	Unknown A
3032.23.4002.21	68 ±5	21 ±3	362 ±6	1 ±3	83 ±2	71 ±4	14 ±3	---	Paradise Valley
3092.500.2	106 ±6	20 ±3	225 ±5	29 ±3	87 ±2	396 ±5	51 ±4	782 ±13	Browns Bench
3092.2009.2	68 ±5	23 ±3	367 ±5	1 ±3	80 ±2	76 ±4	19 ±3	---	Paradise Valley
3092.2500.1	70 ±6	26 ±3	373 ±6	0 ±3	84 ±2	75 ±4	17 ±4	---	Paradise Valley
3092.2599.13	67 ±5	20 ±3	360 ±6	0 ±3	81 ±2	72 ±4	19 ±3	---	Paradise Valley
3092.6205.1	191 ±6	23 ±6	198 ±5	0 ±3	96 ±2	486 ±5	26 ±3	---	Pinto Peak or Double H Mtns.
3092.6222.1	31 ±5	15 ±3	113 ±5	63 ±3	30 ±2	78 ±4	14 ±3	1225 ±12	Unknown A
3092.6285.4	93 ±8	25 ±4	399 ±7	1 ±3	84 ±3	77 ±4	18 ±4	---	Paradise Valley
3092.6362.1	85 ±7	23 ±4	384 ±6	2 ±3	86 ±3	73 ±4	20 ±4	---	Paradise Valley
3095.500.72	52 ±5	16 ±3	207 ±5	47 ±3	64 ±2	413 ±5	45 ±3	---	Browns Bench
3095.509.5	69 ±5	19 ±3	205 ±5	38 ±3	73 ±2	408 ±5	53 ±4	---	Browns Bench

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3095.510.2	74 ±5	17 ±3	214 ±5	32 ±3	84 ±2	400 ±5	50 ±3	---	Browns Bench
3095.510.3	42 ±5	15 ±3	123 ±5	68 ±3	34 ±2	88 ±4	14 ±3	1411 ±14	Malad, Idaho
3095.510.46	85 ±6	26 ±3	363 ±6	0 ±3	81 ±2	72 ±4	16 ±4	---	Paradise Valley
3095.519.12	43 ±5	15 ±3	127 ±5	70 ±3	35 ±2	87 ±4	15 ±3	1467 ±15	Malad, Idaho
3095.1045.1	58 ±5	22 ±3	356 ±5	0 ±3	79 ±2	73 ±4	17 ±3	---	Paradise Valley
3095.3011.1	81 ±6	22 ±3	347 ±6	0 ±3	81 ±2	71 ±4	16 ±4	---	Paradise Valley
3095.6001.1	71 ±6	23 ±3	348 ±6	0 ±3	77 ±2	74 ±4	16 ±4	---	Paradise Valley
3095.6041.1	81 ±6	30 ±3	401 ±6	1 ±3	87 ±2	79 ±4	18 ±4	---	Paradise Valley
3095.6480.2	52 ±6	20 ±3	160 ±5	22 ±3	18 ±2	79 ±4	21 ±4	28 ±12	Unknown
3116.501.1	60 ±5	21 ±3	339 ±5	0 ±3	75 ±2	69 ±4	15 ±3	---	Paradise Valley
3116.1002.1	72 ±6	23 ±3	379 ±6	0 ±3	79 ±2	76 ±4	16 ±4	---	Paradise Valley
3116.2500.1	66 ±5	23 ±3	347 ±6	0 ±3	75 ±2	69 ±4	14 ±3	---	Paradise Valley
3148.103.1	69 ±5	17 ±3	358 ±6	0 ±3	75 ±2	73 ±4	15 ±3	---	Paradise Valley
3154.109.1	66 ±5	21 ±3	365 ±6	0 ±3	81 ±2	72 ±4	17 ±3	---	Paradise Valley
3160.1.221	71 ±5	19 ±3	363 ±6	0 ±3	83 ±2	78 ±4	20 ±3	---	Paradise Valley
3160.115.1	79 ±5	21 ±3	382 ±6	2 ±3	80 ±2	75 ±4	16 ±3	---	Paradise Valley

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3160.500.107	66 ±5	21 ±3	356 ±6	0 ±3	80 ±2	70 ±4	17 ±3	---	Paradise Valley
3160.500.264	61 ±5	20 ±3	341 ±5	0 ±3	75 ±2	71 ±4	19 ±3	---	Paradise Valley
3160.500.326	64 ±5	19 ±3	334 ±6	0 ±3	81 ±2	69 ±4	16 ±3	---	Paradise Valley
3160.512.13	80 ±6	23 ±3	392 ±6	0 ±3	89 ±2	79 ±4	18 ±4	---	Paradise Valley
3160.1003.4	88 ±6	26 ±3	378 ±6	0 ±3	89 ±2	75 ±4	15 ±4	---	Paradise Valley
3160.1084.1	50 ±6	16 ±3	168 ±5	127 ±3	24 ±2	176 ±4	12 ±3	---	Majuba Mtn.
3160.6081.4	69 ±6	16 ±3	373 ±6	2 ±3	81 ±2	72 ±4	20 ±4	---	Paradise Valley
3160.6083.1	65 ±5	17 ±3	348 ±6	0 ±3	78 ±2	71 ±4	15 ±3	---	Paradise Valley
3160.6641.1	71 ±5	23 ±3	355 ±5	0 ±3	80 ±2	70 ±4	18 ±3	---	Paradise Valley
3165.500.1	63 ±5	21 ±3	338 ±5	0 ±3	80 ±2	70 ±4	15 ±3	---	Paradise Valley
3165.6581.3	67 ±5	19 ±3	363 ±6	0 ±3	80 ±2	74 ±4	16 ±3	---	Paradise Valley
3170.1.44	62 ±5	19 ±3	354 ±5	0 ±3	80 ±2	72 ±4	17 ±3	---	Paradise Valley
3170.500.30	62 ±5	17 ±3	210 ±5	43 ±3	64 ±2	424 ±5	43 ±3	---	Browns Bench
3170.500.31	148 ±6	25 ±3	172 ±5	1 ±3	77 ±2	406 ±5	23 ±3	---	Bordwell Spring
3170.500.33	14 ±11	4 ±4	0 ±3	29 ±3	3 ±2	10 ±4	2 ±4	---	Not obsidian
3170.500.43	89 ±5	19 ±3	227 ±5	32 ±3	86 ±2	417 ±5	54 ±3	---	Browns Bench

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3170.500.44	52 ±5	14 ±3	200 ±5	42 ±3	63 ±2	423 ±5	43 ±3	---	Browns Bench
3170.500.59	70 ±5	23 ±3	353 ±6	0 ±3	78 ±2	71 ±4	14 ±3	---	Paradise Valley
3170.500.67	55 ±5	20 ±3	213 ±5	41 ±3	63 ±2	409 ±5	44 ±3	---	Browns Bench
3170.508.3	65 ±5	13 ±3	276 ±5	0 ±3	73 ±2	74 ±4	15 ±3	---	Paradise Valley
3170.510.6	121 ±5	15 ±3	120 ±5	0 ±3	59 ±2	340 ±4	20 ±3	---	Fox Mtn.?
3170.2002.1	90 ±6	17 ±3	111 ±5	19 ±3	62 ±2	425 ±5	32 ±3	---	Browns Bench
3170.2599.900	43 ±6	20 ±3	211 ±5	25 ±3	29 ±2	96 ±4	13 ±3	134 ±13	Unknown D
3170.4067.1	63 ±5	21 ±3	345 ±5	0 ±3	80 ±2	70 ±4	15 ±3	---	Paradise Valley
3170.4072.1	51 ±5	19 ±3	328 ±6	2 ±3	50 ±2	106 ±4	38 ±3	0 ±10	Unknown E
3170.5077.1	41 ±5	14 ±3	118 ±5	66 ±3	32 ±2	83 ±4	15 ±3	1479 ±14	Unknown A
3170.5078.1	35 ±7	14 ±4	101 ±5	68 ±3	27 ±2	105 ±4	11 ±4	1339 ±15	Unknown A
3171.1.9	38 ±5	15 ±3	187 ±5	36 ±3	26 ±2	103 ±4	25 ±3	147 ±12	Unknown D
3171.500.11	62 ±5	16 ±3	362 ±6	1 ±3	80 ±2	76 ±4	19 ±3	---	Paradise Valley
3171.504.7	190 ±7	23 ±3	183 ±5	0 ±3	97 ±2	491 ±5	28 ±3	---	Pinto Peak or Double H Mtns.
3172.500.6	66 ±5	21 ±3	357 ±6	0 ±3	75 ±2	69 ±4	16 ±3	---	Paradise Valley
3172.500.7	69 ±5	18 ±3	319 ±6	0 ±3	79 ±2	68 ±4	19 ±3	---	Paradise Valley

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3178.502.1	74 ±7	13 ±4	214 ±6	50 ±3	71 ±2	429 ±6	49 ±4	---	Browns Bench
3184.1.2	70 ±5	21 ±3	354 ±5	0 ±3	75 ±2	73 ±4	15 ±3	---	Paradise Valley
3184.500.3	41 ±5	16 ±3	201 ±5	21 ±3	32 ±2	91 ±4	12 ±3	156 ±11	Unknown D
3184.508.5	73 ±5	23 ±3	352 ±5	0 ±3	75 ±2	74 ±4	18 ±3	---	Paradise Valley
3184.1001.9	58 ±5	20 ±3	172 ±5	13 ±3	45 ±2	54 ±4	32 ±3	29 ±11	Timber Butte, Idaho
3184.3026.1	42 ±5	16 ±3	205 ±5	23 ±3	32 ±2	93 ±4	11 ±3	133 ±11	Unknown D
3184.4156.2	45 ±5	17 ±3	206 ±5	30 ±3	30 ±2	114 ±4	14 ±3	358 ±12	Unknown
3184.5069.1	41 ±6	18 ±3	132 ±5	27 ±3	37 ±2	195 ±4	20 ±3	510 ±13	Unknown
3185.16.1	76 ±6	16 ±3	225 ±5	50 ±3	68 ±2	449 ±5	43 ±4	---	Browns Bench
3185.16.2	66 ±5	16 ±3	211 ±5	48 ±3	65 ±2	465 ±5	52 ±3	---	Browns Bench
3189.500.1	60 ±5	17 ±3	194 ±5	39 ±3	73 ±2	401 ±5	52 ±3	---	Browns Bench
3190.506.2	51 ±5	19 ±3	181 ±5	42 ±3	68 ±2	400 ±5	42 ±3	---	Browns Bench
3190.507.1	52 ±5	22 ±3	209 ±5	42 ±3	67 ±2	405 ±5	46 ±3	---	Browns Bench
3190.1019.1	58 ±5	16 ±3	216 ±5	46 ±3	69 ±2	438 ±5	43 ±3	---	Browns Bench
3190.1019.5	66 ±5	17 ±3	241 ±5	20 ±3	71 ±2	358 ±5	46 ±3	---	Browns Bench
3190.1045.1	65 ±6	19 ±3	231 ±5	21 ±3	70 ±2	354 ±5	43 ±3	---	Browns Bench

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3191.501.7	58 ±5	22 ±3	224 ±5	20 ±3	68 ±2	333 ±4	44 ±3	---	Browns Bench
3191.501.12	62 ±5	16 ±3	197 ±5	40 ±3	61 ±2	398 ±5	41 ±3	---	Browns Bench
3191.501.13	64 ±5	16 ±3	225 ±5	18 ±3	65 ±2	338 ±4	44 ±3	---	Browns Bench
3191.501.14	78 ±5	24 ±3	235 ±5	19 ±3	74 ±2	366 ±5	47 ±3	---	Browns Bench
3191.501.17	50 ±5	17 ±3	224 ±5	23 ±3	63 ±2	340 ±5	43 ±3	---	Browns Bench
3191.501.23	50 ±6	14 ±3	195 ±5	39 ±3	64 ±2	389 ±5	44 ±3	---	Browns Bench
3191.501.24	45 ±5	15 ±3	232 ±5	19 ±3	65 ±2	324 ±5	44 ±3	---	Browns Bench
3191.501.25	59 ±5	16 ±3	211 ±5	18 ±3	69 ±2	351 ±5	45 ±3	---	Browns Bench
3191.1004.1	73 ±6	25 ±3	374 ±6	0 ±3	81 ±2	73 ±4	19 ±4	---	Paradise Valley
3192.502.8	61 ±5	14 ±3	100 ±5	149 ±3	26 ±2	92 ±4	8 ±4	1019 ±14	Unknown C
3192.1021.1	57 ±5	22 ±3	103 ±5	134 ±3	28 ±2	85 ±4	13 ±3	887 ±14	Unknown
3192.2061.4	36 ±5	15 ±3	195 ±5	21 ±3	31 ±2	94 ±4	13 ±3	146 ±11	Unknown D
3192.2061.6	47 ±6	24 ±3	214 ±5	24 ±3	34 ±2	105 ±4	10 ±4	182 ±12	Unknown D
3192.2065.7	72 ±5	21 ±3	195 ±5	122 ±3	34 ±2	154 ±4	30 ±3	559 ±11	Unknown
3192.6264.3	37 ±7	10 ±4	132 ±5	178 ±4	15 ±2	159 ±5	10 ±4	893 ±19	Unknown
3198.508.1	220 ±7	23 ±3	210 ±5	0 ±3	97 ±2	509 ±6	30 ±4	---	Pinto Peak or Double H Mtns.

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3198.1003.2	40 ±5	18 ±3	211 ±5	26 ±3	30 ±2	107 ±4	11 ±3	239 ±11	Unknown F
3198.1007.1	36 ±5	14 ±3	199 ±5	26 ±3	27 ±2	105 ±4	12 ±3	221 ±12	Unknown F
3198.1016.1	44 ±5	17 ±3	120 ±5	69 ±3	37 ±2	87 ±4	15 ±3	1548 ±15	Malad, Idaho
3198.1017.2	15 ±34	14 ±6	115 ±6	71 ±4	17 ±3	151 ±5	15 ±4	1060 ±12	Unknown
3198.1018.1	76 ±6	20 ±3	207 ±5	49 ±3	68 ±2	449 ±5	48 ±4	---	Browns Bench
3198.1018.2	63 ±5	16 ±3	207 ±5	45 ±3	66 ±2	449 ±5	43 ±3	---	Browns Bench
3198.1018.3	66 ±5	21 ±3	198 ±5	45 ±3	63 ±2	445 ±5	43 ±3	---	Browns Bench
3198.1025.901	72 ±6	21 ±3	216 ±5	45 ±3	72 ±2	416 ±5	43 ±4	---	Browns Bench
3201.1001.1	50 ±6	19 ±3	205 ±5	44 ±3	64 ±2	443 ±5	42 ±4	---	Browns Bench
3204.500.74	73 ±5	22 ±3	367 ±6	0 ±3	83 ±2	75 ±4	17 ±3	---	Paradise Valley
3204.6004.1	70 ±6	17 ±3	363 ±6	1 ±3	86 ±2	77 ±4	19 ±4	---	Paradise Valley
3231.1001.1	56 ±5	16 ±3	193 ±5	42 ±3	61 ±2	459 ±5	40 ±3	---	Browns Bench
3234.500.3	54 ±5	16 ±3	194 ±5	48 ±3	64 ±2	444 ±5	41 ±3	---	Browns Bench
3237.1.17	66 ±5	22 ±3	328 ±6	0 ±3	76 ±2	68 ±4	15 ±3	---	Paradise Valley
3237.1.18	57 ±5	20 ±3	346 ±6	0 ±3	75 ±2	69 ±4	18 ±3	---	Paradise Valley
3237.1.26	72 ±5	21 ±3	365 ±6	0 ±3	83 ±2	75 ±4	15 ±3	---	Paradise Valley

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3237.500.8	68 ±6	24 ±3	355 ±6	0 ±3	81 ±2	71 ±4	19 ±3	---	Paradise Valley
3237.500.21	60 ±6	20 ±3	211 ±5	40 ±3	67 ±2	407 ±5	44 ±3	---	Browns Bench
3237.500.22	52 ±5	16 ±3	169 ±5	16 ±3	24 ±2	123 ±4	34 ±3	38 ±11	Unknown
3237.500.32	58 ±5	23 ±3	336 ±6	0 ±3	74 ±2	69 ±4	16 ±3	---	Paradise Valley
3237.500.33	78 ±5	22 ±3	361 ±6	0 ±3	80 ±2	70 ±4	18 ±3	---	Paradise Valley
13237.2141.1	89 ±8	23 ±4	359 ±7	0 ±3	77 ±3	74 ±4	16 ±4	---	Paradise Valley
3237.4014.4	69 ±5	20 ±3	342 ±6	1 ±3	77 ±2	72 ±4	17 ±3	---	Paradise Valley
3237.6063.1	82 ±7	31 ±4	393 ±7	0 ±3	82 ±3	77 ±4	18 ±4	---	Paradise Valley
3237.6064.1	73 ±5	21 ±3	358 ±6	1 ±3	81 ±2	71 ±4	18 ±3	---	Paradise Valley
3237.6084.1	67 ±5	17 ±3	353 ±6	1 ±3	79 ±2	69 ±4	18 ±3	---	Paradise Valley
3237.6744.1	66 ±5	22 ±3	341 ±5	0 ±3	76 ±2	69 ±4	15 ±3	---	Paradise Valley
3237.6744.7	68 ±5	22 ±3	339 ±5	0 ±3	76 ±2	69 ±4	18 ±3	---	Paradise Valley
3237.6902.1	73 ±5	22 ±3	360 ±6	1 ±3	78 ±2	74 ±4	18 ±3	---	Paradise Valley
3237.6903.3	77 ±7	24 ±3	367 ±6	2 ±3	80 ±3	77 ±4	16 ±4	---	Paradise Valley
3238.500.23	31 ±5	12 ±3	125 ±5	149 ±3	15 ±2	150 ±4	10 ±3	926 ±12	Unknown B
3238.500.24	49 ±5	14 ±3	151 ±5	109 ±3	23 ±2	156 ±4	13 ±3	911 ±12	Unknown B

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3238.500.25	41 ±8	0 ±4	16 ±5	82 ±3	32 ±2	13 ±5	4 ±4	---	Not obsidian
3238.2001.2	90 ±6	21 ±3	401 ±6	0 ±3	84 ±2	71 ±4	19 ±4	---	Paradise Valley
3239.500.1	77 ±6	16 ±3	364 ±6	0 ±3	80 ±2	71 ±4	16 ±3	---	Paradise Valley
3239.500.5	67 ±5	24 ±3	365 ±6	0 ±3	79 ±2	72 ±4	19 ±3	---	Paradise Valley
3239.501.1	69 ±5	23 ±3	356 ±5	0 ±3	76 ±2	71 ±4	15 ±3	---	Paradise Valley
3239.1001.5	68 ±6	18 ±3	366 ±6	0 ±3	80 ±2	71 ±4	18 ±4	---	Paradise Valley
3251.1.10	211 ±7	25 ±4	216 ±5	3 ±3	104 ±2	538 ±6	29 ±4	---	Double H Mtns.
3251.3006.4	79 ±6	21 ±3	376 ±6	1 ±3	87 ±2	76 ±4	17 ±4	---	Paradise Valley
3251.4017.1	94 ±7	23 ±4	395 ±6	1 ±3	91 ±3	80 ±4	22 ±4	---	Paradise Valley
3251.6065.1	80 ±6	19 ±3	356 ±6	1 ±3	81 ±2	74 ±4	15 ±3	---	Paradise Valley
3251.6183.3	96 ±8	33 ±4	422 ±7	0 ±3	86 ±3	76 ±4	16 ±4	---	Paradise Valley
3251.6185.2	76 ±6	27 ±3	373 ±6	1 ±3	87 ±2	77 ±4	18 ±4	---	Paradise Valley
3251.6442.5	99 ±6	28 ±4	392 ±6	1 ±3	82 ±2	75 ±4	16 ±4	---	Paradise Valley
3251.6481.2	112 ±8	35 ±4	459 ±8	1 ±3	93 ±3	82 ±4	17 ±4	---	Paradise Valley?
3251.6543.1	70 ±5	23 ±3	214 ±5	44 ±3	66 ±2	417 ±5	46 ±3	---	Browns Bench
3271.500.27	74 ±5	20 ±3	353 ±5	0 ±3	84 ±2	75 ±4	15 ±3	---	Paradise Valley

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

Trace Element Concentrations

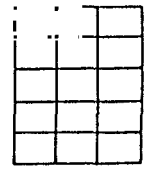
Specimen Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Geochemical Type)
3271.500.191	68 ±5	21 ±3	335 ±5	0 ±3	75 ±2	70 ±4	17 ±3	---	Paradise Valley
3271.522.1	81 ±6	20 ±3	253 ±6	5 ±3	72 ±2	101 ±4	44 ±4	8 ±11	Unknown
3271.1046.5	57 ±5	12 ±3	104 ±5	161 ±3	29 ±2	98 ±4	13 ±3	1034 ±14	Unknown C
3271.2021.1	79 ±5	21 ±3	340 ±5	1 ±3	76 ±2	71 ±4	16 ±3	---	Paradise Valley

Trace element values in parts per million (ppm,±=pooled estimate (in ppm) of x-ray counting uncertainty and linear regression fitting error at 200 and 300 (*) seconds livetime.---=not measured.

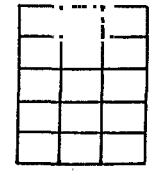
APPENDIX O

Tool Assemblages, by Site and Locus

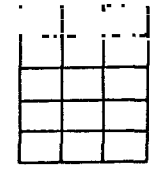
Appendix O. Tool assemblages, by site and locus



			TOOL TYPES																					
			PROJECTILE POINTS												FLAKE TOOLS									
Site	Locality	Locus	Cottonwood	Desert S.N.	Rosegate	Elko	Gatecliff	Humboldt	Large S.N.	Stemmed	Clovis	Out of key	Fragmentary	Cores	Preforms	Scrapers	Pointed tools	Bifacial tools	Retouched flakes	Tool fragments	Notch/denticulate	Crude ret'd. flakes	Microdenticulate	Discoidal tools
3032	4		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	19		-	-	-	-	-	-	-	-	-	-	-	5	-	8	-	-	5	2	4	3	-	-
3032	20		-	-	-	1	-	-	-	-	-	-	-	4	-	1	-	-	3	1	1	-	-	-
3032	21		-	-	-	-	-	-	-	-	-	-	-	8	-	-	1	-	1	-	-	-	-	-
3032	22		-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	1	-	-	-	-
3032	23		-	-	-	-	-	-	-	3	-	1	2	10	1	4	3	-	6	1	9	2	-	-
3032	24		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
3032	25		-	-	-	-	-	-	-	-	-	-	-	6	-	2	3	-	5	2	1	-	-	-
3032	26		-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-
3032	28		-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	40		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
3032	72		-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
3032	93		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	98		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3032	107		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	138		-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	152		-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	158		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
3075			-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3082			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3084			-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-
3085			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3086			-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-

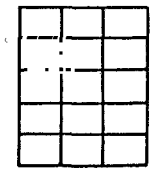


			GROUNDSTONE								CERAMIC WARES			BONE ARTIFACTS						HAMMERSTONES/HEAVY TOOLS				
Site	Locality	Locus	Chopper-hammers	Misc. flake tools	Manos	Metates	Mortars	Pestles	Abraders	Exotics	Brown	Gray	Indet.	Awls	Beads	Misc. tools	Flakers	Scoops	Wedges	Med.& small hammers	Choppers	Scratched stones	Shovels	Large hammers
3032	4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	19		1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3032	20		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	21		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	22		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	23		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-
3032	24		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	25		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-
3032	26		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	28		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	40		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	72		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	93		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	98		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3032	107		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	138		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	152		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3032	158		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3075			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3082			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3084			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	1
3085			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
3086			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

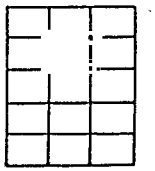


			BIFACES			TOOL CLASSES						SUMMARY DATA			RESOURCE DISTANCES	
Site	Locality	Locus	Modified chunks	Stages 1-3.5	Stages 3.5-5	Quarry tools	Weapons	Fabricating/ Processing byproducts	tools	General utility tools	Domestic equipt.	Type Richness	Class Richness	Assemblage size	to water (m)	to toolstone(m)
3032	4		-	-	-	-	1	-	-	-	-	1	1	1	<250	<250
3032	19		-	28	26	-	-	33	12	39	1	11	4	85	<500	<250
3032	20		-	8	11	-	1	12	2	15	-	8	4	30	<500	<250
3032	21		4	4	1	-	-	16	1	2	-	6	3	19	<500	<250
3032	22		-	5	-	-	-	8	-	1	-	3	2	9	<500	<250
3032	23		3	43	14	1	6	57	16	26	-	17	5	106	<500	<250
3032	24		-	-	-	-	-	1	-	-	-	1	1	1		
3032	25		2	67	12	-	-	75	6	24	-	11	3	105	<500	<250
3032	26		-	-	-	-	-	5	-	1	-	2	2	6	<250	<250
3032	28		-	-	-	-	1	-	-	-	-	1	1	1	<250	<250
3032	40		-	-	-	-	1	-	-	-	-	1	1	1	500+	<250
3032	72		-	-	-	-	1	-	-	-	-	1	1	1	<250	<250
3032	93		-	-	-	-	-	-	-	-	1	1	1	1		
3032	98		-	6	2	-	-	6	1	3	-	4	3	10	<500	<250
3032	107		-	-	-	-	1	-	-	-	-	1	1	1	<500	<250
3032	138		-	-	-	-	2	-	-	-	-	2	1	2	<250	<250
3032	152		-	-	-	-	1	-	-	-	-	1	1	1		
3032	158		-	-	-	-	1	-	-	-	-	1	1	1	500+	<250
3075			-	-	-	-	1	-	-	-	-	1	1	1		
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3084			-	2	-	1	-	2	1	6	-	6	4	10	<250	<250
3085			-	-	-	-	-	-	-	2	-	2	1	2	<250	<250
3086			-	4	-	-	-	4	2	-	-	3	2	6	<250	<500

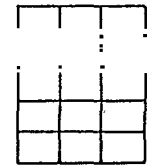
Appendix O. Tool assemblages, by site and locus



			TOOL TYPES																					
			PROJECTILE POINTS												FLAKE TOOLS									
Site	Local-ity	Lo-cus	Cotton-wood	Desert S.N.	Rose-gate	Elko	Gate-cliff	Hum-boldt	Large S.N.	Stem-med	Clo-vis	Out of key	Frag-men-tary	Cores	Pre-forms	Scra-pers	Point-ed tools	Bifac-ial tools	Re-touched flakes	Tool frag-ments	Notch/ dentic-ulate	Crude ret'd. flakes	Micro-dentic-ulate	Disc-oidal tools
3087			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3088			-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3090			-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3091			-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
3092			6	8	2	-	3	2	-	1	-	1	14	13	29	24	13	4	67	21	6	4	2	1
3093			-	-	-	-	-	-	1	-	-	1	-	2	6	-	1	-	2	-	-	-	-	-
3095			5	4	3	2	4	-	-	-	-	5	13	7	17	9	8	2	23	10	3	2	2	-
3096			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3099			-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
3100			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3101			-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
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3102			-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
3104			-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
3106			1	-	-	-	-	-	-	-	-	1	-	2	-	3	-	-	-	-	-	-	-	-
3107			-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3110			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3114			-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-
3115			-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	2	-	-	-	-	-
3116			-	2	-	-	-	1	-	-	-	-	3	-	3	3	2	-	2	1	-	-	-	-
3123			-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3125			-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
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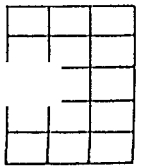


			GROUNDSTONE								CERAMIC WARES			BONE ARTIFACTS						HAMMERSTONES/HEAVY TOOLS				
Site	Local-ity	Lo-cus	Chopper-hammers	Misc. flake tools	Manos	Meta-tes	Mor-tars	Pes-tles	Abra-ders	Exo-tics	Brown	Gray	Indet.	Awls	Beads	Misc. tools	Fla-kers	Scoops	Wedges	Med.& small hammers	Chop-pers	Scrat-ched stones	Sho-vels	Large ham-mers
3087			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3088			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3090			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3091			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3092			3	2	-	7	1	-	1	-	3	2	-	1	1	1	1	-	-	18	4	-	-	-
3093			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3095			-	-	1	11	-	1	3	14	-	-	-	-	-	-	-	-	-	9	2	1	-	1
3096			-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-
3099			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
3100			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3101			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3101		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3102			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3104			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
3106			-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
3107			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3110			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3114			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
3115			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3116			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3123			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3125			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3142			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

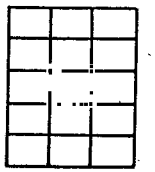


				BIFACES		TOOL CLASSES						SUMMARY DATA			RESOURCE DISTANCES	
Site	Local-ity	Lo-cus	Mod-ified chunks	Stages 1-3.5	Stages 3.5-5	Quar-ry tools	Weap-ons	Fabricating/ Processing byproducts	tools	General utility tools	Domes-tic equipt.	Type Rich-ness	Class Rich-ness	Assem-blage size	to water (m)	to tool-stone(m)
3087			-	4	-	-	-	4	-	-	-	1	1	4	<250	<250
3088			-	2	-	-	-	2	1	-	-	2	2	3	<250	<250
3090			-	2	2	-	-	2	1	2	-	3	3	5	<250	<250
3091			-	2	1	-	-	3	-	1	-	3	2	4	<250	<250
3092			7	196	161	-	37	245	48	286	14	35	5	630	<250	<250
3093			-	7	22	-	2	15	1	25	-	9	4	43	<250	<500
3095			4	162	212	1	36	190	26	260	27	29	6	540	<250	<500
3096			1	10	1	-	-	11	-	4	1	6	3	16	<250	<500
3099			-	1	5	-	1	2	-	7	-	6	3	10	<250	<250
3100			1	-	-	-	-	1	-	-	-	1	1	1	500+	<250
3101			-	3	11	-	1	3	1	12	-	5	4	17	<500	<250
3101		1	1	2	2	-	-	3	1	3	-	5	3	7	<500	<250
3102			1	6	5	-	1	7	-	6	-	5	3	14	<500	<250
3104			1	-	5	-	-	5	-	7	-	5	2	12	500+	<250
3106			1	28	16	-	2	31	4	17	1	10	5	55	500+	<250
3107			-	3	1	-	1	3	-	2	-	4	3	6	<500	<250
3110			-	-	1	-	-	-	-	1	-	1	1	1	<500	<500
3114			-	4	2	-	1	4	2	3	-	6	4	10	<500	500+
3115			-	3	3	-	-	3	2	5	-	5	3	10	<500	<500
3116			-	1	5	-	6	4	5	8	-	10	4	23	<500	<500
3123			-	-	-	-	1	-	-	-	-	1	1	1		
3125			-	-	-	-	1	-	-	-	-	1	1	1		
3142			-	-	-	-	1	-	-	-	-	1	1	1		

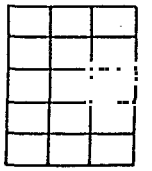
Appendix O. Tool assemblages, by site and locus



			TOOL TYPES																					
			PROJECTILE POINTS												FLAKE TOOLS									
Site	Locality	Locus	Cottonwood	Desert S.N.	Rosegate	Elko	Gatecliff	Humboldt	Large S.N.	Stemmed	Clovis	Out of key	Fragmentary	Cores	Preforms	Scrapers	Pointed tools	Bifacial tools	Retouched flakes	Tool fragments	Notch/denticulate	Crude ret'd. flakes	Microdenticulate	Discoidal tools
3144			-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
3148			-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
3149			-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	-	1	-	-	-
3154			-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
3155			-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3160			1	-	3	8	2	1	1	1	-	1	4	1	10	6	4	-	10	6	1	-	-	-
3160		A	6	4	1	3	-	-	-	-	-	-	12	1	27	3	6	1	9	8	1	-	-	-
3160		B	-	-	-	-	-	-	-	-	-	1	-	-	2	1	1	-	-	-	-	-	-	-
3160		C	1	3	2	-	-	-	-	-	-	-	3	-	12	2	4	1	7	4	3	-	1	-
3162			-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
3165			-	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-	2	-	2	-	1	-
3165		A	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	4	1	-	-	-	-
3171			-	1	-	-	-	-	-	-	-	1	-	8	4	4	2	-	4	2	-	-	-	4
3172			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3173			-	-	-	-	-	-	-	-	-	-	2	1	-	2	-	1	1	-	-	-	-	-
3174			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3175			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3177			-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
3178			-	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
3179			-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
3180			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3181			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	-
3183			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

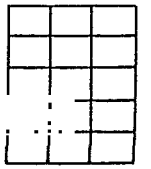


			GROUNDSTONE								CERAMIC WARES			BONE ARTIFACTS						HAMMERSTONES/HEAVY TOOLS				
Site	Locality	Locus	Chopper-hammers	Misc. flake tools	Manos	Metates	Mortars	Pestles	Abraders	Exotics	Brown	Gray	Indet.	Awls	Beads	Misc. tools	Flakers	Scoops	Wedges	Med.& small hammers	Choppers	Scratched stones	Shovels	Large hammers
3144			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3148			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3149			-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3154			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3155			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3160			-	-	-	7	2	2	-	1	-	-	-	-	-	-	-	-	-	1	2	-	-	-
3160		A	2	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3160		B	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3160		C	-	2	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-	4	2	1	1	-
3162			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3165			-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3165		A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3171			-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-	1	-	-
3172			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3173			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3174			-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3175			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3177			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3178			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3179			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3180			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3181			-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3183			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

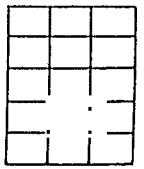


				BIFACES		TOOL CLASSES						SUMMARY DATA			RESOURCE DISTANCES	
Site	Locality	Locus	Modified chunks	Stages 1-3.5	Stages 3.5-5	Quarry tools	Weapons	Fabricating/ Processing byproducts	tools	General utility tools	Domestic equipt.	Type Richness	Class Richness	Assemblage size	to water (m)	to toolstone(m)
3144			-	-	-	-	1	-	-	-	-	1	1	1		
3148			-	-	-	-	1	-	-	-	-	1	1	1		
3149			-	5	3	-	3	5	1	7	2	8	5	18	<250	<500
3154			-	-	-	-	1	-	-	-	-	1	1	1		
3155			-	-	-	-	-	1	-	-	-	1	1	1		
3160			1	59	345	-	22	71	11	364	12	25	5	480	<500	<500
3160		A	-	24	66	-	26	52	10	87	2	19	5	177	<500	<500
3160		B	1	4	11	-	1	7	2	11	3	10	5	24	<500	500+
3160		C	2	31	95	-	9	45	12	116	3	23	5	185	<500	<500
3162			-	-	-	-	1	-	-	-	-	1	1	1		
3165			1	14	35	-	3	17	3	37	3	9	5	63	500+	500+
3165		A	-	7	12	-	-	8	-	17	1	6	3	26	500+	500+
3171			6	34	52	-	2	52	7	64	2	16	5	127	<250	<250
3172			-	1	5	-	-	1	-	5	-	2	2	6	<250	<250
3173			-	3	5	-	2	4	2	7	-	7	4	15	<250	<500
3174			-	-	1	-	-	-	-	1	1	2	2	2	<500	<500
3175			-	-	-	-	-	-	-	-	-	-	-	-		
3177			-	2	1	-	2	2	-	2	-	4	3	6	<250	<250
3178			1	6	4	-	3	7	-	4	-	5	3	14	<250	<250
3179			-	-	2	-	-	-	2	3	-	3	2	5	<250	<250
3180			-	-	-	-	-	-	-	-	-	-	-	-		
3181			-	1	4	-	-	1	-	9	2	6	3	12	<500	<250
3183			-	-	3	-	-	-	-	3	-	1	1	3	<500	<250

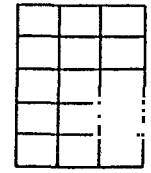
Appendix O. Tool assemblages, by site and locus



			TOOL TYPES																					
			PROJECTILE POINTS												FLAKE TOOLS									
Site	Local-ity	Lo-cus	Cotton-wood	Desert S.N.	Rose-gate	Elko	Gate-cliff	Hum-boldt	Large S.N.	Stem-med	Clo-vis	Out of key	Frag-men-tary	Cores	Pre-forms	Scra-pers	Point-ed tools	Bifac-ial tools	Re-touched flakes	Tool frag-ments	Notch/ dentic-ulate	Crude ret'd. flakes	Micro-dentic-ulate	Disc-oidal tools
3184			1	1	-	2	-	-	1	-	-	1	1	9	6	16	5	-	34	11	8	1	-	-
3185			2	3	-	-	-	-	-	-	-	1	2	-	4	7	-	2	3	-	1	-	-	-
3186			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3189			-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3190			-	2	-	-	-	-	-	-	-	1	6	2	2	4	4	-	6	3	-	-	-	-
3191			-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	4	-	-	-	-	-
3192			1	4	-	-	-	1	-	1	-	-	9	4	4	25	4	1	31	5	1	-	-	-
3193			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3195			-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	1
3196			-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-
3197			-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3198			4	4	-	-	1	2	-	-	-	-	16	7	15	2	1	1	5	4	-	-	-	-
3200			-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3201			-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
3202			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3203			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3204			-	-	2	-	-	-	1	-	-	-	3	2	5	3	5	-	9	1	3	-	-	-
3207			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3208			-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
3228			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3231			-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3232			-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
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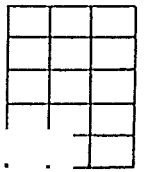


			GROUNDSTONE								CERAMIC WARES			BONE ARTIFACTS							HAMMERSTONES/HEAVY TOOLS				
Site	Locality	Locus	Chopper-hammers	Misc. flake tools	Manos	Metates	Mortars	Pestles	Abraders	Exotics	Brown	Gray	Indet.	Awls	Beads	Misc. tools	Flakers	Scoops	Wedges	Med.& small hammers	Choppers	Scratched stones	Shovels	Large hammers
3184			1	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	3	1	-	-	-
3185			-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-
3186			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3189			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3190			-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3191			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3192			1	1	2	5	-	-	-	1	1	-	-	-	-	-	-	-	-	4	-	2	-	-
3193			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
3195			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	2
3196			-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-
3197			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-
3198			-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-
3200			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-
3201			-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	1	-	-
3202			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3203			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3204			-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	1	-	-
3207			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3208			1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4	1	1	-	-
3228			-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3231			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3232			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3234			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

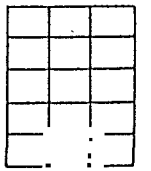


				BIFACES		TOOL CLASSES						SUMMARY DATA			RESOURCE DISTANCES	
Site	Locality	Locus	Modified chunks	Stages 1-3.5	Stages 3.5-5	Quarry tools	Weapons	Fabricating/ Processing byproducts	tools	General utility tools	Domestic equipt.	Type Richness	Class Richness	Assemblage size	to water (m)	to toolstone(m)
3184			5	74	165	-	7	94	30	216	2	23	5	349	<500	<250
3185			-	15	4	-	8	19	9	11	1	14	5	48	<250	<250
3186			-	-	1	-	-	-	-	1	-	1	1	1	<250	<250
3189			-	1	-	-	-	2	-	-	-	2	1	2	<250	<250
3190			-	29	15	-	9	33	9	24	1	13	5	76	<250	<250
3191			-	2	1	-	1	3	1	5	-	6	4	10	<250	<250
3192			4	86	89	-	16	98	32	132	9	24	5	287	<250	<250
3193			-	10	10	-	-	10	1	11	-	4	3	22	<250	<250
3195			-	23	12	2	-	23	3	17	-	6	4	45	<250	<250
3196			4	17	2	-	-	21	2	11	1	7	4	35	<250	<250
3197			-	26	2	-	-	26	1	8	-	4	3	35	<250	<250
3198			-	20	41	-	27	42	4	53	1	17	5	127	<250	<250
3200			-	7	2	1	-	7	1	4	-	6	4	13	<500	<250
3201			-	19	8	-	-	19	2	12	2	7	4	35	<250	<250
3202			-	2	1	-	-	2	-	1	-	2	2	3	<500	<250
3203			2	5	-	-	-	7	-	-	-	2	1	7	<500	<250
3204			6	55	18	-	6	68	12	36	1	16	5	123	<500	<250
3207			-	-	-	-	-	-	-	-	-	-	-	-		
3208			-	-	-	-	1	-	3	6	1	7	4	11	<250	<250
3228			-	2	5	-	-	2	-	5	1	3	3	8	<250	<250
3231			-	-	1	-	1	1	-	1	-	3	3	3	<250	<250
3232			-	5	-	-	-	6	-	-	-	2	1	6	<250	<250
3234			-	2	-	-	-	2	-	-	-	1	1	2	<250	<250

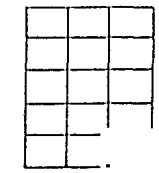
Appendix O. Tool assemblages, by site and locus



			TOOL TYPES																					
			PROJECTILE POINTS												FLAKE TOOLS									
Site	Locality	Locus	Cottonwood	Desert S.N.	Rosegate	Elko	Gatecliff	Humboldt	Large S.N.	Stemmed	Clovis	Out of key	Fragmentary	Cores	Preforms	Scrapers	Pointed tools	Bifacial tools	Retouched flakes	Tool fragments	Notch/denticulate	Crude ret'd. flakes	Microdenticulate	Discoidal tools
3237			-	-	1	-	1	-	1	1	-	1	2	2	2	2	-	-	1	1	-	-	-	-
3237		A	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
3237		B	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3237		C	1	7	1	7	2	3	2	1	1	1	9	2	15	4	5	2	6	4	2	-	-	-
3238			-	-	-	-	1	-	1	2	-	-	1	1	-	1	-	-	-	-	-	-	-	-
3238		A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3239			-	-	1	1	-	-	-	-	-	-	-	-	3	1	2	-	-	-	-	-	-	1
3251			1	2	6	-	1	2	-	-	-	3	30	-	63	4	9	-	8	16	1	-	-	-
3262			-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
3271			-	2	5	1	-	-	1	-	-	-	6	2	3	1	8	-	1	-	-	-	-	-
3271		A	-	-	-	-	-	-	-	-	-	-	2	1	-	2	-	-	1	-	1	-	-	-
3271		B	-	-	3	-	-	1	-	-	-	-	1	3	4	4	-	1	9	2	3	-	-	1
3271		C	-	-	-	-	-	-	-	-	-	-	1	-	3	-	2	1	3	2	1	-	-	-
3170			1	3	-	-	1	-	-	2	-	-	1	3	4	8	5	3	9	2	3	1	-	2
3170		A	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	2	-	-	-	-
3170		B	-	-	-	-	-	-	-	1	-	-	1	-	1	3	-	-	2	1	3	-	-	-



			GROUNDSTONE								CERAMIC WARES			BONE ARTIFACTS						HAMMERSTONES/HEAVY TOOLS				
Site	Locality	Locus	Chopper-hammers	Misc. flake tools	Manos	Metates	Mortars	Pestles	Abraders	Exotics	Brown	Gray	Indet.	Awls	Beads	Misc. tools	Flakers	Scoops	Wedges	Med.& small hammers	Choppers	Scratched stones	Shovels	Large hammers
3237			-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-
3237		A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3237		B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3237		C	-	-	-	6	-	-	-	1	-	-	-	-	-	-	-	-	-	3	2	-	-	-
3238			-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3238		A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3239			-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	3	-	-	-
3251			-	-	6	11	-	-	1	-	1	-	-	1	-	-	-	-	-	1	1	-	-	-
3262			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3271			1	-	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	5	4	1	-	-
3271		A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3271		B	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	3	1	-	-
3271		C	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
3170			-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
3170		A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3170		B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



				BIFACES		TOOL CLASSES						SUMMARY DATA			RESOURCE DISTANCES	
Site	Locality	Locus	Modified chunks	Stages 1-3.5	Stages 3.5-5	Quarry tools	Weapons	Fabricating/ Processing byproducts	tools	General utility tools	Domestic equipt.	Type Richness	Class Richness	Assemblage size	to water (m)	to toolstone(m)
3237			1	19	32	-	7	24	2	37	1	17	5	71	<250	<250
3237		A	-	1	2	-	2	1	1	2	1	6	5	7	<250	<250
3237		B	1	-	-	-	1	1	-	-	-	2	2	2	<250	<250
3237		C	1	44	62	-	35	62	11	79	7	26	5	194	<250	<250
3238			-	13	16	-	5	14	1	17	1	10	5	38	<250	<250
3238		A	-	-	-	-	-	-	-	-	-	-	-	-		
3239			-	7	17	-	2	10	3	23	1	11	5	39	<250	<250
3251			-	39	51	-	45	102	16	77	18	22	5	258	<250	<250
3262			-	-	-	-	-	1	-	-	-	1	1	1		
3271			1	76	94	-	15	82	10	105	4	20	5	216	<250	<500
3271		A	-	15	12	-	2	16	3	14	-	8	4	35	<250	<500
3271		B	1	42	43	-	5	50	8	60	1	18	5	124	<250	<500
3271		C	-	9	6	-	1	12	3	14	1	12	5	31	<250	<500
3170			3	99	58	-	8	109	16	79	2	22	5	214	<500	<250
3170		A	-	2	3	-	1	2	1	6	-	6	4	10	<500	<250
3170		B	-	7	8	-	2	8	6	11	-	9	4	27	<500	<250

APPENDIX P

Provenience of Illustrated Artifacts

Appendix P. Provenience of Illustrated Artifacts

Figure No.		Site/Locality	Reference Number	Specimen Number
Chapter 6. Bifaces				
6.2	a.	26Ek3192	1010	009
	b.	26Ek3192	2022	012
	c.	26Ek3092	8265	007 refit w/8424-001
6.3	a.	number unavailable		
	b.	number unavailable		
	c.	number unavailable		
6.4	a.	26Ek3160	6280	001
	b.	26Ek3106	1052	001
	c.	number unavailable		
6.5	a.	26Ek3115	1001	005 refit w/501-001
	b.	26Ek3160	501	017 refit w/2001-003
6.6	a.	26Ek3160	01	083
	b.	26Ek3093	1029	001
	c.	26Ek3101	500	016
	d.	26Ek3271	1022	009
	e.	26Ek3160	523	001
	f.	26Ek3237	8802	002
	g.	26Ek3160	500	226
	h.	26Ek3271	1044	006
	i.	26Ek3271	500	132
	j.	26Ek3160	500	018
	k.	26Ek3160	500	169
	l.	number unavailable		
6.7	a.	26Ek3197	505	003
	b.	26Ek3192	1010	003
	c.	26Ek3192	2022	014
6.10	a.	26Ek3237	500	022
	b.	26Ek3160	500	107
	c.	26Ek3092	6205	001
	d.	26Ek3170	508	003
	e.	26Ek3238	500	024
	f.	26Ek3170	500	044
	g.	26Ek3170	500	043
	h.	26Ek3192	501	014
	i.	26Ek3192	2061	004
	j.	26Ek3184	1001	009
6.11.		26Ek3237	500	022
6.12	a.	26Ek3095	1081	001
	b.	26Ek3095	2082	003
	c.	26Ek3095	2082	001
	d.	26Ek3095	2081	001

Appendix P, continued.

Figure No.		Site/Locality	Reference Number	Specimen Number
6.13	a.	26Ek3170	4501	005
	b.	26Ek3170	4501	001
	c.	26Ek3170	4501	007
	d.	26Ek3170	4501	008
6.15	a.	26Ek3192	2022	014
	b.	26Ek3192	1010	003
	c.	26Ek3197	505	003
6.16	a.	26Ek3192	2022	009
	b.	26Ek3197	2001	002
	c.	26Ek3192	1010	006
	d.	26Ek3197	2001	010
Chapter 7. Flake Tools				
7.1	a.	26Ek3184	4137	001
	b.	26Ek3092	2041	004
	c.	26Ek3197	2001	014
7.2	a.	26Ek3095	511	010
	b.	26Ek3184	1067	001
	c.	26Ek3192	6101	001
	d.	26Ek3195	1005	001
	e.	26Ek3192	6541	001
	f.	26Ek3086	500	001
	g.	26Ek3185	1013	002
7.3	a.	26Ek3095	2022	011
	b.	26Ek3192	6600	002
	c.	26Ek3032/27	6002	004
	d.	26Ek3192	502	035
7.4	a.	26Ek3204	9006	001
	b.	26Ek3184	6062	001
	c.	26Ek3092	6265	005
	d.	26Ek3160	6521	002
	e.	26Ek3271	500	306
	f.	26Ek3192	1022	003
	g.	26Ek3271	500	095
	h.	26Ek3170	500	020
	i.	26Ek3160	500	128
	j.	26Ek3160	512	012
	k.	26Ek3092	2006	003
	l.	26Ek3095	519	001
7.5	a.	26Ek3271	503	001
	b.	26Ek3237	6842	001
	c.	26Ek3237	6322	002
	d.	26Ek3271	500	263
	e.	26Ek3237	4011	001
	f.	26Ek3032/27	01	119

Appendix P, continued.

Figure No.		Site/Locality	Reference Number	Specimen Number
7.6	a.	26Ek3032/98	4004	001
	b.	26Ek3271	1042	003
	c.	26Ek3160	504	002
	d.	26Ek3086	500	006
	e.	26Ek3095	1081	002
7.7	a.	26Ek3032/27	01	030
	b.	26Ek3185	506	004
	c.	26Ek3170	01	028
	d.	26Ek3160	1007	006
	e.	26Ek3160	517	006
	f.	26Ek3102	500	003
7.8	a.	26Ek3092	6683	009
	b.	26Ek3160	01	195
	c.	26Ek3092	6262	006
	d.	26Ek3095	1029	007
	e.	26Ek3271	503	003
	f.	26Ek3181	1010	002
	g.	26Ek3192	1055	007
	h.	26Ek3092	6082	009
	i.	26Ek3192	2121	009
	j.	26Ek3184	4109	008
	k.	26Ek3160	9020	010
	l.	26Ek3170	4062	004
	m.	26Ek3184	4141	003
	n.	26Ek3092	6163	007
	o.	26Ek3184	3010	009
	p.	26Ek3160	6061	010
7.9	a.	26Ek3239	500	101
	b.	26Ek3092	8382	006
	c.	26Ek3195	2599	084
7.10	a.	26Ek3092	6186	004
	b.	26Ek3160	4072	006
	c.	26Ek3165	4069	003
	d.	26Ek3095	7181	005
	e.	26Ek3095	7200	003
7.11	a.	26Ek3208	2599	013
	b.	26Ek3032/19	4001	016
7.12	a.	26Ek3192	2121	012
	b.	26Ek3160	6521	002
	c.	26Ek3192	6521	009
	d.	26Ek3190	1050	002
	e.	26Ek3192	2101	009
	f.	26Ek3192	6522	003
	g.	26Ek3092	6081	004

Appendix P, continued.

Figure No.		Site/Locality	Reference Number	Specimen Number
Chapter 8. Projectile Points and Preforms				
8.1	a.	26Ek3271	500	270
	b.	26Ek3184	524	002
	c.	26Ek3184	103	001
	d.	26Ek3107	500	002
	e.	26Ek3032/72	66	009
8.3	a.	26Ek3107	500	002
	b.	26Ek3237	6761	002
	c.	26Ek3032/27	01	045
	d.	26Ek3192	502	020
	e.	26Ek3032	01	001
	f.	26Ek3032/138	53	018
	g.	26Ek3032/152	3000	001
	h.	26Ek3092	6421	004
	i.	26Ek3032/23	01	501
8.4	a.	26Ek3238	500	037
	b.	26Ek3184	524	002
	c.	26Ek3271	500	027
	d.	26Ek3092	6606	002
	e.	26Ek3198	1007	902
	f.	26Ek3237	6881	901
	g.	26Ek3192	2203	002
	h.	26Ek3251	505	001
8.5	a.	26Ek3095	6941	001
	b.	26Ek3095	01	004
	c.	26Ek3198	500	004
	d.	26Ek3095	500	008
	e.	26Ek3160	01	103
	f.	26Ek3142	97	001
	g.	26Ek3237	6401	001
	h.	26Ek3032/27	6062	002
	i.	26Ek3238	500	001
	j.	26Ek3237	01	022
	k.	26Ek3160	500	131
	l.	26Ek3184	45	001
	m.	26Ek3237	6322	001
	n.	26Ek3231	4629	001
	o.	26Ek3160	500	266
	p.	26Ek3095	510	019
	q.	26Ek3237	9084	001
	r.	26Ek3237	01	029
8.6	a.	26Ek3271	500	146
	b.	26Ek3251	1022	003
	c.	26Ek3204	2002	001
	d.	26Ek3160	500	103
	e.	26Ek3092	8266	002
	f.	26Ek3251	4015	002
	g.	26Ek3251	4018	001
	h.	26Ek3271	500	301

Appendix P, continued.

Figure No.		Site/Locality	Reference Number	Specimen Number
8.6, cont.	i.	26Ek3160	517	001
	j.	26Ek3237	01	002
	k.	26Ek3160	1009	002
	l.	26Ek3095	01	002
	m.	26Ek3271	1050	001
	n.	26Ek3237	500	056
	o.	26Ek3160	500	310
	p.	26Ek3237	1544	001
8.7	a.	26Ek3092	01	001
	b.	26Ek3198	6101	003
	c.	26Ek3271	500	089
	d.	26Ek3092	6786	001
	e.	26Ek3095	7240	001
	f.	26Ek3092	6362	002
	g.	26Ek3095	510	038
	h.	26Ek3198	503	002
	i.	26Ek3170	2001	001
	j.	26Ek3092	2024	002
	k.	26Ek3095	2023	001
	l.	26Ek3185	1004	002
	m.	26Ek3171	505	002
	n.	26Ek3237	6742	001
	o.	26Ek3237	6701	001
	p.	26Ek3237	6721	001
	q.	26Ek3237	6741	003
	r.	26Ek3237	6722	001
	s.	26Ek3092	6104	001
	t.	26Ek3237	6820	001
	u.	26Ek3092	6822	005
	v.	26Ek3090	8263	001
	w.	26Ek3160	8542	007
	x.	26Ek3061	6541	005
	y.	26Ek3160	6081	008
	z.	26Ek3198	1017	001
	aa.	26Ek3184	503	028
	bb.	26Ek3160	1003	004
	cc.	26Ek3185	1003	002
8.10	a.	26Ek3192	9021	002
	b.	26Ek3095	7121	003
	c.	26Ek3160	4069	002
	d.	26Ek3160	4045	005
	e.	26Ek3095	3010	001
	f.	26Ek3184	4132	001
	g.	26Ek3271	1028	003
	h.	26Ek3093	1011	002
	i.	26Ek3093	505	011
	j.	26Ek3251	6121	007
	k.	26Ek3170	500	061
	l.	26Ek3192	1009	004
	m.	26Ek3185	1009	001
	n.	N14	2674	001

Appendix P, continued.

Figure No.		Site/Locality	Reference Number	Specimen Number
8.10, cont.	o.	26Ek3185	1010	010
	p.	26Ek3160	520	001
	q.	26Ek3093	503	003
Chapter 9. Cores and Modified Chunks				
9.1	a.	26Ek3160	517	016
	b.	26Ek3095	1025	002
	c.	26Ek3190	500	016
	d.	number unavailable		
9.2	a.	26Ek3093	505	007
	b.	26Ek3095	519	021
	c.	26Ek3093	505	013
9.3	a.	26Ek3184	500	003
	b.	26Ek3237	01	026
	c.	26Ek3170	500	030
	d.	26Ek3032/27	01	183
	e.	26Ek3095	1045	001
	f.	26Ek3092	6222	001
	g.	26Ek3192	2065	007
	h.	26Ek3032/24	-	001
	i.	26Ek3271	2021	001
9.4	a.	26Ek3170	2599	900
	b.	26Ek3032/24	-	001
Chapter 11. Hammerstones and Additional Cobble Tools				
11.1.	a.	26Ek3208	2500	003
	b.	26Ek3032/25	01	005
	c.	26Ek3095	3019	008
	d.	26Ek3095	514	003
11.2.		26Ek3204	2599	001
11.4.		26Ek3237	01	006
11.5.	a.	26Ek3237	6702	001
	b.	26Ek3251	500	200
	c.	26Ek3092	8364	001
	d.	26Ek3251	1009	001
11.6		26Ek3160	1001	001
12.1	a.	26Ek3251	501	004
	b.	26Ek3160	1005	002
	c.	26Ek3160	501	002
	d.	26Ek3170	500	005
12.2.		26Ek3095	1023	001
12.4	a.	26Ek3160	500	053
	b.	26Ek3160	01	208

Appendix P, continued.

Figure No.		Site/Locality	Reference Number	Specimen Number
12.5	a.	26Ek3095	1025	001
	b.	26Ek3198	1003	001
	c.	26Ek3160	515	001
12.8	a.	26Ek3160	500	031
	b.	26Ek3237	2142	001
	c.	26Ek3095	1001	003
	d.	26Ek3192	502	010
	e.	26Ek3184	2021	020
13.1	a.	26Ek3192	6521	002
	b.	26Ek3092	6663	002
	c.	26Ek3160	4027	001
	d.	26Ek3192	6541	005
13.2	a.	26Ek3192	6141	002
	b.	26Ek3160	4042	002
	c.	26Ek3092	6662	006
14.2	a.	26Ek3092	9085	005
	b.	26Ek3092	8382	001
	c.	26Ek3092	6403	006
	d.	26Ek3208	2599	019
Chapter 21. Reduction Trajectories				
21.10		26Ek3184	6001	002
21.11		26Ek3184	4094	001
21.12		26Ek3160	501	017 refit w/2001-003

ARCHAEOLOGICAL INVESTIGATIONS AT TOSAWIHI, A GREAT BASIN QUARRY

Part 2: A Regional Survey

by

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ABSTRACT

The Bureau of Land Management, Elko Resource Area, has requested that an environmental impact statement be prepared in anticipation of the expansion of mining activities by Ivanhoe Gold Company in the Ivanhoe Mining District, Elko County, Nevada.

As one contribution to that environmental analysis, Intermountain Research has completed a sample survey of 28,480 acres coterminous with a Tosawihi Quarries National Register District proposed by Rusco (1983), excluding areas previously examined. The purposes of the survey were to aid an assessment of the appropriateness of the proposed National Register district boundaries, to provide baseline data for an assessment (presented elsewhere) of cumulative effects on cultural resources lying within the study area, and to gather archaeological data that address activity patterns associated with prehistoric use of Tosawihi beyond the core Quarries (site 26Ek3032) area. Analyses of survey data were driven by testable propositions derived from earlier Intermountain Research work at Tosawihi Quarries. The results of these investigations are reported here.

Complete coverage of 2,929 acres (10.3% of the study area) was attained, and 61 discrete mapped silicification zones within, or just beyond, study area borders were examined. A judgmental survey of 17 springs also was undertaken. Two hundred and thirty-six prehistoric and historic features were recorded in the course of the survey.

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The Class II archaeological survey reported here was directed by Melinda Leach and supervised by Steve Botkin. Robert G. Elston, Christopher Raven, and Eric Ingbar contributed initial project planning and have provided creative insights along the way; Ingbar crafted the sample design. Leach, Botkin, Kathy Ataman, Kris Carambelas, and Ingbar developed field recording methods and, with Elston and Raven, participated in discussions about the Tosawihi production sphere.

Leach, Botkin, and Carambelas served as crew leaders, and able field technicians included Kathy Ataman, Doug Bird, Caitlin Carroll-Carambelas, Dan Dugas, Lynn Rogers, Susan Stornetta, and Kerry Varley. Evangeline Elston, *chef extraordinaire*, fed us well and kept the field camp running at peak efficiency. Jana Hembree, Bird, and Carroll-Carambelas were tireless post-field assistants, preparing data summaries, entering data into the computer, and compiling UTMs.

Mary Rusco opened her Tosawihi survey files to us, and Nancy Wicker and Carol Marcio, of the Bureau of Land Management, Elko Resource Area, provided us with helpful hydrologic maps and data. In-field logistics and support were provided by Ed Lopez, Penny McPherson, Jeff Campbell, and Steve Diezel of Ivanhoe Gold Company.

The report was written by Leach and Botkin, and Rogers contributed the discussion on historic use of the region. Report production was facilitated by Kathy Nickerson; maps and other figures were prepared by Michael Drews and Evangeline Elston.

INTRODUCTION

The Bureau of Land Management, Elko Resource Area, is preparing an environmental impact analysis that addresses expanded mining activities proposed by Ivanhoe Gold Company (IGC) in the Ivanhoe Mining District, Elko County, Nevada. IGC requested that Intermountain Research complete a BLM Class II archaeological survey of the study area depicted in Figure 1. This report documents the results of that survey.

The Class II study area encompasses 28,480 acres (Figure 2) and subsumes several broad tracts of land that have been the subject of prior Intermountain Research investigations (cf. Elston, Raven and Budy 1987; Budy 1988; Raven 1988; Drews 1988; Intermountain Research 1988a, 1988b, 1988c; Elston 1989; Leach and Botkin 1991; Elston and Raven 1992). The formerly surveyed parcels contain the largest, most intensively exploited opalite quarries presently known in the Great Basin, the Tosawihi Quarries (26Ek3032).

In 1983, Mary Rusco prepared a National Register of Historic Places nomination for a Tosawihi Quarries National Register District, the boundary of which defines the sampling universe for the Class II survey reported here. The purposes of this survey were to aid an assessment of the appropriateness of the Rusco-proposed National Register district boundary, to provide baseline data for an assessment of cumulative impacts on cultural resources lying within the study area*, and to gather archaeological data that address activity patterns associated with prehistoric use of Tosawihi, beyond the core Quarries area.

The Class II survey, conducted between June 3 and June 26, examined 10.3% (2,929 acres) of the study area. As well, a judgmental survey of 61 discrete zones of opalite silicification and 17 springs within, or just beyond, study area borders was undertaken. Two hundred and thirty-six prehistoric and historic features were recorded in the course of the survey.

Data collection and analyses were driven by models and assumptions developed in our earlier work at Tosawihi (Elston and Raven 1992). After four seasons of testing and data recovery at 79 locales in and around the Quarries, we had learned a great deal about prehistoric economic behavior relative to the extraction and processing of lithic material. Still, a series of unanswered, yet nonetheless important, questions remained about the role of the Quarries and its peripheries in a larger geographic and economic system (Elston and Raven 1992): How did archaeological patterns recognized at the Quarries, largely motivated by intensive use of toolstone sources, relate to those existing in a larger upland regional context? Did the outlying uplands function as part of an *economic system* that supported exploitation of the Tosawihi Quarries? Did use of the uplands as a whole focus, explicitly, on heretofore unknown toolstone sources, on 26Ek3032 sources, or was some other suite of non-lithic resources inviting their occupation? Due to limitations in the size of the Class II study area, some of these questions must be addressed from a limited venue, but others are explored in detail.

The following report assesses the value of that portion of the Tosawihi uplands incorporated in our survey as a "lithic terrane" (cf. Elston 1992b), deals with the distribution of quarrying and non-quarrying activities, evaluates spatial and locational relationships between artifacts, features and environmental phenomena, and examines the economic effects of distance on reduction stage of lithic artifacts. It also speaks to the cultural resource management issue of Tosawihi Quarries National Register District boundaries.

*The cumulative impacts analysis is reported elsewhere (Burke and Moore 1991).

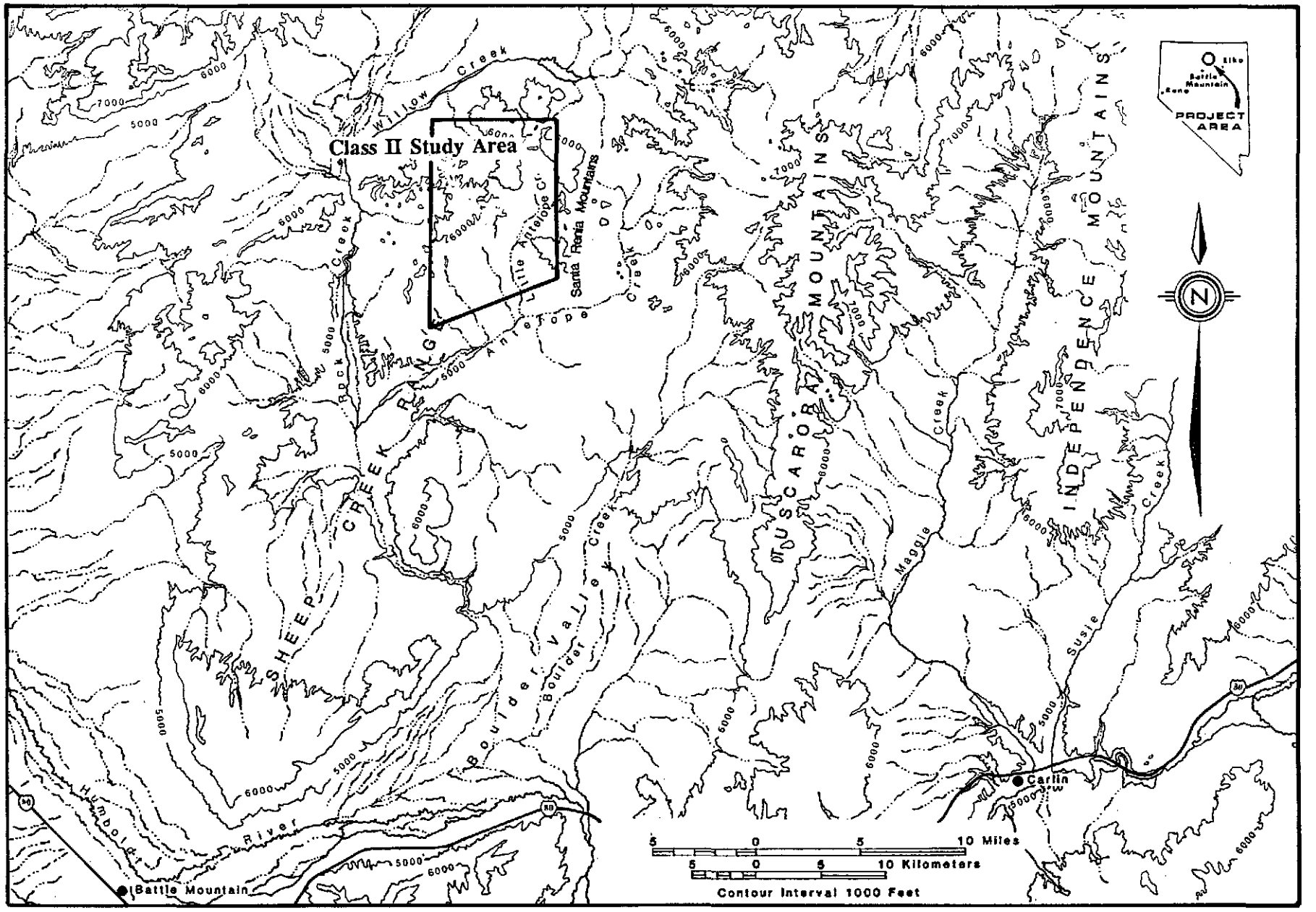


Figure 1. Project vicinity map.

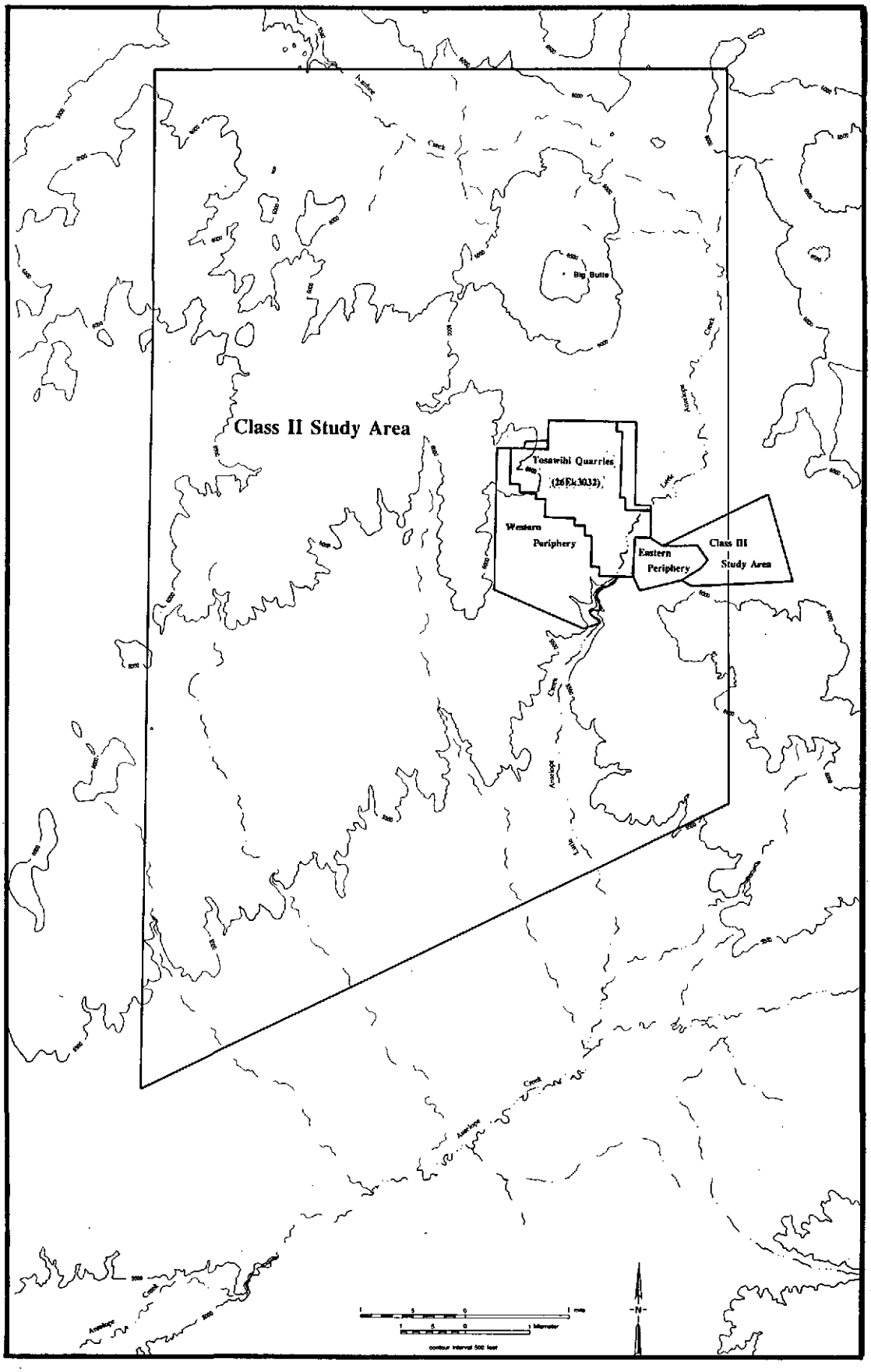


Figure 2. Map of the Class II study area, depicting previous Tosawihi surveys.

Chapter 1. THE NATURAL AND CULTURAL SETTING

The Tosawihi Quarries proper (that is, archaeological site 26Ek3032) and several contiguous tracts have been the focus of intensive archaeological research since 1987. For the most part, detailed discussions of environmental context generated as a consequence of those studies apply directly to the broader compass considered by the present work. The general presentation that follows is drawn largely from Elston and Raven (1992), the most comprehensive synthesis of local archaeological inquiry to date.

The Tosawihi Quarries National Register District and the Class II study area, which subsumes them, lie near the northern hydrographic limit of the Great Basin in north central Nevada (Figure 3), where they occupy a moderately dissected upland just north and west of the junction of the Sheep Creek Range and the Santa Renia Mountains. Minor perennial streams that eventually feed the Humboldt River (Willow Creek, Rock Creek, and Antelope Creek) flank the study area on the north, west, and south, respectively.

Rising abruptly northward from the alluvial flats along Antelope Creek, elevations in the project area range from 5300 to 6889 feet amsl and constitute a zone that is altitudinally and ecologically transitional between the Humboldt River plain at Battle Mountain (4500 feet amsl) located 61 km to the south, and summits in the Tuscarora Mountains (8500 feet amsl) that dominate the skyline 24 km to the north and east. Its intermediate position fosters local climatic conditions less severe than extremes recorded for the region as a whole, where mean monthly temperatures range from lows of -5° C in January to highs in July of 21° C and annual precipitation, falling primarily as snow, ranges between 10 cm and 40 cm (Houghton, Sakamoto and Gifford 1975; Brown 1960). Summers in the study area are short, dry, and hot, while winters are long, cold, and snow-bound often until late March.

It is the geological content of the project area rather than any of its biotic offerings that attracted human use of the place over the last ten millennia. Toolstone and/or minerals liberated from the local substrate and the leavings of those efforts to acquire them constitute virtually the entire archaeological record there, from prehistoric and historic times.

Geology and Landforms

For our purposes, the most direct impact on the effective Holocene landscape derives from Miocene events that sequentially placed 50-150 m thick volcanic deposits, first by the emanation of massive ashes, ash-flow tuffs and rhyolites, and then by the introduction of basaltic and andesitic flows (Fiero 1986:117-120; Coates 1987:68). During the late Miocene or early Pliocene, tuffs and ashes over an area of ca.130 km^2 in the immediate vicinity of Tosawihi were altered by hydrothermally-induced silicification. Subsequent dehydration and crystallization formed the vast beds of chert-like cryptocrystallines referred to as opalite (Bailey and Phoenix 1944). In his discussion of the lithic terrane of Tosawihi, Elston (1992b) describes the origin and evolution of bedrock stratigraphy and details the complex interplay of the physical properties of the local geology and the resulting archaeological record.

Today, this assortment of Miocene rocks dominates much of the surface geology of the study area and, with the exception of the opalite, of the north central portion of the Great Basin. Rhyolites from the initial wave of volcanism predominate throughout the eastern half of the study area (Cornucopia 1987). Comprising the highest landforms in the study area, they have weathered into prominent high domes or craggy, deeply incised highlands. Slopes almost everywhere in the rhyolite country of the study area are steep and in many places precipitous, save for where they are moderated by colluvial accumulations in the bottomlands of Big Butte Valley and along alluvial terraces fringing Ivanhoe and Little Antelope Creeks.

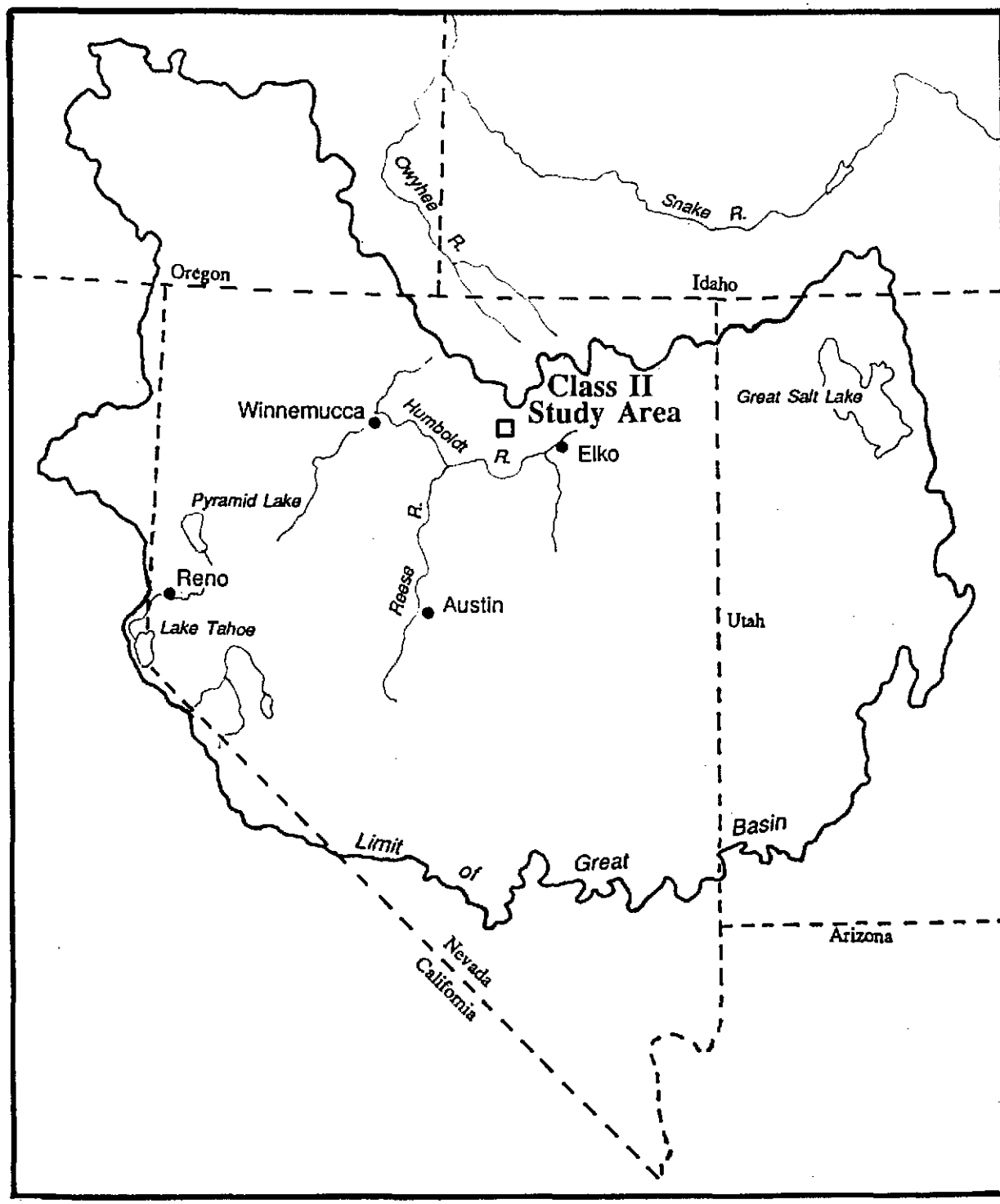


Figure 3. The place of the Class II study area in the Great Basin.

Less severe, more gently rolling topography prevails in the western half of the study area where basalt and softer undifferentiated tuffs comprise much of the bedrock. Here, these deposits typically are dissected into a series of parallel south-trending ridges and deep intervening stream channels that coalesce along their toe slopes near the southwestern limit of the study area to form a broad alluvial plain above Antelope Creek.

The younger rocks, introduced by flows of basaltic andesite, occur in more localized distributions. They form erosion-resistant ridgecrests capping the softer tuffs in the central and western portions of the area.

Beds of opalite-bearing altered tuffs, dipping 10-15 degrees southeast, span the full east/west dimension of the study area. Ranging in size from little more than boulder-sized outcrops to vast exposures that constitute locally prominent landforms of over several square kilometers as mapped by Cornucopia (1987), these deposits occur in virtually every quarter of the study area (Figure 4). Field inspection during survey, however, disclosed that many of these locations consist of tuffs insufficiently silicified to have provided knappable toolstone. Although outliers were encountered, exposures of workable opalite toolstone are most extensive and most densely distributed throughout a swath in the central portion of the study area proximal the Tosawihi Quarries site (26Ek3032).

Soils observed over much of the study area appear similar to those examined more closely during test excavations in and around the Tosawihi Quarries (cf. Elston and Dugas 1992). Most soils are colluvial products, silty to sandy loams derived from the in-place weathering of the bedrock. Coarseness of the matrix and incidence of gravels and other inclusions vary from place to place, largely as a function of slope and of depth and composition of the substrate. Colluvial soils are blanketed by accumulations of eolian silts in many locations, especially on the higher ridge crests and upper leeward slopes. This phenomenon has important archaeological consequences: excavation at several sites (e.g., 26Ek3184, 26Ek3192, 26Ek3198) in the vicinity of the Tosawihi Quarries revealed that these deposits have buried prehistoric cultural features. It seems likely that such deposition has occurred in the Class II study area, as well (cf. Botkin, Dugas, and Elston 1992).

On ridges defined by basaltic andesite flows, bedrock has weathered into platy slabs to form extensive pavements and talus stripes. Alluvial deposits in the principal drainages are often relatively deep and, in places, terracing is pronounced. Many stream channels are deeply entrenched and most are bottomed by rounded cobbles and boulders. Strata of Mazama tephra are exposed in cutbanks at several locations within and adjacent the study area and (with equivocal cultural association) were encountered during subsurface testing at two localities of the Tosawihi Quarries site (Leach and Botkin 1991).

Water

Water is scarce under present conditions in the study area. Deeply incised gorges, relict spring mounds, and Pleistocene stream deposits in the basal levels of stratigraphic sections of sites along principal drainages demonstrate the prevalence of wetter conditions in the remote past. However, little suggests that water ever was plentiful over most of the span of human presence in the vicinity.

Most of the area lies high on the local watershed, topographically isolated from the more generous aquifers that contribute to the comparatively lush settings of the Antelope Creek and Boulder Creek drainages (along the western foothills of the Tuscarora Mountains immediately east). Although bracketed by perennial tributaries of the Humboldt River, only ephemeral streams cross the study area (Figure 5). Ivanhoe Creek, Little Antelope Creek, and their influents drain the northwestern and southeastern halves of the area, and while they channel copious flows after snowmelt, they are dry by August. BLM hydrologists identify some fourteen springs and seeps in the study area (BLM Elko Resource Area, written communication). Based on field observations since 1987 and more focused scrutiny during Class II survey, most of these are ephemeral. Even those charged sufficiently to contribute to stream

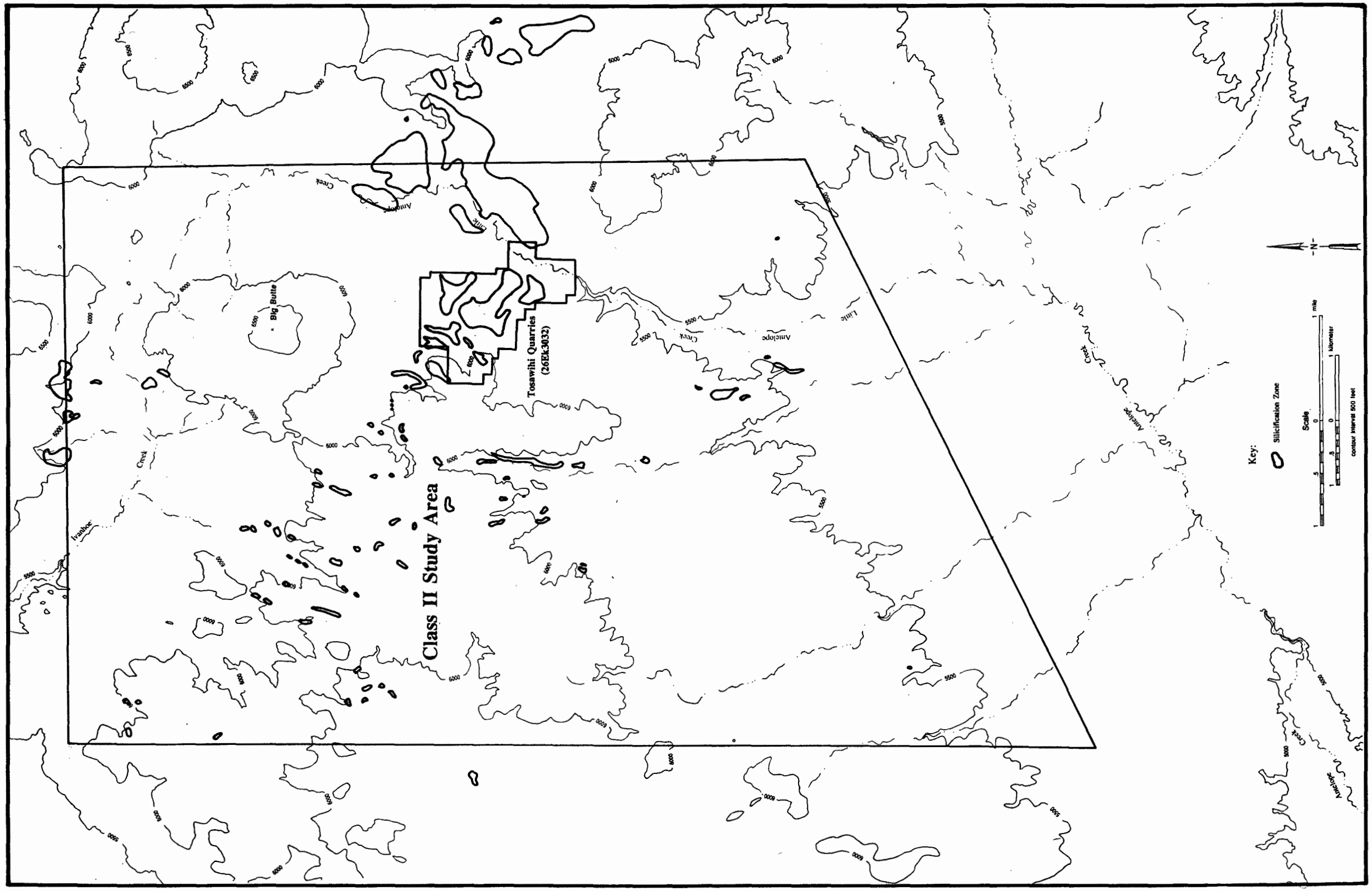


Figure 4. Silicification of the Tosawihi vicinity (after Cornucopia 1987).

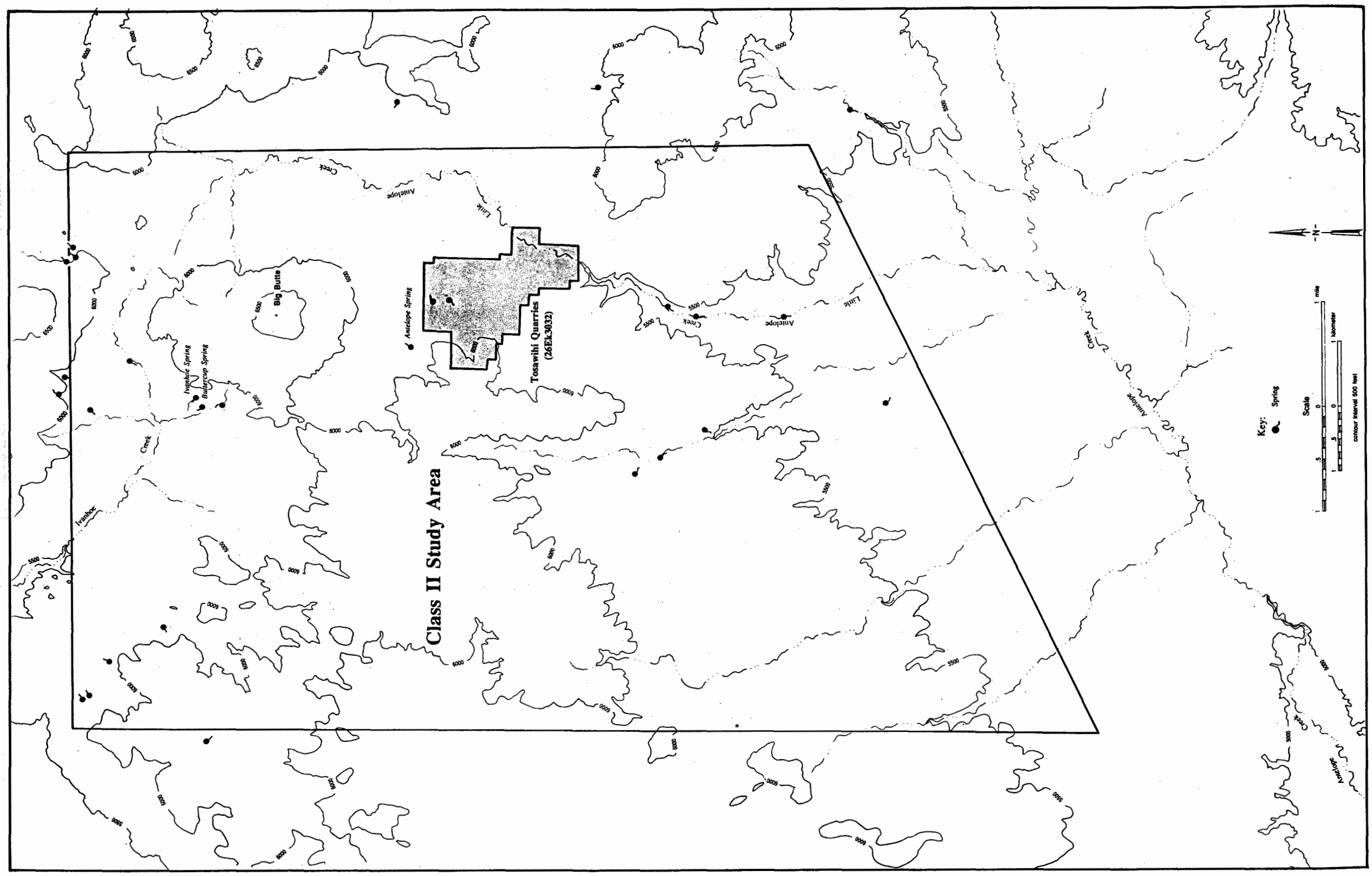


Figure 5. Water sources in the Tosawihi vicinity.

flow in May were moribund by late June. More persistent sources are rare. Most of these occur in the vicinity of Big Butte Valley in and around the northern extreme of the Tosawihi Quarry site.

Owing in large part to the paucity of water, biotic resources in the Tosawihi vicinity almost never appear to have offered prehistoric foragers subsistence opportunities that could not be pursued more effectively in the comparatively more game-rich, well-watered ecozones that surround it (cf. Raven 1992a; Schmitt, Ingbar, and Raven 1992:624).

Plants

Lying within the Artemisian biotic province, the study area occupies a mid-elevation sagebrush steppe. Essentially treeless except at a few locations, plant structure is characterized by an intricate edaphically-controlled mosaic of big sage and low sage communities. The big sage community, dominated by tall sagebrush (*Artemisia tridentata*) accompanied by a grass component of Great Basin wildrye (*Elymus cinereus*) and bluebunch wheatgrass (*Agropyron spicatum*), prevails in deeper soils of silty bottomlands and semi-shadowed northern ridge slopes. The low sagebrush community occurs associated with near-surface bedrock locations on knolltops, steeper slopes, and other settings where shallow soils predominate. Here, low sagebrush (*Artemisia arbuscula*), phlox (*Leptodactylon* sp.), squirreltail grass (*Sitanion hystrix*), and Idaho fescue (*Festuca idahoensis*) constitute the most commonly encountered species. At higher elevations in the northern and eastern quarters of the study area these communities are augmented by mountain shrubs of the Montane Zonal Series (Billings 1951: 113-119): bitterbrush (*Purshia tridentata*); and serviceberry (*Amelanchier alnifolia*). Some rocky barrens, especially in the rhyolite highlands east of Little Antelope Creek, support little vegetation other than clumps of cushion cactus (*Coryphantha vivipara*) and harlequin colonies of lichen.

Riparian assemblages are confined almost exclusively to the wettest most heavily shaded drainage bottoms and the most persistent springs. These settings include relatively lush but highly localized stands of wild rose (*Rosa* spp.), gooseberry (*Ribes aureum*), chokecherry (*Prunus virginiana*), serviceberry, and willow (*Salix* sp.).

Cattle graze throughout the study area. In zones most heavily grazed and/or most recently burned by wildfires (Big Butte Valley and contiguous areas to the west as well as the alluvial flats above Antelope Creek) large tracts presently are occupied by the alien cheatgrass (*Bromus* sp.) and native pioneer species, including rabbitbrush (*Chrysothamnus* spp.), mustard (*Brassica* sp.) and thistle (*Cirsium* sp.).

Local communities host several species of plant foods economically important to aboriginal foragers. In addition to the grasses listed above, we observed numerous forbs generally scattered diffusely throughout the area. These include several buckwheats (*Eriogonum* spp.), globe mallow (*Sphaeralca* sp.), Mentzelia, lupines (*Lupinus* spp.), larkspur (*Delphinium nuttallianum*), and bitterroot (*Lewisia rediviva*). However, as Raven (1992a) points out, under current ecological conditions and those reasonably inferred for the past, plant foods likely never formed the basis for prehistoric subsistence strategies within the project area and probably played minor roles in the diets of aboriginal quarriers.

Animals

The project area falls fully within Merriam's (1889) Upper Sonoran life zone, characterized over most of its extent by abundant and diverse faunal associations (cf. Hall 1946). Yet conditions of seasonal aridity and

low plant productivity result in few animals being found here, compared to those available in the relatively lush riparian and higher altitude locations that surround the study area (Raven 1992a). No formal species census has been completed for the Tosawihi vicinity. Our knowledge of wildlife in the area, based on observations compiled over the last several years of fieldwork, is unquestionably incomplete.

At present, no large mammals reside permanently in the project area. The largest mammalian species, pronghorn antelope (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*), move into the Tosawihi vicinity soon after snowmelt. Although mule deer move in groups of as many as twenty individuals early in the season, they soon disperse to browse the later greening higher country elsewhere. Neither Big Horn Sheep (*Ovis canadensis*) nor elk (*Cervus canadensis*) inhabit the area today, but their occurrence in nearby ranges suggests the possibility of their presence prehistorically. Archaeological recovery of bison (*Bison bison*) bones and elk antler in the Tosawihi Quarry vicinity implies access to, if not the local presence of, an even larger food species in the past (cf. Schmitt 1992).

In contrast, small mammals abound in the region today. We suspect most species attributed by Hall (1946) to the high valley/foothill biomes of the region occur in the project area today or did so prior to the declining productivity that followed in the wake of cattle grazing (Raven 1992a). Ground squirrels (particularly *Spermophilus elegans nevadensis*) are abundant almost everywhere and occur at times in especially staggering numbers in and around Big Butte Valley. Other species observed include wood rat (*Neotoma cinerea*), pocket gopher (*Thomomys* sp.), cottontail rabbit (*Sylvilagus nuttallii*), pigmy rabbit (*Sylvilagus idahoensis*), jackrabbit (*Lepus townsendii* and *L. californicus*), chipmunk (*Tamias* sp.), marmot (*Marmota flaviventris*), badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), coyote (*Canis latrans*), and bat (order CHIROPTERA).

Linsdale (1936) discusses the avifauna of the region encompassing the study area. Confirmed sightings during fieldwork include bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus*), great horned owl (*Bubo virginianus*), barn owl (*Tyto alba*), burrowing owl (*Speotyto cunicularia*), marsh hawk (*Circus cyaneus*), common raven (*Corvus corax*), loggerhead shrike (*Lanius ludovicianus*), cliff swallow (*Petrochelidon pyrrhonota*), western meadowlark (*Sturnella neglecta*), horned lark (*Eremophila alpestris*), flicker (*Colaptes* sp.), mourning dove (*Zenaidura macroura*), poor-will (*Phalaenoptilus cunicularia*), killdeer (*Charadrius vociferus*), sage grouse (*Centrocercus urophasianus*), turkey vulture (*Cathartes aura*), and chukar partridge (*Alectoris chukar*), an introduced species.

A few dace (*Rhinichthys* sp.) seen in pools along Little Antelope Creek constitute the only fish observed by us in the project area. Raven (1992a) suggests that bigger fish important in prehistoric economies along the upper Humboldt (Lahontan cutthroat trout (*Salmo clarki henshawi*), Lahontan mountain sucker (*Pantosteus lahontan*), and Lahonton tui chub (*Siphateles bicolor*) came no nearer the project area than Rock Creek or Willow Creek (cf. La Rivers 1962:101-104).

Stebbins (1966) describes the reptiles and amphibians attributed to the region. We observed bull snakes (*Pituophis melanoleucus sayi*), western yellow-bellied racers (*Coluber constrictor mormon*), garter snakes (*Thamnophis* sp.), western rattlesnakes (*Crotalus viridis*), horned lizards (*Phrynosoma* sp.), side-blotched lizards (*Uta stansburiana*), and several varieties of spiny lizards (*Sceloporus* spp.). Leopard frogs (*Rana pipiens*) and tree frogs (Family Hylidae) were the only amphibians seen during fieldwork.

People

Drawing from baseline ethnographic and ethnohistoric works of Steward (1937, 1938, 1939, 1941), Harris (1940), and Powell and Ingalls (1874), Raven (1992a) summarizes current understanding of local aboriginal cultural context, economy and land use.

At the time Euroamerican trappers and explorers initially explored the area, in the first half of the nineteenth century, the reaches of the Humboldt River in the vicinity of Battle Mountain and adjacent uplands were inhabited by the *Tosawihi* ("White Knife") subgroup of the Western Shoshone. On the basis of linguistic evidence (Miller 1966, 1986), Western Shoshone entered the region in the course of a northward and eastward expansion of Numic speaking peoples that commenced some ten to fifteen centuries ago. This expansion culminated in the occupation of a vast area that today encompasses about half of the state of Nevada and contiguous portions of California, Idaho, and Utah (Figure 6). Earlier residents of the region, presumably displaced or absorbed by the newcomers, are known only from archaeological remains. Such remains reflect occupation of the area over the full span of documented human use of central northern Nevada (Elston and Drews 1992).

Initially, the name *Tosawihi* was used by ethnographers without specificity to refer to many groups in the region (Harris 1940:39; Powell and Ingalls 1874). But Steward (1938) advocated the name for those groups who wintered along the Humboldt River in the vicinity of Battle Mountain and whose foraging range subsumed the mountains around Rock Creek. The name is noteworthy for its symphony: Thomas et al. (1986:283) point out that it refers also to the high toolstone-quality lithic material that occurs in the mountains north of Battle Mountain (this almost certainly a reference to the opalite deposits in and around the Tosawihi Quarries; Raven 1992a).

Estimates of Tosawihi Shoshone population for the nineteenth century vary widely, from the Powell and Ingalls (1874) low of 194, to Harris's (1940:42) estimate of 800-1000 individuals. Most sources concur that the riparian corridor along the Humboldt River was densely populated (ca. one person per two square miles [Steward 1938:628]), but that beyond this comparatively lush zone density diminished to ca. one person per fifteen to twenty square miles (Harris 1940:42).

Steward (1938:161-162) and Harris (1940:44) report that in winter people settled in camps composed of two to ten related family groups, distributed in loose clusters along the Humboldt River. In summer these aggregates dispersed into individual family-based bands to forage within a 25-100 mile radius of the winter camps (Harris 1940:40-45). Ethnographic accounts offer little detail about aboriginal subsistence patterns. Steward (1938:162) describes forays as far to the south as the vicinity of present-day Austin for the procurement of pine nuts and northward to the forks of the Owyhee River for salmon. Although communal drives took antelope and rabbits, most subsistence chores were performed by individuals. From normative accounts at least, men were tasked with the acquisition of game, and women engaged in the collection of plant foods.

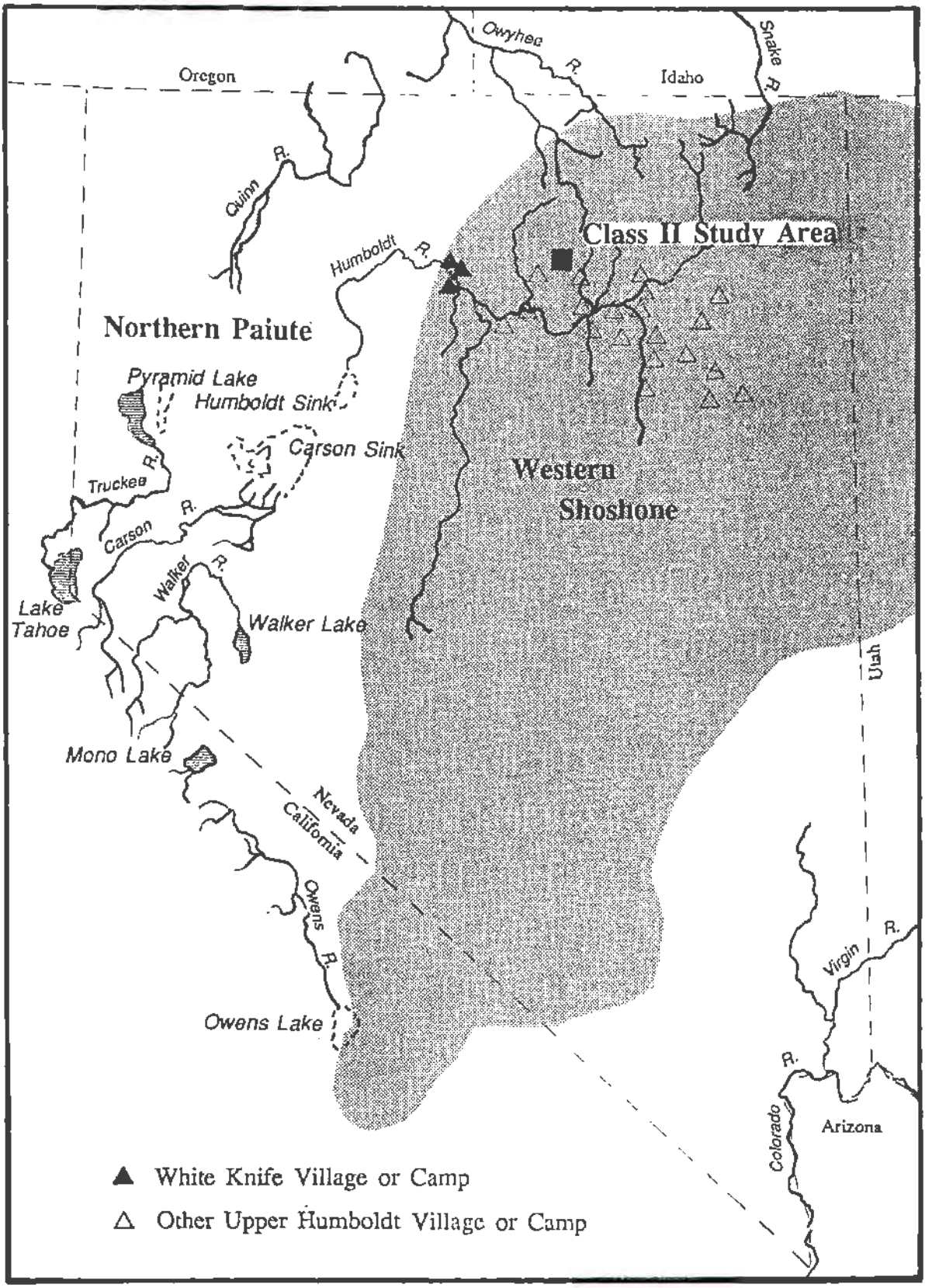


Figure 6. Western Shoshone Territory (after Steward 1937, 1938).

Chapter 2. PREVIOUS ARCHAEOLOGICAL RESEARCH

Several syntheses of the archaeology of the western Great Basin (Elston 1986), northern Nevada (James 1981; Smith et al. 1983), and the Humboldt River Basin (Elston and Budy 1990; Rusco 1982) provide a broader framework within which the archaeological record of the project vicinity may be considered (Figure 7). The perspective provided by these studies, as well as the results of site-focused work in central northern Nevada to date, are detailed in discussions by Raven (1992a).

To summarize, earlier work in the region discloses the wide distribution of Tosawihi chert over a broad area north of the Humboldt River, roughly congruent with the ethnographic territory of the Western Shoshone between the Osgood Mountains and Elko (Rusco 1979:2). White chert raw material dominates assemblages at sites along the Humboldt River (Stephenson and Wilkenson 1969; Rusco 1976b, 1979, 1982), and in upland settings north of the river (Crittenden and Elston 1981; Elston et al. 1981; Clay and Hemphill 1986). Recent mining-related cultural resource management studies in Boulder Valley and the western foothills of the Tuscarora Mountains report an overwhelming preponderance of white chert in lithics assemblages (Hicks 1989; Rafferty and Blair 1988; Russell, Tratebas, and Schroedl 1986; Tipps 1989). Much of this material may be attributed to Tosawihi sources, based on results of ultraviolet fluorescence examination of a sample of these assemblages (Ataman and Botkin 1991; Elston 1992c). Tosawihi-like raw material is reported from as far as 150 km north of the Quarries in the Snake River Plain (Rusco 1979, citing personal communication from Don Crabtree) and from Gatecliff Shelter (Novick 1987) in the Monitor Range to the south of Tosawihi.

Despite continuous knowledge (and use) of the place by the Tosawihi themselves (Rusco and Raven 1991) and ethnographic references to the toolstone sources there since the time of Steward's (1941) work, the Tosawihi Quarries did not become the direct focus of archaeological study until Mary Rusco began fieldwork there in the mid-1970s. Rusco and her colleagues were first to map and describe the Quarries (Rusco 1976a, 1976b, 1979) and to recognize the important role played by opalite procured at Tosawihi in the prehistoric economies of the Humboldt River Basin (Davis, Fowler, and Rusco 1976; Rusco 1978,1982; Rusco and Davis 1979, 1987; Rusco and Seelinger 1974; Rusco, Davis, and Jensen 1979; Rusco et al. 1982). In 1983, Rusco prepared a National Register of Historic Places nomination for Tosawihi.

A decade after Rusco's work, minerals development in the Ivanhoe Mining District has inspired intensified and accelerated scrutiny of the local prehistoric record. The Tosawihi Quarries site and contiguous zones have been the focus of federally mandated archaeological study by Intermountain Research since 1987. Cultural resource management work there commenced with intensive reconnaissance of the Quarries proper (Elston, Raven and Budy 1987) and adjacent lands to the west (the Western Periphery; Budy 1988), east (the Eastern Periphery; Raven 1988), and north (the Northern Corridor; Drews 1988). Subsequently, phased testing and data recovery programs were undertaken at 79 archaeological locations in and around site 26Ek3032 (Intermountain Research 1988a, 1988b, 1988c; Elston 1989; Leach and Botkin 1991). The most detailed and comprehensive presentation of the results of inquiry to date are provided by Elston and Raven (1992).

At this writing, archaeological investigations at Tosawihi continue. Analysis of data garnered during excavation of a large quarry pit complex (Locality 36) in the Quarries currently is underway. Immediately before Class II fieldwork began, some 300 acres adjacent and east of the Quarries were examined by Class III-level survey, resulting in the recording of thirty-six previously undocumented prehistoric sites (Botkin 1991).

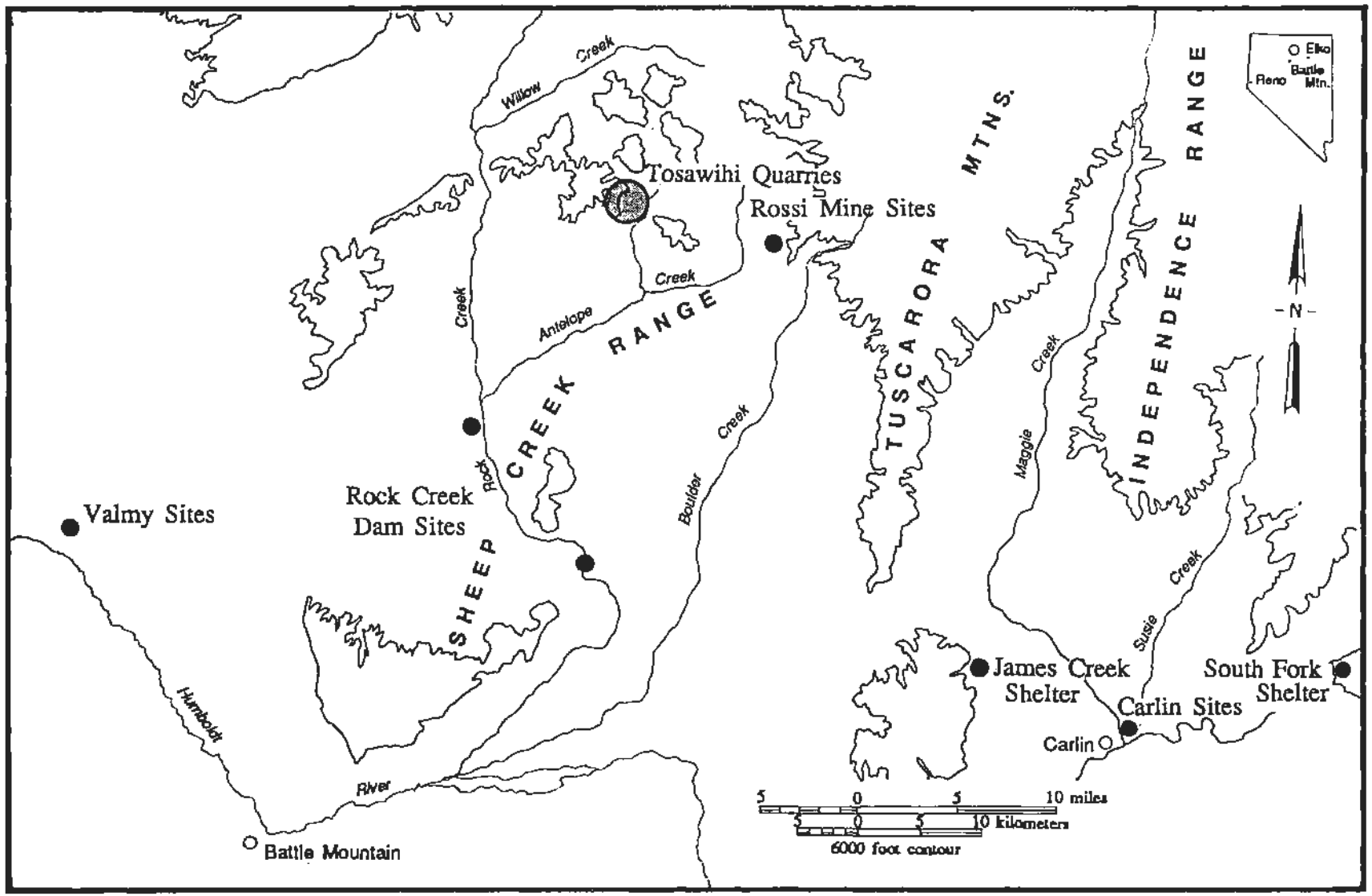


Figure 7. Locations of previous archaeological research in the Tosawihi vicinity.

Chapter 3. RESEARCH DESIGN

Exploitation of the Tosawihi Quarries region was driven largely by prehistoric acquisition of the high quality opalite toolstone that surfaces in massive mapped silicification zones there (Elston and Raven 1992). Even the off-quarry residential sites peripheral to the Quarries appear to represent the short-term encampments of small groups of people who came to Tosawihi to procure opalite toolstone. Evidence of non-lithic resource procurement and processing is rare, and the opportunities for such, given the paucity of plants and game in the region, appear to have been extremely limited (Schmitt, Ingbar, and Raven 1992). Indeed, all discrete archaeological remains investigated by Intermountain Research in its undertakings at and near the Quarries appear to relate directly to a complex system of prehistoric lithic production.

Descriptive and predictive models for the Tosawihi lithic production system have been outlined previously in detail (Elston 1988; Elston 1992a, c; Elston, et al. 1992). These models appeal to cost-minimization principles, employing optimization constructs from economics and behavioral ecology (Belovsky 1987; Stephens and Krebs 1986), and drawing upon experimental and ethnographic cost/benefit data. The result is a comprehensive consideration of how mobility patterns, labor organization, and procurement technology serve as strategies that can reduce overall lithic production costs and/or increase output.

Certain assumptions are inherent in such models, of course. We assume that hunter-gatherers were rational decision-makers who judged costs and benefits of lithic procurement and gauged risks, payoff, and losses (Elston 1992c). Further, having weighed such variables, we assume hunter-gatherers employed a flexible repertoire of organizational and technological options to meet changing circumstances. As conditions relating to access to toolstone, locations and distribution of food resources, seasonality, and social constraints varied, so too did their responses.

Toolstone procurement confers no direct caloric benefits, but it does consume time and energy that could be used for acquiring such benefits (Elston 1992a). Getting toolstone begins with searching for a source, then prospecting and assaying the toolstone follow. Extracting raw material can involve simply picking up surface rocks, or it may require excavation of soil to recover toolstone clasts or even costlier excavation of material from subsurface beds and outcrops. The processing or manufacture of transportable forms then involves decortication, contouring, reduction, and often heat-treatment. Each of these activities requires expenditure of energy and time.

Collecting and processing raw materials also carry with them a series of "opportunity costs" lost chances to acquire, process, or consume food or other non-lithic resources (Elston 1992c). Because lithic procurement effectively competes with other beneficial activities, we expect that hunter-gatherers will minimize the costs of getting and processing toolstone. So they will attempt to maximize efficiency by (1) minimizing labor costs in relation to yield or output, (2) minimizing loss of other potential benefits, and (3) minimizing distances travelled and over which quarried products are transported.

The efficient hunter-gatherer can minimize both labor/procurement costs and opportunity costs through scheduling, mobility, use of efficient quarrying techniques and tool design, and organizational decisions. Altering residential mobility (moving residences closer to toolstone sources), changing the shape or size of the annual range to include toolstone sources, arranging to be in the vicinity of usable sources when other resources are homogeneously available, employing efficient extraction techniques all are strategies for altering the cost of getting toolstone (Elston 1992c). Further, situating reduction and residential sites close to quarries and reducing toolstone bulk before transport are strategies for diminishing effort, travel, and transport costs (Raven 1992b; Bloomer and Ingbar 1992).

Research Propositions

The Class II data collection and analyses were designed explicitly to address propositions advanced in Elston and Raven (1992) and Elston et al. (1992), and to evaluate the role of the Tosawihi Quarries in a larger geographic context. The level of scrutiny afforded by surface reconnaissance cannot yield quantitative data directly comparable to intensive excavation (like that conducted at the Quarries and their peripheries). But we can evaluate qualitatively, if not quantitatively, several broad expectations anticipated by our previous Tosawihi investigations. What follows are research propositions and data expectations that organize subsequent analytical discussions.

Use of the Lithic Terrane

Variables that seem to have affected exploitation of toolstone sources at the main Quarries are toolstone quality, depth of colluvium over bedrock, proportion of high quality toolstone to waste rock, and convenience with regard to residences and potable water (Elston et al. 1992; Raven 1992b). Discrete silicification zones (as mapped by Cornucopia, 1987; see Figure 4) in the Class II study area should be used when they are sufficiently high in quality, accessible from residential locations, and situated conveniently near water. Even high quality sources will go unexploited, however, or will be less intensively exploited, if their location relative to water and potential campsites is unfavorable (Elston et al. 1992).

The spatial distribution of opalite products originating at the Tosawihi Quarries will be examined in order to assess the magnitude of a Tosawihi "zone of production". This analysis will enable us to evaluate the appropriateness of the proposed (Rusco, 1983) National Register District boundary.

The Character and Distribution of Formed Artifacts and Debitage

The *intensity* of quarry-related activity, manifest in densities of quarrying features, quarrying tools, and byproducts, and of early stages of lithic production (bifaces and debitage), should be related directly to distance from toolstone sources, and should diminish as distance from toolstone sources increases (Elston et al. 1992). Because transportation costs vary directly with distance and weight of the load (Jones and Madsen 1989), eliminating substantial toolstone mass before transport reduces the cost of getting usable toolstone to its destination (Elston et al. 1992). Early stages of reduction therefore should be undertaken at or near the stone source. The relative proportion of later stages of lithic reduction should tend to increase as a function of distance from toolstone sources (Bloomer and Ingbar 1992).

Non-quarrying-related tools and weapons, on the other hand, should exhibit a distribution less dependent on the distribution of toolstone. Instead, their spatial patterning should be related to water and other, non-lithic resource distributions.

The Character and Distribution of Features

All reaches of the Class II study area lie within a reasonable daily travel distance to the heart of the Quarries. We expect, therefore, that diurnal quarrying forays (Elston 1992a) could have been mounted from campsites in the study area. Features reflecting mid to late stage reduction of toolstone packages originating at the Quarries should, then, be observed to the limits of the study area.

Campsites occupied by quarriers should be located near those water sources closest to sources of toolstone. Springs in the study area that are nearest utilized toolstone sources, therefore, should manifest signs of residentiality, even if short-term and ephemeral. And such residential features should cluster near exploited toolstone sources. Reduction features near quarries should be clustered and characterized by early stage reduction debris, while those near residential features should manifest higher proportions of later stage debris (Raven 1992b). Anomalous clusters of early stage reduction features may predict the general location of otherwise undiscovered toolstone sources (Elston et al. 1992).

Later stages of reduction entail removal of less waste mass, so limited transport can occur prior to final reduction without incurring excessive transport costs. Further, if later stages in the reduction trajectory are to be improved by heat-treatment (a time-intensive process), it may be advantageous to transport partially reduced material to a camp setting, where its processing can be tended in off-hours or by a non-quarrying labor force. In this case, late stage and post heat-treatment reduction stations should lie some distance from the source and should cluster around a residential zone (Elston et al. 1992).

Chapter 4. SAMPLE DESIGN AND FIELD METHODS

The Class II sampling universe, encompassing 28,480 acres, is coterminous with the limits of the Tosawihi Quarries National Register District proposed by Rusco (1983), although it excludes areas of prior surveys (see Figure 2). To affect survey of at least 10% of the study area, as directed by the Bureau of Land Management, a random stratified sample of 151 19.4 acre (7.84 ha; 280 m x 280 m) survey quadrats was drawn.

The mapped study area initially was divided into 1446 potential survey quadrats (Appendix A). The southwest corner of each quadrat was assigned a row and column coordinate designation beginning with the row/column origin (0,0) of the southwest corner of the study area (Figure 8). For example, the quadrat designated "North 24, East 17" would be that quadrat lying 24 units north and 17 units east of the southwest corner of the study universe.

Each potential survey quadrat then was stratified (Table 1) according to across-unit average slopes under or over 6%, to the presence or absence of potential toolstone sources (silicification zones mapped by Cornucopia, 1987; see Figure 4), and to the presence or absence of nearby water (in the current or any adjacent quadrat; within approximately 560 m). Ten percent of the units in each stratum (defined by all possible co-occurrences of the above categories) were selected randomly (Table 1; Appendix B). The 151 selected units (Figure 9) were plotted on 7.5' USGS maps for use in the field.

Table 1. Summary of Class II Sample Selection.

		Slope <6%		Slope >6%		Total
Number of Potential Units in Each Stratum (overall %)						
Has Water	Has Toolstone	4	(.3)	4	(.3)	8
	Has No Toolstone	26	(1.8)	44	(3.0)	70
Has No Water	Has Toolstone	72	(5.0)	48	(3.3)	120
	Has No Toolstone	577	(39.9)	671	(46.4)	1,248
Total		679		767		1,446
Number of Units Selected for Survey in Each Stratum (No. of Acres Surveyed)						
Has Water	Has Toolstone	4[a]	(77.6)	4[a]	(77.6)	8
	Has No Toolstone	3	(58.2)	4	(77.6)	7
Has No Water	Has Toolstone	7	(135.8)	5	(97.0)	12
	Has No Toolstone	57	(1105.8)	67	(1299.8)	124
Total		71		80		151

[a]100% of these strata selected due to rarity.

Employing topographic maps plotted with quadrat unit boundaries, compasses, and natural and cultural landmarks, the survey quadrat was located on the ground. A three-member team commenced walking nine parallel transects, spaced 30 m apart (each team made three passes, 280 m in length). Each crew member was responsible for maintaining a parallel course, and for completing artifact tally sheets, feature location maps, and biface and projectile point recording forms. Encountered projectile points were measured and traced in outline. Bifaces were measured, assigned to a pre-defined technological stage, and characterized as to heat-treatment. Quadrat-level data were recorded concerning overall debitage density (using scales consistent with earlier Tosawihi surveys) and character, raw material availability, observed game sign, observed plant communities, water availability, slope, and modern disturbance.

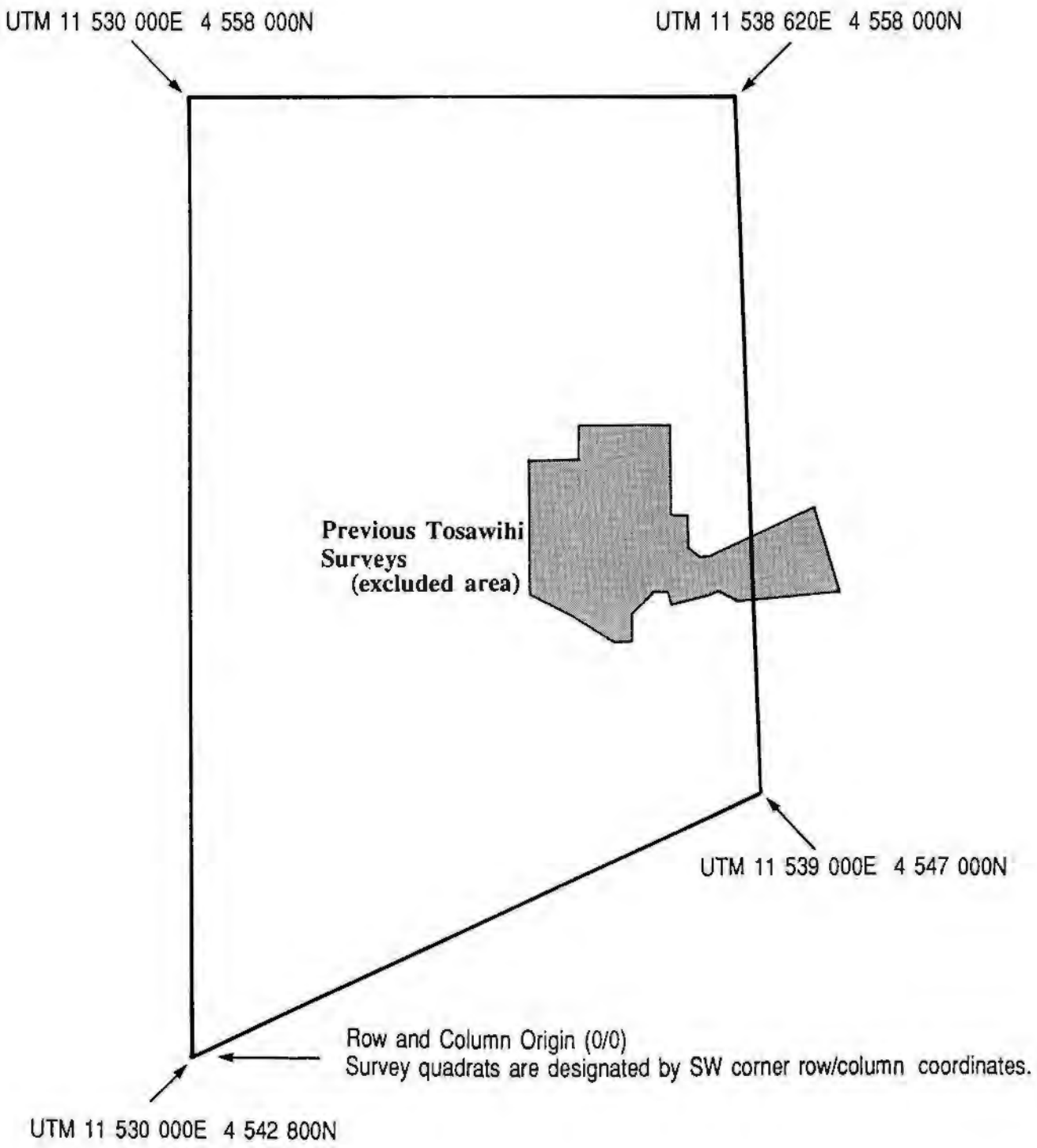


Figure 8. The Class II sampling universe.

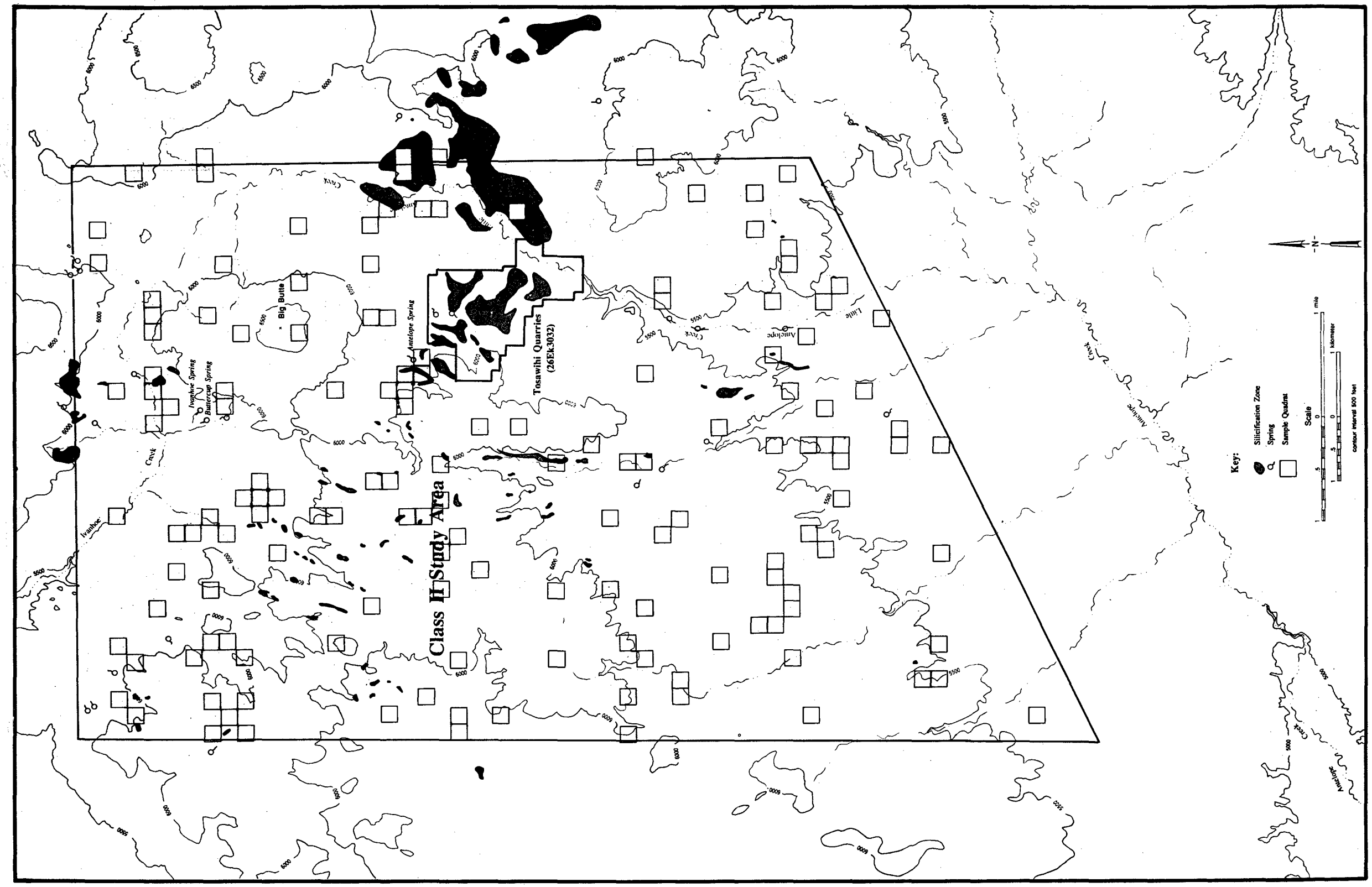


Figure 9. Locations of survey quadrats in the Class II study area.

The actual unit of observation reported herein, then, is the survey quadrat as represented by the suite of nine transects examined in it. Data derived from the survey consist of recorded artifact and feature densities and character (both prehistoric and historic), and overall lithic reduction intensity across sampling strata. It is important to note that we did not record sites or site boundaries, that feature data consist of type, dimensions, and a qualitative assessment of assemblage diversity, and that only artifacts observed within a four meter swath (two meters either side of the transect center line) were tallied. Strict adherence to this swath of observation for purposes of artifact tally allows rigorous comparability of artifact densities among quadrats.

No artifacts were collected save those tools in imminent danger of disturbance or destruction (e.g., by vehicular traffic, vandalism, and the like). The recovered assemblage consists of three projectile points, one crescent, one eccentric chipped stone artifact, and one chert biface fragment, all of which will be included in a collection of Tosawihi materials soon to be transferred to the Nevada State Museum. Additionally, 88 non-artifactual rock samples were collected from surveyed silicification zones.

Silicification Zone Reconnaissance

Because the significance of Tosawihi Quarries lies chiefly in the massive-scale toolstone exploitation exhibited at their core (26Ek3032), it is important to know if there are other, similarly intensive quarrying zones within the Class II study area. We visited a judgmental sample of known silicification zones within, and just beyond, the limits of our study area in order to characterize evidence of prehistoric quarrying activity outside the core Quarries area.

Ninety known silicification zones were plotted (see Figure 4) from a geologic map of the Ivanhoe Mining District (Cornucopia 1987). Seventy-seven of these zones lie within non-excluded portions of the Class II study area, and formed a discrete stratum in the stratified random selection of survey units. Thirteen zones fall beyond the Class II sample universe borders or within previously surveyed regions. Of the 90 mapped zones, 24 encompass more than 2.5 acres and 66 zones are somewhat smaller.

Once we had plotted all known zones, we recognized the wisdom of selecting a sample of zones to field-check, thereby reducing potentially prohibitive travel time between small, widely-spaced opalite outcrops. Rather than conducting a 100% sample of all discrete zones (as we originally had thought to do), we restricted our silicification zone evaluation to (1) those zones that fell within our stratified, randomly-selected survey units, (2) those zones that had been surveyed in the course of prior Tosawihi projects (cf. Elston, Raven, and Budy 1987), and (3) those large zones lying immediately east of the most intensively-used zones in the Quarries and the Eastern Periphery (cf. Botkin, Dugas, and Elston 1992; Botkin 1991). As logistics and time allowed, we bolstered our sample with a purely judgmental selection of additional zones that were convenient to survey units. Three formerly unknown sources of silicification were discovered in the course of the Class II survey, and are included in the qualitative analysis which follows. In all, 61 (68%) silicification zones were examined.

Chapter 5. CLASS II SURVEY RESULTS

Prehistoric Use of the Region

Use of the Lithic Terrane

The opalite components of the Tosawihi Quarries (26Ek3032) lithic terrane saw wide-spread, intensive aboriginal exploitation (Rusco 1983; Elston, Raven, and Budy 1987; Elston and Raven 1992). From its broader geographic perspective, the Class II survey sought to characterize use of the lithic terrane in the archaeologically unexplored uplands surrounding Tosawihi, and to compare this aspect of land use with that observed within the Quarries proper. To this end, 61 mapped silicification zones in and around the study area were inspected and evaluated for evidence of prehistoric use, toolstone quality, and the nature and intensity of quarrying efforts.

Only 16 (26%) of the locations examined exhibited evidence of aboriginal use (Figure 10, Table 2). For the most part, the 45 zones not utilized appear to have been ignored by quarriers due to the low quality of their opalite. Indeed, many zones geologically mapped as "silicified" (Cornucopia 1987) proved upon field checking to consist of soft tuffs not sufficiently silicified to produce knappable raw material.

Table 2. Character of Silicification Zones Examined During the Class II Survey.

		Quality of Material					Type of Use		
Utilization	Survey	Unknown	Poor	Fair	Good	Total	Outcrop	Quarry Pits	Outcrop & Pits
Used									
	Class II	-	-	5 (31.3)	11 (68.7)	16	8 (50.0)	1 (6.2)	7 (43.8)
	Other Tosawihi				6 (100.0)	6			6 (100.0)
Not Used		7 (15.5)	36 (80)	1 (2.2)	1 (2.2)	45	-	-	-

Parenthetic numbers are percentages.

Elsewhere mapped silicification zones within the sample exhibited the full range of toolstone quality recorded for sources within the Tosawihi Quarries (cf. Elston. 1992b). All 16 of the utilized sources encountered in the present study area were of fair (n=5, 31%) to good (n=11, 69%) toolstone quality. We should note, however, the potential circularity in such an assessment because we, like prehistoric quarriers, were limited in our ability to judge accurately the quality of sources on the basis of their visual inspection. As a result of weathering, virtually any naturally exposed opalite surface consists of low quality stone. The quality of pristine material was visible to us only where weathered surfaces had been breached in the course of prehistoric quarrying or as a result of historic mining disturbance. In the case of the latter, several blade cuts in soft, low quality opalite revealed high quality opalite. We suspect that our superficial inspection scored lower the quality of toolstone at many outcrops than would be the case under closer, more invasive observation techniques. Nevertheless, only two sources evaluated as fair to good quality stone did not show prehistoric use. No zones judged to be of low quality appear to have been used prehistorically.

Only sources of good toolstone-quality opalite display high intensity use, and it is only in these zones where quarry pitting, the most costly of extraction methods, occurs. Apparently, sources of lower quality stone did not inspire the investments of time and labor demanded by pit excavation. Instead, these zones served as outcrop quarries exclusively; at many such places characterized by low intensity use, exploitation seems to amount to little more than assay of the outcrops or perhaps acquisition of a small quantity of stone needed to perform some expedient task.

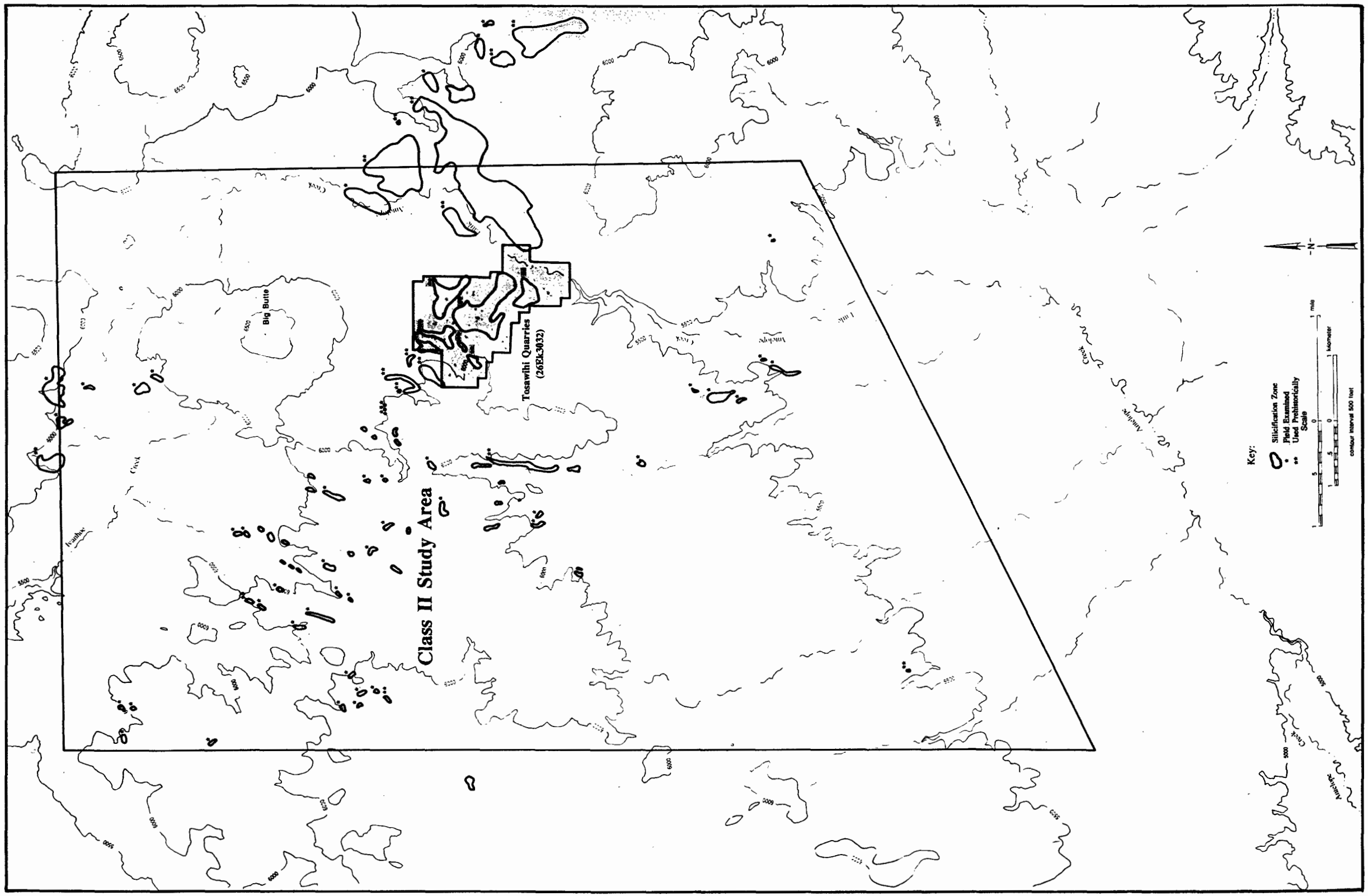


Figure 10. Utilized silicification zones in the Class II study area.

For reasons that we do not understand fully, the largest of the sources appear to have been subjected to the most intensive use. Of the 10 utilized zones covering more than 2.5 acres, 75% (n=7) display moderate to heavy use, while the majority (67%) of the zones smaller than 2.5 acres are characterized by low use intensity. One possible explanation for this may lie in the physical make-up of the rock itself brought about by vagaries of the silicification process. The composition of bedrock referred to by the gloss "opalite" is in fact exceedingly heterogeneous; the product of complex juxtapositions of usable and unusable strata of tuffs, opal, jasper, and sinter (cf. Elston 1992b). At sources examined in the Tosawihi Quarries we observe that toolstone quality in any given zone varies greatly over even limited horizontal and vertical distances. The smaller zones in the Class II study area constitute narrow windows on the bedrock that are of very limited extent over any dimension. Often these take the form of little more than isolated outcrops on ridge tops in the western half of the area, that offer only minimal opportunity for the encounter of the variable potential qualities of the stone. At such places, good quality rock may already have been removed by erosion or may be inaccessible, buried beneath deep colluvial debris. On the other hand, most of the largest zones lie in the eastern half of the study area where down cutting accomplished by major water courses has stripped away softer overburden and rendered many zones into dominant landforms that are not only aerially extensive but also sufficiently incised to expose a wide range of potentially useful strata. Certainly, the larger landforms afford access to a broader selection of assayable material types within the bedrock and present quarriers with a higher probability of success in their search for serviceable stone. Additionally, we infer that the intensity of use focused on the more extensive zones is an artifact of synergistic quarrying behaviors reflective of the economics of toolstone procurement. Results of experimental quarrying disclose that costs of opalite extraction may be reduced markedly by exploiting established sources (Elston 1992a). Archaeological data from the Tosawihi Quarries are unambiguous in the portrayal of the sequent reuse of sources, often for periods spanning hundreds of years (Elston and Dugas 1992).

In terms of the spatial distribution of utilized sources, the highest incidence and intensity of toolstone extraction encountered during Class II survey coincides with zones in the immediate vicinity of the Tosawihi Quarries. Although potentially usable stone outcrops in places throughout the full geographic and topographic extent of the study area, only four (25%) of the utilized sources occur farther than 2.5 km from 26Ek3032. These zones lie in what seems to be a comparatively little used hinterland near the northern, western, and southern limits of the study area at distances of 6 km to 9 km from the heart of the Tosawihi Quarries (see Figure 10). Each of these sources, containing only fair toolstone, evidences minimal use as outcrop quarries.

By contrast, three-quarters of the zones that saw use lie immediately adjacent the zones that constitute the Tosawihi Quarries site. In terms of the quality of their toolstone and the pronounced intensity of their aboriginal exploitation, these sources are indistinguishable from the remains that characterize the archaeological record of the Tosawihi Quarries themselves. Like the sources within 26Ek3032, these zones all are of high toolstone quality. Each covers an area well in excess of 2.5 acres and quarry pit excavation constitutes the dominant extraction technique.

Although inspection of silicification zones focused solely on primary opalite sources, quadrat survey during the Class II exercise and earlier observations reveal that secondary deposits in the form of opalite stream cobbles contribute to the lithic terrane at Tosawihi as well. Cobble sources are found in greatest abundance in the drainage bottoms downstream of 26Ek3032. They occur principally in the beds of Little Antelope Creek and its tributaries and, with diminishing density and size, are available as far away as the confluence of Antelope Creek and Rock Creek some 20 km west of the Quarries (R.G. Elston, personal communication 1991). Due to their hardness, numerous internal fracture plains, and other flaws that impede their workability, cobbles appear to have been low ranked raw materials. This especially is the case in places where alternative supplies could be obtained from better quality primary sources. In the immediate vicinity of Tosawihi we see only sporadic use of stream cobbles as toolstone. However, as distance from the Quarries increases we observe an increase in the incidence of cobble use until at some geographic extremes of the study area and beyond, we find that the secondary sources constitute the only locally available opalite supplies.

The Character, Density, and Distribution of Formed Artifacts and Debitage

Bifaces

Lithic production at Tosawihi Quarries consisted resoundingly of the production of bifaces. We have, now, an excellent understanding of the organization of local biface production achieved through intensive technological examination of a large sample (well over 4000) of bifaces produced at the Quarries (Ataman and Botkin 1991; Bloomer, Ataman, and Ingbar 1992). Research issues driving biface analyses in these earlier Tosawihi investigations concerned lithic procurement patterns, function of bifaces produced at Tosawihi, and role of bifaces in mobility and exchange systems. Analysis of production stages, manufacturing techniques, function, breakage rates, geographical distribution, and raw material heat-treatment has produced a comprehensive evaluation of biface technology and lithic export for this region.

Biface production is a reductive process, a continuum of form from flake, cobble, or block to finished core or tool (Bloomer, Ataman, and Ingbar 1992). The reduction continuum can be segmented into useful analytical units; bifaces with characteristic morphological or flake scar attributes can be assigned to reduction stages (Callahan 1979; Crabtree 1972; Young and Bonnichsen 1984). The Tosawihi bifaces were classified into Stages 1 through 5, according to Callahan's (1979) model, ranging from blanks (Stage 1), edge-prepared bifaces (Stage 2), bifaces with primary thinning (Stage 3), bifaces revealing secondary thinning (Stage 4), to relatively finely shaped bifaces (Stage 5) (Bloomer, Ataman, and Ingbar 1992).

Early stage processing took place at the Quarries, and mid-reduction stage items, having been heat-treated at some stage prior to export, then were transported out of the area, probably as mid to late Stage 3 bifaces (Ataman and Bloomer 1992; Ataman and Botkin 1991). Heat-treatment of Tosawihi toolstone was common (the process is evident in the toolstone as a distinct luster on the surfaces of flake scars), a process that yields increased compliance or flaking predictability and control. Ultimately, finished bifaces are more likely to have been used as knives, rather than as bifacial cores.

The formed artifact assemblage observed during Class II survey was dominated by bifaces. Two hundred forty whole and fragmentary bifaces observed on transect were monitored for material type, reduction stage, completeness, and evidence of heat-treatment (Table 3), using criteria defined in earlier Tosawihi research (Ataman and Bloomer 1992; Bloomer, Ataman, and Ingbar 1992). Opalite was the preferred material type in 99% of bifaces observed on transect, and over 92% of bifaces were fragmentary. Though we conducted no technological analysis of breakage patterns, most fragmentary bifaces from the main Quarries area (comprising over 90% of the entire assemblage) were broken during manufacture (Bloomer, Ataman, and Ingbar 1992) and we assume this to be the case with the Class II bifaces. The few complete bifaces observed (n=18) ranged from early Stage 2 to late Stage 3 forms.

Table 3. Bifaces Observed on Transect During Class II Survey.

Reduction Stage	Frequency (%)		Frequency (%) of Stage Heat-Treated	
Stage 1	2	(0.8)	0	(0.00)
Early Stage 2	25	(10.4)	1	(4.00)
Late Stage 2	26	(10.8)	4	(15.38)
Early Stage 3	41	(17.1)	11	(26.83)
Mid Stage 3	30	(12.5)	13	(43.33)
Late Stage 3	42	(17.5)	19	(45.24)
Early Stage 4	46	(19.2)	32	(69.57)
Late Stage 4	18	(7.5)	15	(83.33)
Stage 5	10	(4.2)	9	(90.00)
Total	240	(100.00)	104	

The biface assemblage is characterized by the entire range of reduction stages, with late Stage 3 (17.5%) and early Stage 4 (19.2%) bifaces being most common. As depicted in Figure 11, bifaces discarded in the early stages of production (Stage 1 through early Stage 3) are distributed broadly over the Class II region (in 22% of the survey quadrats). Middle stage (middle Stage 3) bifaces are slightly more restricted in their distribution (14% of survey quadrats), while late Stage (late Stage 3 through Stage 5) bifaces were observed in more quadrats (28%) than any other forms.

Considering all stages of bifaces in the aggregate, the largest proportion (33.3%) of the total lies within 1 km of the principle Quarries with minor peaks (20.4% and 15.4%) at 3 km and 4 km, respectively. We compared the distribution of all bifaces across 1000 m radii against the distance distribution of quadrats to evaluate whether quadrat placement might have skewed biface frequency distribution in some regular way. A Kolmogorov-Smirnov two-sample test revealed a significant difference in the proportional contribution of each data set (Dmax=.21, Dcrit=.14, at p=0.05, n1=240, n2=151). The location of quadrats relative to the Quarries is not determining the location of bifaces. The high proportion of bifaces close to the Quarries reflects not sampling bias but rather a behavioral phenomenon relating to production and discard of large numbers of bifaces near toolstone sources.

The distribution of early, middle, and late stage bifaces was examined relative to their linear distance from the main Quarries (Figure 12). Middle stage bifaces are not significantly different from early or late stage forms in their proportional distribution across distance radii. Still, more middle stage bifaces (33%) were discarded within 1 km of the Quarries than in any other distance class. Early and late stage bifaces do differ significantly in their distribution, however (Kolmogorov-Smirnov two-sample test: Dmax=.4, Dcrit=.19, at p=0.05, n1=94, n2=116). Early forms reach their highest densities adjacent the main Quarries in quadrats that contain large, high quality silicification zones (see Figure 11). Fifty-three percent of these bifaces were discarded within 1 km of the Quarries. In stark contrast, only 17% of late stage bifaces were abandoned in this nearby zone.

The characteristic distribution of bifaces across stages differs considerably from that profile observed in other Tosawihi study areas (Figure 13). The aggregate biface assemblage from all prior Tosawihi investigations is dominated by Stage 3 bifaces (Bloomer, Ataman, and Ingbar 1992), while the Class II assemblage is distributed more evenly over stages, with substantially higher proportions of late stage bifaces.

As mentioned, bifaces probably were exported from the main Quarries as early Stage 3 to late Stage 4 forms, with most departing as middle and late Stage 3 bifaces (Ataman and Bloomer 1992). That the Class II assemblage contains higher proportions of discarded later stage forms than the main Quarries suggests that the more distant environs of the Class II region were further along a production and transport network that originated at the Quarries. Yet, the presence of broadly distributed early stage bifaces, indeed to the limits of the Class II study area, indicates that primary lithic production was continuing beyond the main Quarries, as well.

Stageable biface forms are distributed differentially among the five principal Tosawihi study areas. Figure 14 depicts the proportions of bifaces, by stage, comprising the biface assemblages of all study areas in the aggregate. Each biface stage is shown as a discrete box, with study areas listed along the y-axis; the boxes are clustered into early, middle, and late stage groupings. To illustrate, a dot plotted along the percentage scale at a given study area in the "Stage 1" box signifies the proportion contributed by that study area to the assemblage of Stage 1 bifaces found in all study areas (the percentages demarcated in each box sum to 100%).

Biface stage and location of discard are powerfully associated (chi-square=523.21, df=32, p<0.001): early reduction stages tend to be associated with the Quarries and the Eastern Periphery, while later forms tend to dominate in the Western Periphery, Northern Corridor and the Class II study area. This pattern is illuminated by a dot plot of adjusted standardized residuals (Figure 15; Everitt 1977) that highlights significant (p=0.05)

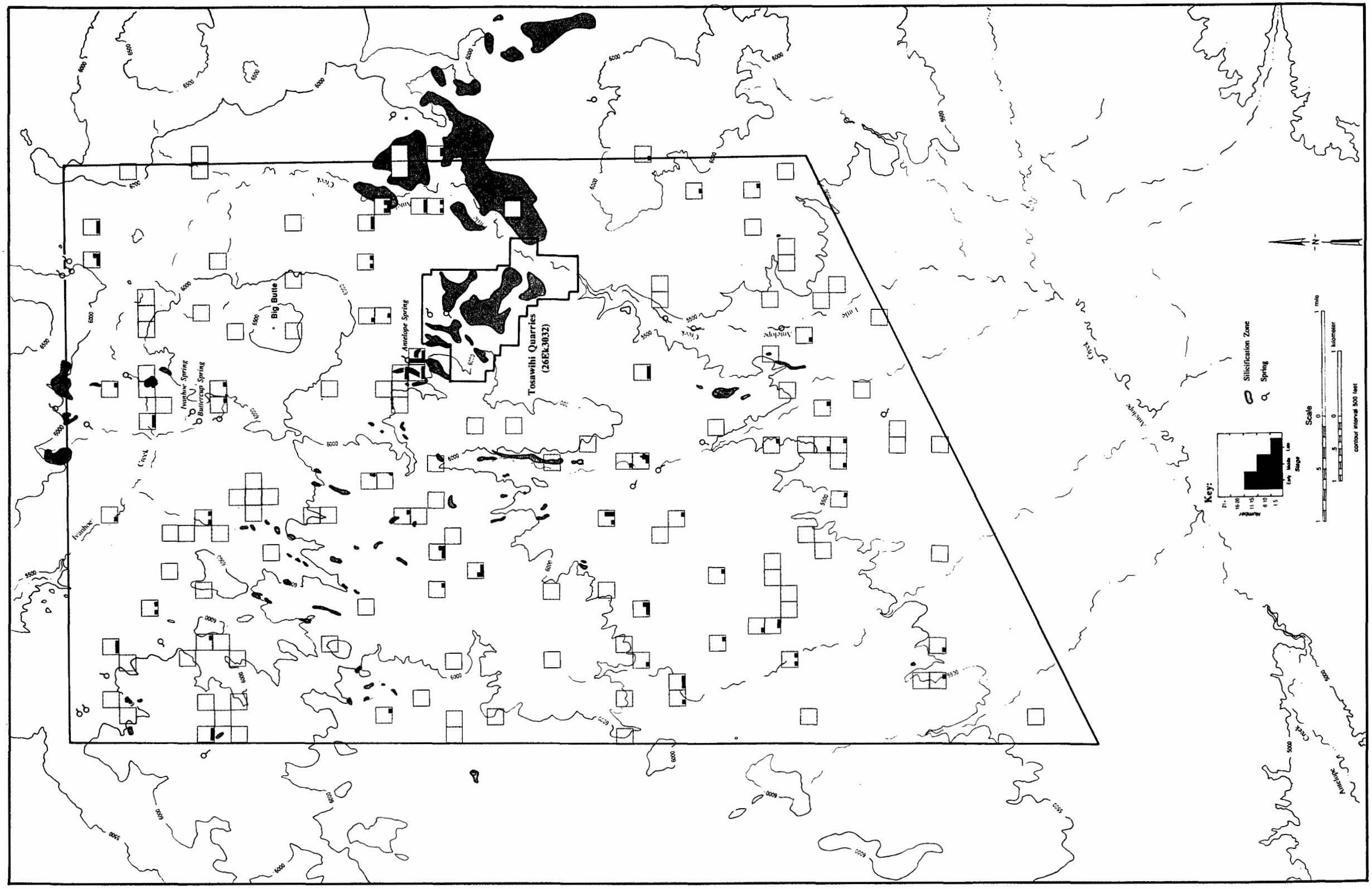


Figure 11. Bifaces, by reduction stage, observed in the Class II survey.

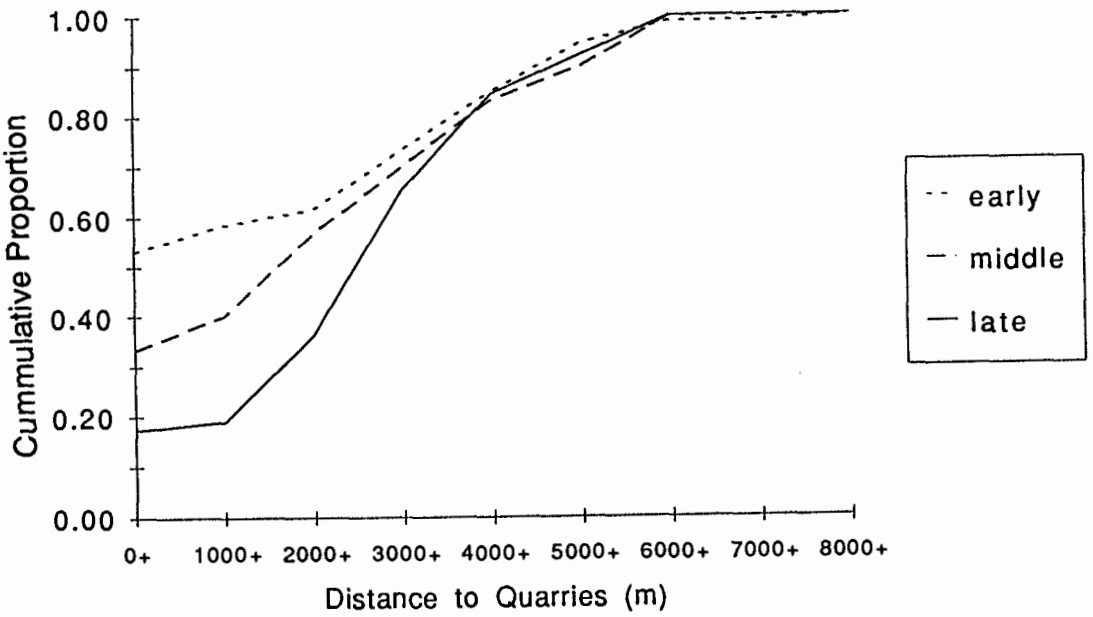


Figure 12. Cumulative proportions of bifaces by radial distance to the principal Quarries.

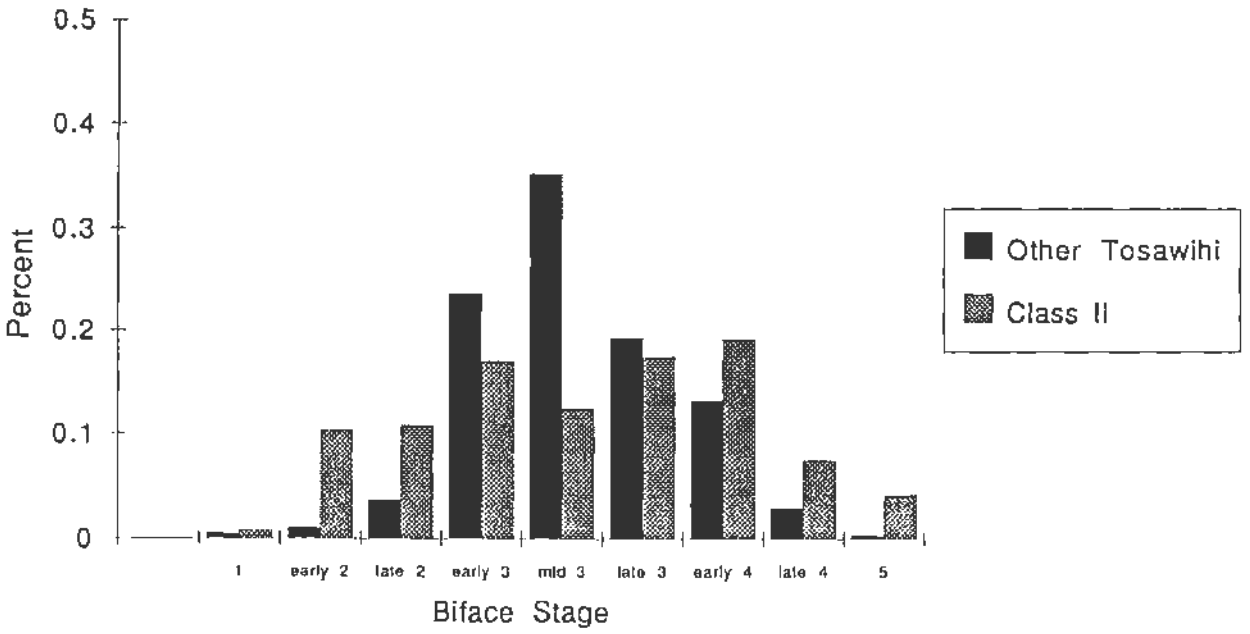


Figure 13. A comparison of biface reduction stages observed during the Class II survey and other Tosawihi surveys.

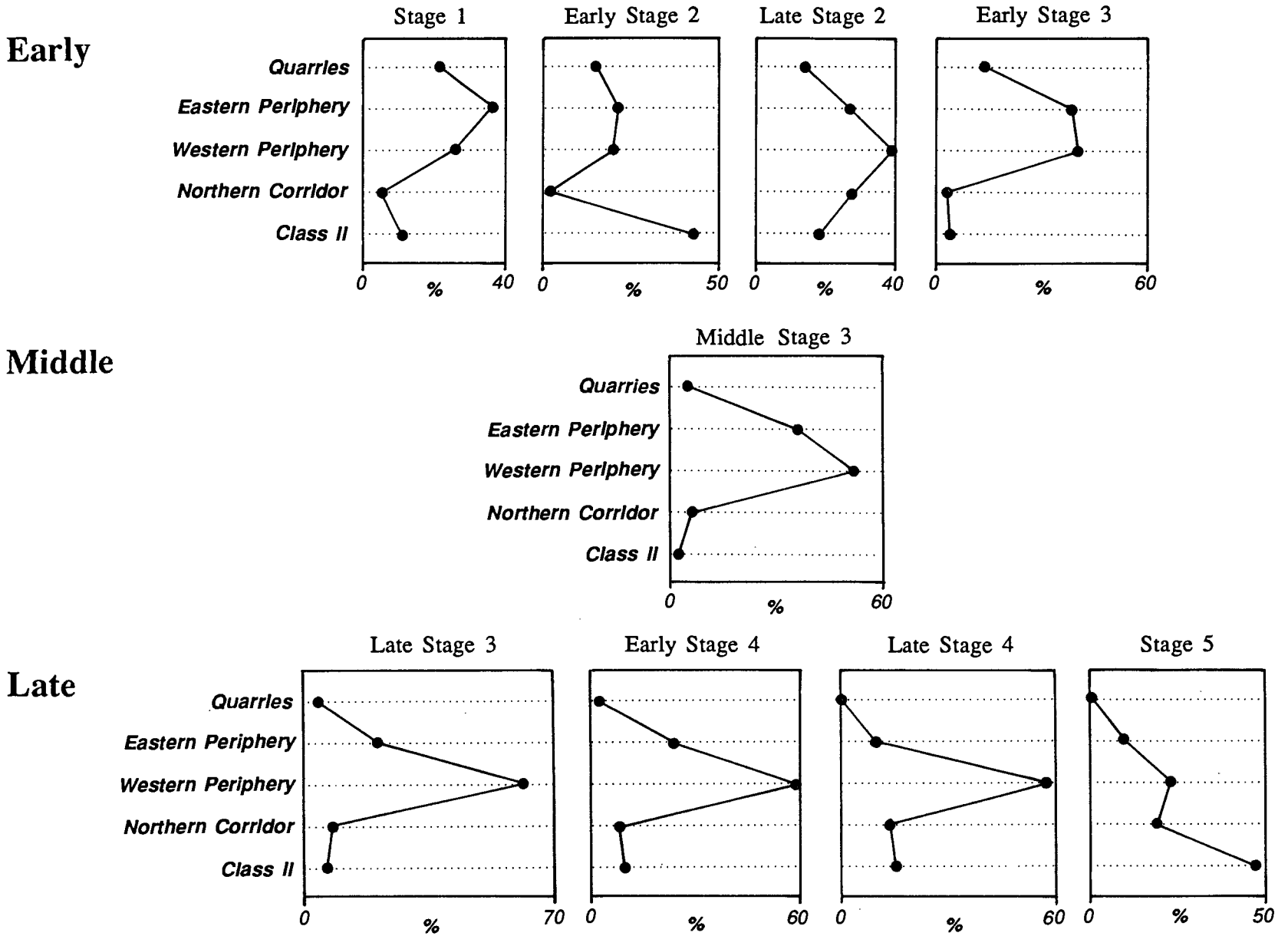


Figure 14. Proportions of staged bifaces observed across all Tosawihi study areas.

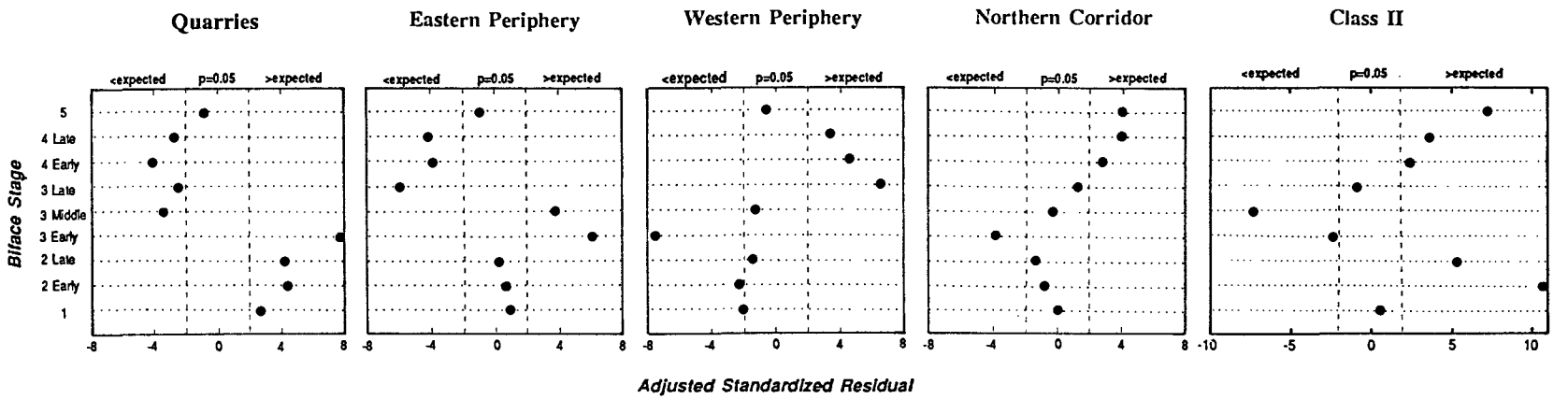


Figure 15. Adjusted standardized residuals for staged bifaces observed across all Tosawihi study areas.

deviations from chi-square expected values (adjusted standardized residual values that are higher/lower than expected under a model of independence are shown by a dot in the appropriate column).

In the main Quarries, there are significantly more Stage 1, Stage 2 and early Stage 3 bifaces than later forms. In the Eastern Periphery, outside the Quarries proper but containing a number of toolstone sources, early and middle Stage 3 bifaces are more common than expected. In the Western Periphery, an area that is somewhat removed from usable toolstone sources and which contains several residential camps, late Stage 3 and Stage 4 bifaces are more commonly found. The Northern Corridor, even farther from the main Quarries, yielded higher than expected frequencies of Stage 4 and 5 bifaces. This dominance of late forms is echoed in the Class II study area, where Stage 5 bifaces are particularly strongly manifest (48% of all Stage 5 forms were found in the Class II region).

The higher than expected frequency of Stage 2 bifaces in the Class II assemblage is also an interesting pattern. We see (in Figure 11), however, that the highest densities of early stage bifaces (Stage 1- early Stage 3 items) are found in only two quadrats adjacent 26Ek3032, which contain their own large, high-quality silicification zones. The presence of these large toolstone sources in a portion of the Class II study area adjacent the principal Quarries renders that portion effectively equivalent to the Quarries.

The stage at which Class II bifaces were discarded and the frequency with which they were heat-treated (see Table 3) reveals a regular pattern (chi-square=63.65, $p<0.001$), suggesting significant value in the increased control yielded by heat-treatment as bifaces advanced in stage (and declined in size). Earlier stages of bifaces (Stages 1-early Stage 3) were heat-treated less often than expected (under conditions of statistical independence), while later stages (particularly early Stage 4 - Stage 5) were heat-treated more frequently than expected (analysis of adjusted standardized residuals [Everitt 1977]). The proportion of heat-treated bifaces, within stage, increases notably from early to middle Stage 3, and then again from late Stage 3 to early Stage 4. Between 70% and 90% of all Stage 4 and 5 bifaces were heat-treated, suggesting that heat-treatment was a significant technological element of the final stages of manufacture.

In prior Tosawihi studies (Bloomer, Ataman, and Ingbar 1992), it was observed that those items farthest from toolstone sources were most likely to be heat-treated. In the Class II region, heat-treatment and distance from the main Quarries are indeed associated positively (chi-square=40.81, df=7, $p<0.001$; Table 4).

Table 4. Cross-Tabulation of Heat-Treated and Non-Heat-Treated Bifaces Against Distance Radii from Tosawihi Quarries (26Ek3032).

	Bifaces	
Distance from Quarries (km)	Heat-Treated (%)	Non-Heat-Treated (%)
0 - 0.9	16[a]	84[b]
1.0 - 1.9	67	33
2.0 - 2.9	71[c]	29[d]
3.0 - 3.9	55	45
4.0 - 4.9	54	46
5.0 - 5.9	50	50
6.0 - 6.9	50	50
7.0 - 7.9	-	-
8.0 - beyond	-	100

[a]Significant ($p<.05$) Adjusted Standardized Chi-Square Residual = -5.987
[b]Significant ($p<.05$) Adjusted Standardized Chi-Square Residual = 5.987
[c]Significant ($p<.05$) Adjusted Standardized Chi-Square Residual = 3.192
[d]Significant ($p<.05$) Adjusted Standardized Chi-Square Residual = -3.192

Bifaces within 1 km of the main Quarries are highly unlikely to be heat-treated, reflecting their primary production at the Quarries, confirming previous observations that heat-treatment tends to take place away from sources of lithic extraction, and echoing the Tosawihi pattern of relatively early stage reduction near these important toolstone sources. Beyond this distance, however, the proportion of heat-treated bifaces jumps dramatically and remains relatively high for a radius of several kilometers. Interestingly, once a 5 km radius has been reached, bifaces are equally likely to be heat-treated or not heat-treated. This pattern may indicate primary production taking place at some distance from the Quarries, perhaps originating at an unknown toolstone source.

Projectile Points

The full chronological range of Great Basin time-markers witnessed in the principal Quarries (Elston and Drews 1992) was observed in the Class II survey area (Table 5), save for the earliest Clovis form. Though projectile points generally were not collected, all points encountered during survey were traced. Points were assigned to temporal styles by comparison of metrics to Thomas's (1981) Monitor Valley key (Appendix C).

Table 5. Projectile Points Observed During Class II Survey.

	Material (%)			Observed		
Point Type	Opalite (or other)	Obsidian	Basalt	On Transect	Off Transect	Total
Desert Series	1 (.02)	-	-	1	-	1
Rosegate	4 (.08)	2 (.04)	-	4	2	6
Elko Series	9 (.18)	-	-	7	2	9
Gatecliff	4 (.08)	-	-	2	2	4
Humboldt	3 (.06)	-	-	2	1	3
Large Side Notched	2 (.04)	-	-	1	1	2
Great Basin Stemmed	1 (.02)	-	1 (.02)	-	2	2
Not Typable	18 (.36)	4 (.08)	1 (.02)	18	5	23
Total	42 (.84)	6 (.12)	2 (.04)	35	15	50

The presence of Great Basin Stemmed, Gatecliff series, Humboldt series, Elko series, Rosegate series, and Desert series point styles documents use of the Class II region from the Pre-Archaic through the Archaic. And their frequent manufacture from opalite, rather than from other materials, signals directed use of the region for procurement of raw material, as well. The general landscape distribution of projectile points compared to other artifact forms is discussed below.

Additional formed artifacts were recorded during Class II survey (Appendix D). Tool types have been defined in earlier Tosawihi reports (especially, Elston and Raven 1992).

Debitage

Just beyond the principal opalite sources of the Tosawihi Quarries, debitage densities decline significantly. While the Quarries present a near continuous distribution of debitage, ranging from sparse to a virtually unbroken pavement of opalite reduction debris (see Elston, Raven, and Budy 1987: Figure 9), debitage

was absent to sparse in 90% of all Class II survey quadrats. Nineteen percent (n=28) of the survey quadrats were entirely devoid of debitage. Seventy-one percent (n=107) of all quadrats were characterized by generally sparse (average density of less than 1 flake per square meter) levels. Only 9% (n=14) contained light (1-100 flakes per square meter) densities of debitage, and just 1% (n=2) contained moderate (more than 100 flakes per square meter) levels. Those quadrats containing light to moderate debitage densities consistently are located either adjacent the large silicification zones extending from the principal Quarries or near significant water sources (Figure 16).

The relative overall density of debitage across quadrats appears unrelated to the distribution of silicification zones well outside the main Quarries. Quadrat debitage density, ranging from absent to sparse to light, was compared at 500 m distance radii (ranging from 0 - 2500 m) from silicification zones. No correlation between debitage density and distance of quadrat from silicification was revealed in a chi-square test of the two variables (chi-square=11.34, $p<.25$, df=10). This finding is hardly surprising, given the generally poor quality and infrequent use of outlying mapped outcrops discussed above.

Debitage reduction patterns mirrored those seen in biface reduction forms: as one leaves the Quarries, debitage size generally becomes smaller and thinner. During Class II survey, we observed mostly medium to small debitage, suggesting the transport of relatively good (already thin and requiring little additional reduction) flake blanks or medium to late stage bifaces away from the Quarries. If toolstone sources external to the Quarries had been importantly used, we would have expected to see reduction scatters consisting of large, chunky (primary reduction) debitage clustered about silicification zones. Instead, the debitage assemblages in only 7.2% of all quadrats were generally characterized as dominated (50% or more) by large debitage. In marked contrast, 60.3% of quadrats contained predominately medium-sized debitage. Just over 10% were characterized primarily by small debitage.

The high proportion of quadrats with small and medium-sized debitage reflects a mid-stage reduction focus over a large portion of the Class II region. The Class II environs, then, are still well within a "zone of production" marked by continued *reduction* of toolstone products extracted from the main Quarries, rather than *use* of finished products.

The Density and Distribution of Artifacts Across Sampling Strata

As expected, bifaces and assayed cobbles outrank in density all other formed artifact types (Table 6). Densities of artifacts across sampling strata are highly variable, though in all cases artifacts occur with greatest frequency on slopes less than 6%. In this more gentle landscape, quarrying or lithic reduction-related implements and by-products (eg. bifaces, cores, assayed cobbles, modified chunks, percussion tools) occur in highest densities in quadrats containing toolstone that are relatively near water. In contrast, points and preforms, flake tools, and exotic materials (primarily obsidian) are most common near water, regardless of toolstone availability. These two distribution profiles—one near toolstone and water, the other near water independent of toolstone availability—reflect two quite different behavioral dimensions. The dimension represented by bifaces, cores, assayed cobbles, modified chunks, and percussion tools refers to a lithic extraction-tool production trajectory while the latter (points and preforms, flake tools, and exotic materials) suggests more diversified maintenance and resource procurement activities. Because the target resources of each activity set can be expected to differ markedly, so can the locations in the landscape in which they occur.

The association between artifact types and individual sampling strata (each possible pair of conditions re slope, stone, and water) is demonstrably significant (chi-square=41.94, 79.66, 78.89, respectively, $p<.001$ in all cases; groundstone and percussion tools removed from analysis due to rarity). An analysis of adjusted standardized residuals (Everitt 1977) signaled particular classes of data that were responsible for the significant

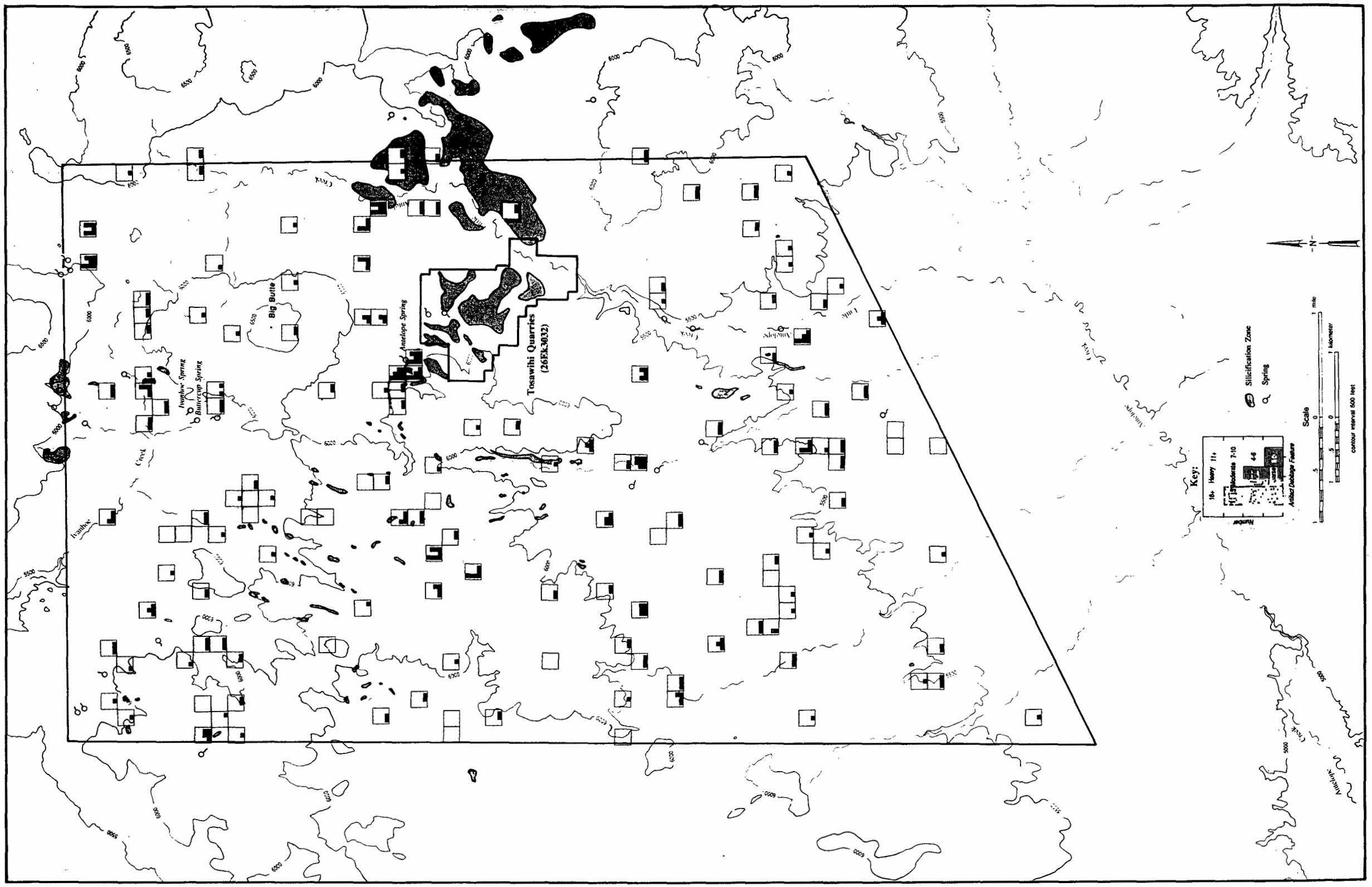


Figure 16. Relative densities of debitage, artifacts, and features across the study area.

chi-square. More flake tools and bifaces than expected occurred on slopes over 6%, and more assayed cobbles and modified chunks occurred near water and toolstone sources and on slopes under 6%. This latter phenomenon no doubt was conditioned by the prevalence of large silicification zones in the gentle valleys and plains immediately north and east of the main Tosawihi Quarries. More bifaces and points/preforms than expected occurred away from water and toolstone, suggesting that there may be a secondary lithic production trajectory that relates to later stage tool fabrication in conjunction with game procurement activities. This pattern accords well with our observation that late stage biface production is relatively common in the Class II study area, in contrast to the Quarries.

Table 6. Distribution and Density of Prehistoric Artifacts Across Sampling Strata.

Sampling Strata			**Artifact Frequency**									
Slope[a]	Stone[b]	Water[c]	Bifaces	Points/ Preforms	Cores	Assayed Cobbles	Modified Chunks	Ground-stone	Percussion Tools	Flake Tools	Exotic Material	Total
0	0	0	96	21	5	33	15	1	2	6	8	187
0	0	1	13	4	-	-	-	-	-	1	5	23
0	1	0	16	4	-	-	-	-	-	2	5	27
0	1	1	41	-	2	76	28	-	4	-	2	153
1	0	0	58	12	2	1	3	3	-	6	5	90
1	0	1	2	-	-	-	-	-	-	-	-	2
1	1	0	4	2	-	4	2	-	-	-	-	12
1	1	1	10	1	-	-	-	-	-	1	1	13
Total			240	44	9	114	48	4	6	16	26	507

Sampling Strata			**Artifact Density** *(Frequency per Acre Surveyed)*[a]									
Slope[b]	Stone[c]	Water[d]	Bifaces	Points/ Preforms	Cores	Assayed Cobbles	Modified Chunks	Ground-stone	Percussion Tools	Flake Tools	Exotic Material	Total Density/ Acre
0	0	0	.087	.019	.005	.030	.014	.001	.002	.005	.007	0.169
0	0	1	.223	.069	-	-	-	-	-	.017	.086	0.395
0	1	0	.118	.029	-	-	-	-	-	.015	.037	0.199
0	1	1	.528	-	.026	.979	.361	-	.052	-	.026	1.972
1	0	0	.045	.009	.002	.001	.002	.002	-	.005	.004	0.069
1	0	1	.026	-	-	-	-	-	-	-	-	0.026
1	1	0	.041	.021	-	.041	.021	-	-	-	-	0.124
1	1	1	.129	.013	-	-	-	-	-	.013	.013	0.168
Artifact Class Density across Sample Universe (n/2929.4 acres surveyed)			.082	.015	.003	.039	.016	.001	.002	.005	.009	.173

[a]See Table 1 for acres surveyed

[b]Slope 0=Quadrat mean slope is <=6%
1 = Quadrat mean slope is >6%

[c]Stone 0=Quadrat contains no toolstone source
1 = Quadrat contains toolstone source

[d]Water 0=Quadrat lies more than 560 m from a water source
1 = Quadrat lies within 560 m of a water source

The Character, Density, and Distribution of Features

The array of feature types distributed across sampling strata is dominated, not unexpectedly, by quarrying features (cairns, cobble quarries, cobble aggregations, outcrop quarries, and quarry pits) and reduction scatters (Table 7; Appendix E). Two culture-bearing rockshelters and several linear rock alignments and rock rings situated near saddles or overlooking water sources (probably serving as hunting blinds) round out the assemblage of features observed during Class II survey.

Table 7. Distribution and Density of Prehistoric Features Across Sampling Strata.

Sampling Strata			Features (n)											
Slope[a]	Stone[b]	Water[c]	Cairn	Cobble Aggregation	Cobble Quarry	Isolate	Linear Rock Alignment	Outcrop Quarry	Quarry Pit	Reduction Scatter	Rock Ring	Rock-shelter	Other[d]	Total
0	0	0	-	1	2	-	3	4	-	63	1	-	-	74
0	0	1	-	-	-	-	-	-	-	5	-	-	-	5
0	1	0	1	-	-	-	-	4	1	18	-	-	-	24
0	1	1	3	-	-	-	-	1	10	2	-	-	-	16
1	0	0	2	1	1	1	-	-	2	6	1	2	1	75
1	0	1	-	-	-	-	-	-	-	1	-	-	-	1
1	1	0	-	-	-	-	-	1	-	2	-	-	-	3
1	1	1	-	-	-	-	-	-	-	16	-	-	-	16
Total			6	2		1	3	10	13	171	2	2	1	214

Sampling Strata			Feature Density (*Density Per Acre Surveyed*)											Total
Slope[a]	Stone[b]	Water[c]	Cairn	Cobble Aggregation	Cobble Quarry	Isolate	Linear Rock Alignment	Outcrop Quarry	Quarry Pit	Reduction Scatter	Rock Ring	Rock-shelter	Other[d]	Density/ Acre
0	0	0	-	.001	.002	-	.003	.004	-	.057	.001	-	-	0.067
0	0	1	-	-	-	-	-	-	-	.086	-	-	-	0.086
0	1	0	.007	-	-	-	-	.029	.007	.133	-	-	-	0.177
0	1	1	.039	-	-	-	-	.013	.129	.026	-	-	-	0.206
1	0	0	.002	.001	.001	.001	-	-	.002	.049	.001	.002	.001	0.058
1	0	1	-	-	-	-	-	-	-	.013	-	-	-	0.013
1	1	0	-	-	-	-	-	.010	-	.021	-	-	-	0.031
1	1	1	-	-	-	-	-	-	-	.206	-	-	-	0.206
Feature Class Density across Sample Universe (n/2929.4 acres surveyed)			.002	.001	.001	.0003	.001	.003	.004	.058	.001	.001	.0003	.073

[a]Slope 0=Quadrat mean slope is <=6%
1 = Quadrat mean slope is >6%

[b]Stone 0=Quadrat contains no toolstone source
1 = Quadrat contains toolstone source

[c]Water 0=Quadrat lies more than 560 m from a water source
1 = Quadrat lies within 560 m of a water source

[d]Aggregation of chunky debitage

Generally, feature densities are highest near toolstone and water, regardless of slope gradient, followed by somewhat lower densities where toolstone and water sources are disjunct. It is important to note, however, that the association between high feature densities and toolstone availability is established chiefly by quadrats adjacent the principal Quarries (cf. Figure 16). Silicification zones mapped well beyond the Quarries boundaries rarely are associated with high feature densities, further confirming our observation that these zones offered few quarrying opportunities. Indeed, quarrying features recorded during survey cluster chiefly (76%, n=17) around the large opalite outcrops immediately adjacent the Tosawihi Quarries. Only six (26%) quarrying features were observed beyond these core silicification zones, and these are characterized by relatively ephemeral use. Where significant aggregations of features do occur in the outlying regions of the Class II region, *relative* proximity to water (usually within 1 km), not mapped silicification zones, appears to be the critical determinant (see below).

Not surprisingly, cairns (usually mounds of opalite cobbles near quarry pits), quarry pits, and outcrop quarries tend to be most common in quadrats with toolstone; again, these quadrats are those containing the large mapped toolstone sources closest to the Quarries. The presence of such features in quadrats that originally were stratified as containing no toolstone, indicates the discovery of previously unknown, minor toolstone sources. Reduction scatters are found most frequently in toolstone-rich quadrats (primarily adjacent the Quarries), confirming our proposition that reducing toolstone bulk near the place of extraction, as a cost-efficient strategy, should be common.

Because rarity of certain feature types disallowed the application of a standard chi-square test for examining the distribution of all feature types across sampling strata, we examined only two basic classes of features, reduction scatters and all other outcrop quarrying-related features (counts for outcrop quarries and quarry pits were collapsed). The distribution of reduction scatters and quarrying features is associated significantly with slope, toolstone, and water availability (chi-square=10.35, 26.67, 15.66, respectively; $p<.005$ in all cases). Particularly strong associations (and hence those contributing substantially to the significant chi-square result) include quarrying features on slopes less than 6% (almost all major silicification zones are on gentle slope), and reduction features that lie on steeper slopes in quadrats without toolstone, and/or away from water. Thus, reduction of toolstone was not restricted to locations with immediate (that is, less than 560 m distant) access to water, nor was it tethered to nearby toolstone or easy topography. As pointed out above, however, access to water within a kilometer, or so, appears to have conditioned clustering of reduction features.

Access to water conditioned other, more diverse activities beyond quarrying and reduction. In the dry Tosawihi uplands, we logically surmised that water sources might be critical residential activity loci. Acknowledging that surficial examination, without excavation, might make assignment of "residentiality" difficult (cf. Leach 1992), we undertook a qualitative evaluation of a wide range of potential residential contexts. We briefly examined a judgmental sample of seventeen mapped (on 7.5′ USGS quads) and unmapped water sources (most of them running well in June) for evidence of prehistoric use. Eighty-two percent (n=14) revealed substantial usage, supporting artifact scatters ranging from 4,000 m^2 to 117,000 m^2 (average size=38,670 m^2, where size could be estimated from cursory examination). All spring site assemblages were dominated by opalite reduction debris, occasionally characterized by high color variation suggesting multiple toolstone sources for the raw material reduced at these locations. Other material types, including basalt and obsidian, often were represented, as well. Mid-to-late stage biface reduction debris almost exclusively characterized the debitage component of these assemblages, and heat-treatment was commonly manifested. Assemblage diversity tended to be high, with ubiquitous, mid-to-late stage bifaces, projectile points and preforms, and occasionally rarer implements such as drills, shaft abraders, and millingstones. Such variable maintenance/processing tools, multiple reduction features (at seven of the occupied sites), and a relatively rare hunting blind at one spring suggests repeated, though short-term, multi-functional usage.

Similarly complex and diverse features recorded in Class II quadrats were invariably adjacent ephemeral springs or watered drainages. Four such features contained assemblages with millingstones and diverse raw material types; these may well prove (if excavated) to contain short-term residential components.

The distribution of potentially residential sites appears unrelated to the availability of nearby toolstone sources. As we have seen, outlying silicification zones were used infrequently, while all major water sources were occupied intensively. Because Class II springs lie within relatively easy travelling distance of the far superior toolstone sources of 26Ek3032, it is likely that diurnal quarrying trips were mounted from these locations. The high-quality middle to late stage opalite reduction debris (often heat-treated) that dominates their assemblages establishes their place in a wide-ranging Tosawihi production system, originating at the Quarries.

Summary and Conclusions

The Class II lithic assemblage represents an extension of the same homogeneous production trajectory revealed at the Quarries. Spatial variability in the distribution of bifaces is patterned predictably, revealing key aspects of the organization of lithic production at Tosawihi. Large proportions of bifaces (particularly early stage bifaces) were discarded nearer the Quarries, where they were being produced and broken in manufacture. Later stage bifaces, on the other hand, tended to be produced and discarded in the more distant environs of the Class II universe. Yet the continuing presence of early stage biface forms and middle stage reduction debris, out to the limits of the study area, suggests that the Class II region was still well within a unified "zone of production."

Silicification zones in the Class II study area were remarkably underused relative to outcrops observed in the heart of the Quarries. The quality, size, and location of opalite outcrops appear to have influenced whether or not zones were used as toolstone sources and determined the intensity and type of extraction methods that were applied at them. Mapped silicification zones often were smaller and poorer in quality than those opalite exposures exploited in the principal Quarries.

Too, the persistent use of Quarries facilities (for example, old quarry pits) and bedrock exposures may well have attracted repeated *re*use (thereby allowing exploitation of the fruits of prior quarriers' efforts). Scavenging for usable toolstone in old quarry pit berms, using old hearths and other facilities, may have provided a more cost-effective method of toolstone extraction (cf. Elston et al. 1992). In many instances, it may have been cheaper simply to return to the Quarries for toolstone than to initiate new exploitation of previously untapped (and probably disappointing) sources beyond the Quarries peripheries.

Debitage density, feature density, and artifact density in previously surveyed Tosawihi study areas were substantially greater than those observed in the Class II study area. Proximity to the heart of Tosawihi Quarries, conditioned significantly the density of archaeological remains in the upland region; quadrats adjacent the northern boundary of the Quarries, in particular, yielded higher densities of artifacts, features and debitage than those seen throughout most of the rest of the study area (see Figure 16).

Proximity to the high quality toolstone sources of 26Ek3032, then, may be considered a key variable in predicting the character/density of remains. As one achieves even modest distance from the heart of the Quarries, feature density declines dramatically (Table 8).

Table 8. Density of Prehistoric Features Recorded in the Tosawihi Environs.

Survey	Acres Surveyed	Number of Features Recorded	Feature Density (per acre surveyed)
Tosawihi Quarries	823	322	.39
Eastern Periphery	170	183	1.08
Western Periphery	480	153	.32
Class II	2,929	214	.07

The Tosawihi Quarries exhibited 322 prehistoric features and feature clusters (Elston, Raven, and Budy 1987). At a density of .39 features per acre surveyed, Quarries features are over five times more dense than the prehistoric remains discovered in the Class II study area (214 prehistoric features at a density of .07 features per acre surveyed). Preservation of discrete, surficially observable features may be largely a factor of depositional processes and/or recency of deposition. Nonetheless, it is doubtful that depositional processes within an 8-10 km radius (to the limits of the Class II study area) of the Quarries would have been variable enough to account for such dramatic differences in feature density.

Historic Use of the Region

by C. Lynn Rogers

We have little evidence of historic events occurring in the study area prior to the 1860s. Peter Skene Ogden *may* have passed through the immediate vicinity on his beaver-trapping expedition of 1828-29 (Elliot 1984:35), and in the 1840s and 1850s, thousands of immigrants headed for California and Oregon followed the Humboldt River corridor through this part of then "Utah Territory." Though the Humboldt River lies some 30 miles south of Tosawihi Quarries, use of the study area may have occurred at that time, as intensified EuroAmerican occupation displaced Western Shoshone and Northern Paiute people along the Humboldt River. Known historic uses of the Tosawihi Quarries region from the 1860s to present include cattle ranching, sheep production, hunting, and mercury mining.

Two recent studies shed light on Western Shoshone groups and their use of the Quarries from the mid-1800s to the present (Clemmer 1990; Rusco and Raven 1991). Shoshone activities at Tosawihi Quarries, reported in a recent ethnographic study, included collecting opalite, rhyolite tuff, and plants, hunting, visiting power spots, and buckarooing for local ranches (Rusco and Raven 1991:13, 27-29).

Ranching Industries

Cattle and sheep ranching have been significant industries in Elko County since at least the 1870s. According to Bancroft (1981:275), Elko County contained the most good agricultural and grazing land among all Nevada counties. In 1880, 200,000 lbs of wool were shipped from Battle Mountain, an impressive indication of local sheep populations (Bancroft 1981:248). Tosawihi Shoshone were employed by local ranches, including the Betty O'Neill, Hadly, 25, Spanish, Izzenhood, YP, and Packer ranches during the twentieth century (Rusco and Raven 1991:13, 27).

There are no ranch headquarters in the immediate study area, but the entire region is grazed by fee arrangement with the Bureau of Land Management. Ranches lie to the north, to the west and southwest along the Humboldt River, and to the east, near Dunphy. Very likely, the ranchers in the lowlands transfer cattle to the upland Ivanhoe District for summer forage.

Mining Uses

At Tosawihi, mercury ore deposits lie in beds of cryptocrystalline silicate (opalite) or along steep vertical faults. Cinnabar was discovered in the district by W.F. Roseberry and W.C. Davis in 1911. The Ivanhoe

Mining District (Figure 17) was organized circa 1915 (Lincoln 1982:47), and commercial production began that same year, at which time numerous claims were staked and a 6-pipe Rocca retort was installed. Production continued from 1915 until the end of World War I (Zeier 1987:6); 20 to 50 flasks of mercury were produced by 1917.

Mining in the Ivanhoe District resumed in 1929, and continued through the 1940s. Most 1930s mercury was extracted from the Butte Quicksilver Mine (including the Velvet, Clementine, and Butte claims), with the second largest producer being the Governor Mine. The World War II era was the most productive period of all at Ivanhoe, when the Silver Cloud Mine gained prominence as the largest producer (some 700 flasks by 1943). Operations were intermittent from 1943 to 1947 (Zeier 1987:6).

Mercury production ceased from 1947 to 1957, when, for the next five years, cinnabar mining was pursued in response to rising international mercury prices. This time, little profitable ore could be found at Ivanhoe and only 30 flasks of mercury were produced in the district (Zeier 1987:7-8).

Since the 1970s, gold mining has replaced mercury production in the Ivanhoe Mining District. Present-day development centers on open-pit gold mining and heap-leach processing.

Cultural Remains

Of all the historic and current activities mentioned above, only a few are visible in the archaeological remains encountered during our Class II survey of 1991 (Table 9; Appendices D and E).

Table 9. Distribution of Modern and Historic Features Across Sampling Strata.

Sampling Strata			Feature Types (n)										
Slope[a]	Stone[b]	Water[c]	Cairn	Historic Camp	Historic Dump	Historic Road[d]	Historic Wall	Mining Feature	Modern Road[d]	Other Historic	Other Modern	Pit, Unknown Function	Total
0	0	0	-	1	10	2	-	42	14	1	2	1	73
0	0	1	-	-	-	-	-	-	3	-	1	-	4
0	1	0	-	-	-	-	-	7	5	-	-	-	12
0	1	1	1	-	-	-	-	7	5	-	1	-	14
1	0	0	1	-	5	3	2	51	10	-	3	1	76
1	0	1	-	-	-	-	-	-	-	-	-	-	0
1	1	0	1	-	-	-	-	11	-	-	-	-	12
1	1	1	-	-	-	-	-	1	-	-	-	-	1
Total			3	1	15	5	2	119	37	1	7	2	192

[a]Slope 0=Quadrat mean slope is <=6%
1 = Quadrat mean slope is >6%

[b]Stone 0=Quadrat contains no toolstone source
1 = Quadrat contains toolstone source

[c]Water 0=Quadrat lies more than 560 m from a water source
1 = Quadrat lies within 560 m of a water source

[d]Historic or modern roads have been counted whenever they crosscut an individual quadrat. Thus, the same feature may have been counted two or more times across different quadrats.

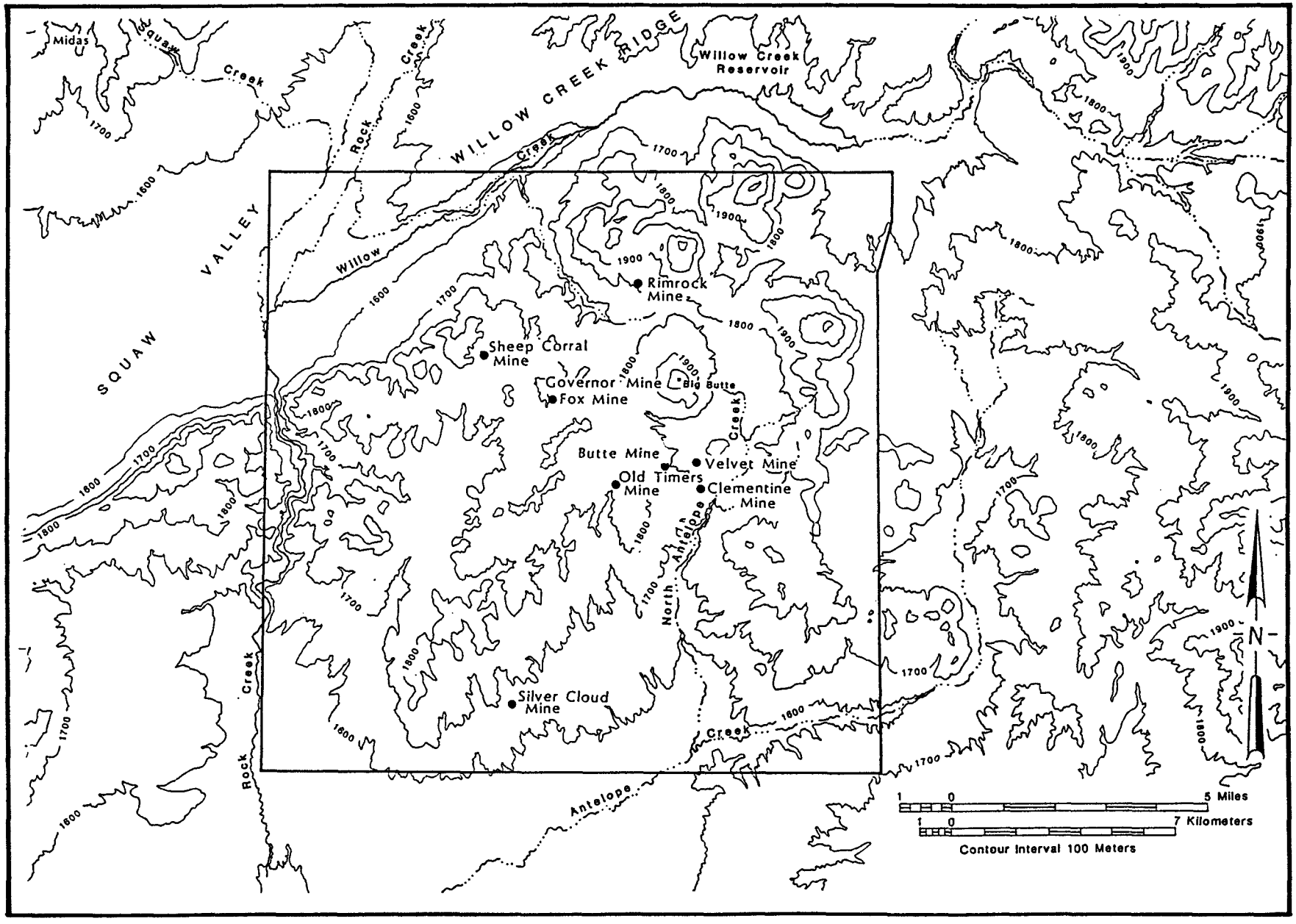


Figure 17. The Ivanhoe Mining District.

Mercury prospecting/mining features and artifacts attributable to the 1930s, 1940s, and 1960s were observed. Modern prospecting, drilling, road-building, and waste-rock dumps, associated with gold extraction, are ubiquitous and were encountered frequently during survey. Cattle-ranching features and artifacts were observed occasionally. No remains identified during Class II survey are definitely attributable to such activities as hunting, rock-collecting, artifact-collecting, visiting of sacred places, or very early prospecting/mining.

Ranching Features

Several kinds of features were recorded that can be attributed to cattle management, including post and barbed wire fences, small earthen dams, ponds, and reservoirs. Five earthen dams, all on small drainages, were encountered, three of them at springs within drainages. Three dams lie in the south half of the study area, well removed from historic mining features, while the two northern dams are very near clusters of historic mining remains. Food and tobacco cans were observed at three of the water-collection features. Fences were encountered occasionally during survey.

Of the 15 historic artifact "dumps" encountered during Class II survey, none can be tied directly to ranching. However, two can clusters might be the remains of temporary "cow camps", since they are distant from all mining features. One is located directly north of Big Butte, while the other lies in the southwest sector of the study area.

Mercury Mining Features

Features considered related to mercury mining and milling include prospect pits, waste rock mounds, tailings mounds, bulldozer cuts, dry-laid stone walls, earthen platforms, adits, shafts, roads, machinery complexes, furnaces, retorts, large open pits, and domestic and industrial debris clusters. Several such features were observed during Class II survey.

During field recording, crews made rough assessments of the age of mine, mill, and prospect features on the basis of several criteria. The type of feature (hand-dug pit or adit vs. bulldozer scrape or trench), the degree of revegetation on a feature (fresh and bare bulldozer cut versus overgrown ones), and the association of datable artifacts with the feature (rebar versus hole-in-cap cans) were considered in making field calls.

Based on the temporal criteria noted above, distinct patterns of feature distribution are apparent within the study area boundaries. Twenty-one "older" mercury mining features, presumably dating from ca. 1911 to ca. 1947, are clustered in an arc, curving from the southwest to the west of Big Butte. The arc begins at Antelope Spring (for the purposes of this survey), continues north of the Old Timer's Mine, then southwest of the Fox and Governor mines, and ends just east of the Sheep Corral Mine. This pattern of old prospect pits and cuts probably continues east of Antelope Spring, into the old Butte, Velvet, and Clementine mine areas. No Class II survey parcels were located in this area, disallowing any test of this hypothesis.

Artifacts commonly associated with the older mercury mining features include food, tobacco, and kerosene cans, glass bottles, wash basins, iron barrels, metal and canvas machine parts, and structural materials; corrugated tin sheets, wire, iron pipe, milled lumber, wire nails, and fire brick. The most numerous can types include sanitary food cans (1903 to present), venthole-type evaporated milk cans (ca. 1900 to 1960s), and pocket tobacco cans (1913 to 1970s) (Rock 1984:100-105).

Newer mercury mining features consist of bulldozer scrapes and trenches, presumably dating to the 1960s period of mercury extraction and exploration. We suspect that most modern gold prospecting consists of exploratory drilling, rather than of surface trenching. A discernible pattern of bulldozer cuts is apparent within the survey area: bulldozer cuts (n=64) were observed in 32 of the 151 Class II survey quadrats. Six such features occurred in the south half of the study area, in five quadrats. The remaining 27 quadrats, or 84% of those with bulldozer cuts, lie in the north half of the survey area, to the southwest, west, and northwest of Big Butte. Cut features are especially numerous around Antelope Spring, near the Sheep Corral Mine, and in a north-south corridor between the Old Timer's Mine and Ivanhoe Creek.

An extensive mercury milling complex, thought to be a 1960s vintage rotary furnace, was observed. The unnamed mill is located in ca. 0.75 mi east of the Sheep Corral Mine, and includes numerous terraced platforms connected by haul roads, a rotary furnace, a retort(?) consisting of 72 vertical iron flues 25 ft in height, a large tailings mound, two waste rock mounds, and a large industrial dump consisting of lumber, huge hoses on wooden wheels, bins, chutes, plywood, and heavy cable.

Additional mercury mine/mill complexes were noted during survey, but were not recorded in detail. Though they fell outside sample quadrats, they are worthy of brief mention. At Buttercup Spring, stone foundations for at least two small buildings, and cinder block and brick remains of a third, industrial structure were observed. Much domestic debris near the spring also was noted, suggesting an early twentieth century mercury processing camp complex.

Imposing remains of a second cinnabar mine and mill complex, known as the "Jackson and Surprise claims" lie 1 mi southwest of the Old Timer's Mine (Garside 1982:1). The "mine" is an open, rectangular cut in the hillside, perhaps 60 ft long by 20 ft wide, with a nearby rotary furnace. The complex probably dates to the 1960s. According to Garside (1982:1), the rotary furnace post-dates 1944 reports about the claims.

Other prominent complexes, such as Butte 1, Butte 2, Velvet, and Clementine mines have been reported elsewhere in detail (Zeier 1987).

Historic Artifacts

A total of 357 historic artifacts was tallied for all surveyed quadrats. Of the 151 sample quadrats, only 43 (29%) contained historic artifacts, and 72% (n=257) of the artifacts are concentrated in only four quadrats. Tin cans account for 51% of all recorded artifacts (n=182). The next largest group consists of structural materials, accounting for 24% (n=87) of the total. The artifact clusters reflect intensive mercury mining and milling locations; they provide dramatic contrast to surrounding portions of the study area. And the concentrations confirm that a significant historic use of the quarry area has been mercury prospecting, mining, and milling.

Chapter 6. AN EVALUATION OF THE PROPOSED TOSAWIHI QUARRIES NATIONAL REGISTER DISTRICT BOUNDARY

A proximal aim of the Class II survey was to aid an assessment of the Tosawihi Quarries National Register District boundary defined by Mary Rusco (1983). Criteria employed by Rusco to establish the limits of the district in the infancy of Tosawihi study anticipated many of the issues that would drive future research there. She proposed boundaries that were designed to "...enclose a natural geological district (occurrences of the silica-replaced rhyolites)...", "...to include all loci where surface occurrences of the knappable stone were quarried...", and "...to include associated campsites..." (Rusco 1983). To her credit, these criteria continue to provide useful general guidelines for predicting where Tosawihi-related archaeology may be found in the landscape. They fall short only in that they fail to describe the full geographic extent of such remains.

Appropriateness of the 1983 district boundary was evaluated in terms of the degree to which its original configuration subsumes archaeological locations demonstrated to be of particular relevance to the address of questions pertinent to Tosawihi Quarries research (Elston et al. 1992). We succeeded in determining that, as currently drawn (Figure 18), the boundary of the district does not enclose adequately the extent of archaeological locations that characterize Tosawihi prehistory. Subsequent inquiry has refined the notion of what constitutes the importance and uniqueness of Tosawihi archaeology. Today we can identify how such remains look on the ground and how they may be used to differentiate Tosawihi-specific phenomena from other aspects of prehistoric land use in the region.

Results of work in and around the Tosawihi Quarries site since 1987 assert that the distinctive theme in the prehistoric occupation of the area derives from its well-preserved record of lithic *production*. Toolstone *use*, by contrast, appears to contribute little to the record there (cf. Elston and Raven 1992). By this we mean that, although opalite constitutes the principal raw material used for tool manufacture over a broad expanse of the Upper Humboldt River region, the overwhelming predominance of remains created during toolstone procurement and early stage preparation of the stone distinguish the archaeology of the Tosawihi vicinity from that of its immediate surroundings. It is the potential for Tosawihi archaeology to inform about lithic production as one aspect of prehistoric economy that imparts significance to the place in terms of the National Register.

For purposes of the Class II exercise then, identification of appropriate boundaries for the district hinged on our ability to differentiate between remains characteristic of "zones of production" and those reflecting "zones of use". This dichotomy has played a central role in interpretation of the Tosawihi record undertaken so far and the theoretical underpinnings, archaeological consequence, and explanatory utility of this perspective is discussed fully in earlier documentation (Elston 1992c). Briefly, we view production and use as behavioral extremes that bracket the full range of opalite-focused activities undertaken by aboriginal occupants of the region. Toolstone production and toolstone use encompass different sets of chores, each motivated by different goals, and as a result, each is expected to manifest a distinctive archaeological signature (Elston et al. 1992).

Data in hand reveal unambiguously that, at Tosawihi, lithic production means biface production (Elston 1992a). With the creation of bifaces as its goal, lithic production at Tosawihi is manifest by the remains of behaviors that reflect toolstone extraction, rendering of the stone into portable forms (bifaces), and transport of raw material away from the source areas.

As we have argued, the bulk of the record within the zone of production reflects the outcome of a complex suite of strategies (mobility patterns, labor organization, and technology) manipulated to minimize the various *costs* and *risks* inherent in toolstone production. Archaeologically, these strategies are signalled by the exploited opalite sources themselves and the accumulations of toolstone processing debris accrued during biface manufacture. Opalite waste overwhelmingly dominates site contents, few formed artifacts other than failed bifaces occur, and tools indicative of maintenance/subsistence tasks are relatively rare. In the few instances where sites of apparent residential function occur, most seem to have served as the venue for subsistence chores that supported groups otherwise preoccupied by toolstone procurement (Leach 1992).

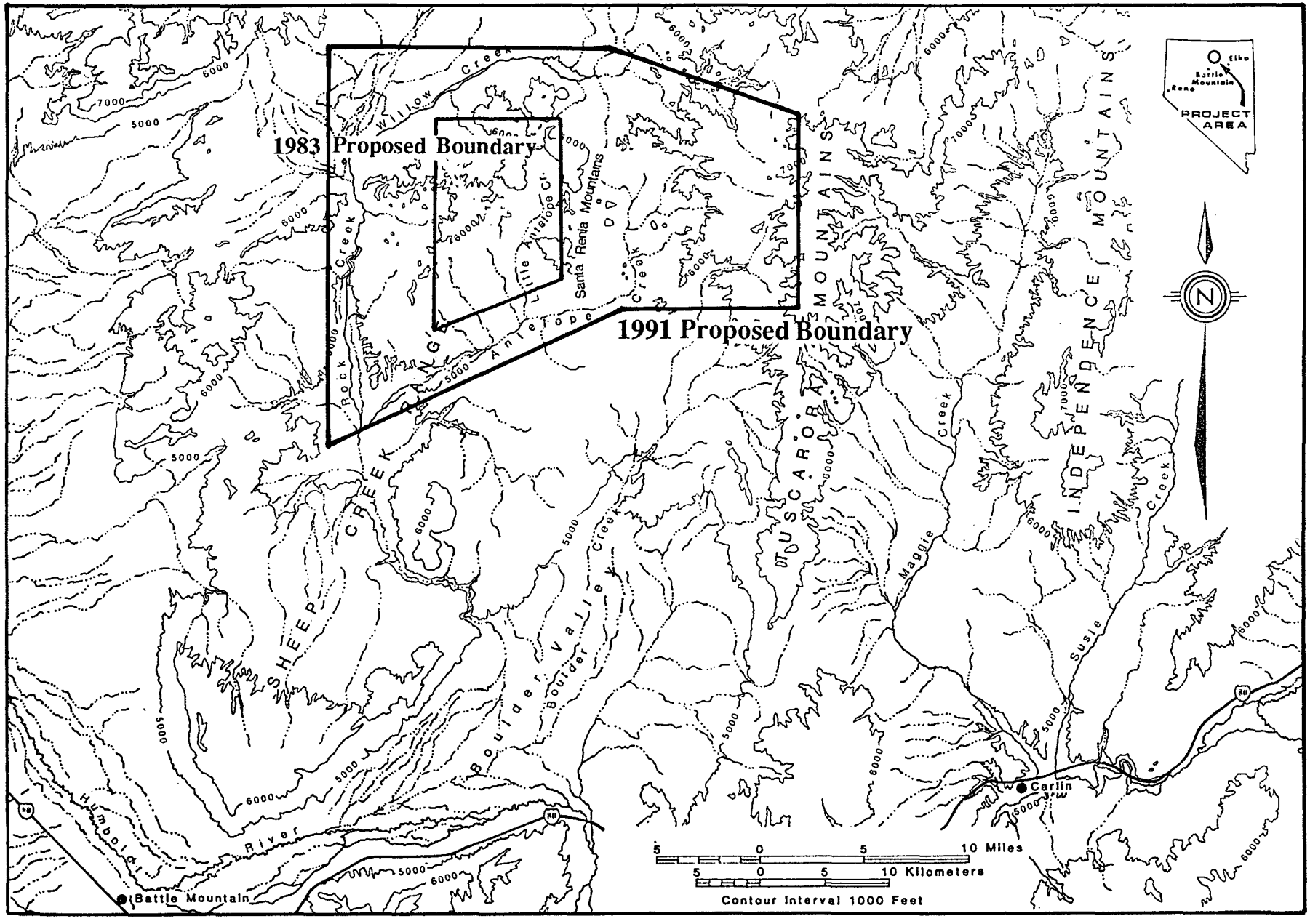


Figure 18. Proposed expansion of the Tosawihi Quarries National Register District.

An emphasis on lithic production is displayed by the predominance of bifaces within assemblages and by the character of their debitage collections (Bloomer, Ataman, and Ingbar 1992; Bloomer and Ingbar 1992). Bifaces tend to be reduced more fully and more commonly manifest signs of heat-treatment as distance from toolstone source increases, presumably a reflection of the sequential processing of stone during transport.

We observe, however, that evidence of biface use (edge damage, debitage indicative of sharpening, repair, etc.) is virtually absent. *This observation is important for purposes of boundary definition.*

Within the zone of use, by contrast, opalite-focused behavior involves the application of the stone to tasks that convert energy from the environment into useful forms for human benefit. Here, costs incurred during opalite production are compensated when the utility of the stone is realized through use. The stone may confer benefit directly as a food-getting tool or as a tool used for the manufacture of other implements, or it may be applied indirectly to the acquisition of an array of desired ends, from sustenance to sex, through trade.

Archaeologically, site contents in the zone of use should reflect general use of the landscape—residential bases, temporary camps, or special-purpose locations, for example—where people engaged in myriad tasks other than toolstone production. Employing models of toolstone transport, we can assert that most toolstone should arrive at the zone of use in a highly processed state (cf. Elston 1992a). Opalite components of assemblages should be dominated by utilized forms and the waste accrued through their use, maintenance, and eventual discard. Proportions of tools to lithic waste should be high and most of the material should display evidence of heat-treatment.

The divergent archaeological signatures of toolstone *production* and toolstone *use* and the demonstrated importance of the former as a hallmark of what is significant about the Tosawihi record give us a model from which we can advance a geographic limit. The task of boundary assessment via the Class II survey, then, became one of determining how well the district, as presently defined, corresponds to that piece of landscape whose archaeological content relates most directly to lithic production activities. In a word, survey results indicate that, indeed, it does not correspond well.

Class II survey monitored the archaeological content of 151 19.4 acre sample quadrats within the 28,480 acre study area, a tract coterminous with that defined by Rusco as the proposed National Register district. Throughout the course of fieldwork, we found ourselves everywhere *within* an area whose archaeological character corresponds to that predicted for a zone of production, but in none of the areas examined did we encounter the *limits* of such a zone.

Across the full compass of the sample universe, artifacts observed in quadrats pertain overwhelmingly to the extraction and processing of opalite raw material. Furthermore, we observed utilized mapped silicification zones (potential toolstone sources) throughout the study area and considerably beyond the current district boundary. At examined water sources, presumably attractive for offerings other than chert, assemblages appear to derive predominantly from opalite processing even when far removed from opalite supplies. Maintenance/ subsistence components of these locales, although occasionally abundant, appear to reflect tasks ancillary to more dominant toolstone processing functions (like comparable remains at similar sites studied in the heart of the Quarries (cf. Leach 1992; Leach, Dugas, and Elston 1992).

Thus, overall results reveal that the district boundary is inadequate as presently drawn. The district is too small, failing to enclose a sufficient complement of remains demonstrated to be significant for interpreting Tosawihi prehistory. We conclude that a more appropriate boundary lies elsewhere, beyond the limits of the Class II study area. Survey results corroborate many of our general impressions about the kinds of aboriginal behaviors that produced the distinctive archaeology of the Tosawihi vicinity, and validate the importance of questions that have guided research there so far. These results, along with the growing body of archaeological data that has accrued over the last several years elsewhere in the Upper Humboldt region, suggest where more realistic boundaries for the district might be found.

We propose modification of the district boundaries to capture more fully the zone of lithic production affiliated with the Tosawihi Quarries. Such a change necessitates expansion of current boundaries outward into portions of the landscape we *expect* to contain evidence of a shift in opalite focused behaviors from production to use.

Such a proposition might appear to offer little to resolution of the boundary issue given the vast extent of the area where white chert raw material dominates prehistoric tool kits (Stephenson and Wilkenson 1969; Rusco 1976a, b, 1978, 1979, 1982). Ethnographic accounts and extant archaeological data, however, allow us to narrow considerably the area that we propose contains a more appropriate district boundary.

We assume that Shoshone winter camp locations plotted by Steward (1938) along the Humboldt River and the lower reaches of its major tributaries must lie fully within the zone of toolstone use. These locations should be excluded from consideration as part of a district defined by lithic production. On similar grounds, opalite components of assemblages derived from locations at comparable distances from Tosawihi such as the Valmy sites (Elston et al. 1981), Treaty Hill (Davis, Fowler, and Rusco 1976; Rusco and Davis 1979), James Creek (Elston and Budy 1990) and others (cf. Raven 1992a) pertain overwhelmingly to toolstone use and likewise lie far outside a suitable district boundary. Description of assemblages from lower Rock Creek and lower Boulder Creek, although nearer the Tosawihi sources, imply that these areas also constitute zones of toolstone use rather than production (Botti 1985; Clay and Hemphill 1986).

Models of toolstone procurement offer further assistance in our efforts to define geographically specific district boundaries. These models predict that, on a regional scale, the transition from the dominance of toolstone production to toolstone use should occur relatively near the opalite sources (cf. Elston 1992a). We assume that rational foragers will recoup the costs of toolstone production by converting the potential benefits of the stone into consumable gains through its use as soon as and as near its point of procurement as subsistence opportunities allow. Although we control little empirical data with which to support this assumption, we expect archaeological evidence for the interface of the zone of production and the zone of use to coincide with changes in the resource complement of the landscape.

Translation of an area so defined onto the Tosawihi landscape constitutes our best approximation of more appropriate district boundaries. On this basis, we propose a district redrawn to enclose an expanse of ca. 770 square kilometers centered on the Tosawihi Quarries site, 26Ek3032, with boundaries that correspond to drainages of principal tributaries of the Humboldt River surrounding the Tosawihi uplands (see Figure 18). The new district would be bounded on the west by Rock Creek, on the north by Willow Creek, and on the south by segments of Antelope Creek and Boulder Creek. Eastern limits of the district subsume the western foothills of the Tuscarora Mountains drained by influent streams along the upper reaches of Boulder and Antelope Creeks.

This considerable expansion of the district is justified by the demonstrated importance of toolstone processing and transport to an understanding of lithic production at Tosawihi. In economic and technological terms these elements provide the link between opalite extraction and opalite use. The revised boundary constitutes the geographical expression of this linkage.

We possess first hand knowledge of the archaeological content of few places within the expanded district. These data and the observations of our colleagues working nearby (P-III Associates, Inc., personal communication 1991) offers circumstantial support for the assertion that lithic production continues to be the dominant theme of prehistoric land use for a considerable distance beyond the boundaries defined by Rusco.

Our observation that suitable limits for the proposed district lie beyond the Class II study area derives in large part from the environmental factors that conditioned prehistoric use of the place. Artifactual evidence and ecological inference suggest that, due to the meager subsistence opportunities offered by the countryside immediately surrounding Tosawihi, the area probably seldom inspired visits by aboriginal foragers except for those intent upon toolstone acquisition (Raven 1992a; Schmitt, Ingbar, and Raven 1992). By contrast, the

comparatively well watered, game-rich riparian corridors along the drainages selected as new district boundaries constitute the places nearest the quarries where subsistence opportunities improve markedly. Here we expect to see a transition in land use patterns reflecting increased emphasis on toolstone use.

Over the course of Tosawihi-focused work we have had the opportunity to examine closely only one site within these more productive habitats, site 26Ek3251. Located 10 km north of the quarries at the confluence of Ivanhoe and Willow Creeks, testing and data recovery were undertaken there as part of the mitigation program for the northern main access road to the Hollister mine (Schmitt and Dugas 1992). This work provided an opportunity to examine changes in the archaeological record along a continuous transect parallelling Ivanhoe Creek and spanning the full distance between the opalite sources and one of the perennial drainages proposed for consideration as a revised district boundary.

Although opalite processing remains occur in abundance at 26Ek3251, the site is unique among sites so far investigated for the extent to which it displays evidence of opalite use. Composition of the recovered assemblage suggests subsistence and maintenance functions for the site to a degree unprecedented for sites examined in less provident environmental contexts (Leach 1992; Ingbar 1992). Rather than a processing locus with evidence of minor ancillary residential use like those we have seen closer to the toolstone sources (cf. Leach 1992), site function at 26Ek3251 appears to derive from more general use of the landscape in which opalite processing plays only a part. The overall character of the site is what we would expect: a location at the limit of the sphere of toolstone production.

Examination of other sites along Ivanhoe Creek reveals that as toolstone sources upstream are approached, site contents revert rapidly to the remains of toolstone processing. A similar pattern prevails near the proposed southern limit of the redesigned district. Sites along Little Antelope Creek near its confluence with Antelope Creek, though known from survey level descriptions provided by others (Stoner and Peterson 1990), appear to represent transitional locations where toolstone use supplants toolstone production.

Eastward expansion of the district is predicated on the findings of investigations in Boulder Valley and the western foothills of the Tuscarora Mountains (Hicks 1989; Rafferty and Blair 1988; Russell, Tratebas, and Schroedl 1986; Schroedl 1986; Tipps 1989). From our reading of results of survey and limited testing, site rosters there are dominated by chert processing loci. Investigators report, however, numerous locations where these remains are highly augmented by maintenance and subsistence assemblages (P-III Associates, Inc., personal communication 1991). Most of the very few collections from the area we have seen resemble the one obtained from 26Ek3251. Further, ultraviolet characterization of the materials suggest that much of the white chert in sites in the Boulder Valley area is derived from sources at the Tosawihi Quarries (Kathy Ataman, personal communication 1991; Doug Bird, personal communication 1991; Ataman and Botkin 1991).

Chapter 7. CONCLUSIONS

Tosawihi Quarries was central to a region exploited by Shoshone people during spring and summer (Elston 1992a). The Quarries were within the daily travel radius of foraging camps on Willow Creek, Rock Creek, Little Antelope Creek, Antelope Creek, and Ivanhoe Creek (Elston 1992a), drainages that encompass the Class II study area. The study area, then, would have been traversed regularly by people approaching and leaving the Quarries, and indeed, archaeological patterning in our sample demonstrates a clear relationship between the outlying uplands of the Class II study area and the toolstone sources at the heart of Tosawihi.

At the outset of this report, we advanced several general expectations about the nature and distribution of the Class II archaeological record. These expectations were derived from our earlier research at Tosawihi Quarries and were founded on fundamental principles of cost-minimization. We expected the Class II record to reflect, as did the record at the main Quarries, a prehistoric concern for reducing effort in toolstone extraction and toolstone transport. We believe we have found evidence that supports well this contention.

High proportions of bifaces were prepared, broken in manufacture, and discarded in the immediate vicinity of the main Quarries. Most of these were early stage bifaces, with relatively few late stage bifaces finding their ultimate destination in this zone. Instead, later stage forms were discarded farther away, in settings where they were undergoing heat-treatment and being reduced further. Reduction features were densest in the zone immediately around the principal Quarries, declining rapidly as distance away from the Quarries was attained.

The broad distribution of medium-sized debitage and Stage 2 and 3 bifaces suggests that the Class II environs were well within a large zone of lithic production, originating at the Quarries. Occasionally, we found maintenance and non-lithic resource processing tools—weapons, flake tools, millingstones, exotic materials—relating to concerns other than raw material extraction. Such items often were clustered at springs and attendant campsites used, very probably, in the support of people visiting the Quarries for toolstone procurement (cf. Leach 1992; Elston 1992a).

Mapped silicification zones away from the heart of the Quarries or their extension immediately to the east were notably underused. Their generally lower quality, inaccessibility relative to water, and small size may have impaired their attraction to prehistoric quarriers. In contrast, the principal Quarries, near good water, offered massive expanses of outcropping toolstone which, when assayed and excavated for millennia by quarrying groups, would have presented lower-cost and increasingly accessible toolstone deposits.

We have concluded our examination of the Class II study area with the certainty that we have not isolated the principal realm of lithic production that originates at Tosawihi Quarries. The Tosawihi zone of production is large, complex, and subsumes, but is not defined by the Class II survey universe boundaries. We suggest that use of the Class II region was related overwhelmingly to procurement of toolstone rather than to intensive exploitation of other non-lithic resources. We recommend, therefore, that a proposed Tosawihi Quarries National Register District be expanded to incorporate those lands where the archaeological record similarly reflects lithic *production* of Tosawihi opalite, rather than lithic tool use, as its chief component.

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APPENDIX A. Listing of Potential Survey Quadrats in the Study Universe (n=1446)

Listing of Potential Survey Quadrats in Study Universe (n=1446)

Quadrat Number		% Grade	Slope	Toolstone	Water	Combined Score
North	East		0 <=6%	0-has no ts.	0-water>560m	(slope,ts,water)
			1 >6%	1-has ts.	1-water<560m	
0	0	4.3	0	0	0	0
1	0	5	0	0	0	0
1	1	5.5	0	0	0	0
1	2	4.3	0	0	0	0
2	0	6.9	1	0	0	100
2	1	5.1	0	0	0	0
2	2	4.6	0	0	0	0
2	3	4.2	0	0	0	0
2	4	3.2	0	0	0	0
3	0	8.4	1	0	0	100
3	1	4.5	0	0	0	0
3	2	5.1	0	0	0	0
3	3	5.5	0	0	0	0
3	4	5.7	0	0	0	0
3	5	5.4	0	0	0	0
3	6	4	0	0	0	0
4	0	6.2	1	0	0	100
4	1	5.7	0	0	0	0
4	2	5.6	0	0	0	0
4	3	6.8	1	0	0	100
4	4	7.1	1	0	0	100
4	5	6.6	1	0	0	100
4	6	5.1	0	0	0	0
4	7	3.9	0	0	0	0
4	8	3.5	0	0	0	0
5	0	7.6	1	0	0	100
5	1	5	0	0	0	0
5	2	6.6	1	0	0	100
5	3	6.3	1	0	0	100
5	4	6.2	1	0	0	100
5	5	6	0	0	0	0
5	6	5.3	0	0	0	0
5	7	4.6	0	0	0	0
5	8	4	0	0	0	0
5	9	4	0	0	0	0
5	10	4.2	0	0	0	0
6	0	8.7	1	0	0	100
6	1	7.3	1	0	0	100
6	2	7.7	1	0	0	100
6	3	7	1	0	0	100
6	4	5.6	0	0	0	0
6	5	4.7	0	0	0	0
6	6	4.5	0	0	0	0
6	7	4.3	0	0	0	0
6	8	3.9	0	0	0	0
6	9	3.8	0	0	0	0
6	10	4.3	0	0	0	0
6	11	5.4	0	0	0	0
6	12	5.7	0	0	0	0
7	0	8.8	1	0	0	100
7	1	8.8	1	0	0	100
7	2	8.9	1	0	0	100
7	3	8.3	1	0	0	100
7	4	5.4	0	0	0	0
7	5	4	0	0	0	0
7	6	4.2	0	0	0	0
7	7	4.5	0	0	0	0
7	8	3.8	0	0	0	0
7	9	3.6	0	0	0	0
7	10	3.9	0	0	0	0
7	11	5.2	0	0	0	0
7	12	4.3	0	0	0	0
7	13	3.6	0	0	0	0
7	14	1.3	0	0	0	0
7	15	1.1	0	0	0	0
8	0	6.2	1	0	0	100
8	1	7.2	1	0	0	100
8	2	8.1	1	0	0	100
8	3	9.9	1	0	0	100

8	4	6.2	1	0	0	100
8	5	5.5	0	0	0	0
8	6	5.9	0	0	0	0
8	7	6	0	0	0	0
8	8	3.9	0	0	0	0
8	9	3.8	0	0	0	0
8	10	3.6	0	0	0	0
8	11	2.9	0	0	0	0
8	12	5	0	0	0	0
8	13	3.2	0	0	0	0
8	14	1	0	0	0	0
8	15	0.6	0	0	0	0
8	16	0.8	0	0	0	0
8	17	1.3	0	0	0	0
9	0	3.7	0	0	0	0
9	1	4.6	0	0	0	0
9	2	7.5	1	0	0	100
9	3	8.1	1	0	0	100
9	4	7.3	1	0	0	100
9	5	7.5	1	0	0	100
9	6	8.1	1	0	0	100
9	7	8	1	0	0	100
9	8	3.5	0	0	0	0
9	9	2.5	0	0	0	0
9	10	1.8	0	0	0	0
9	11	2.5	0	0	0	0
9	12	4.5	0	0	0	0
9	13	3.5	0	0	0	0
9	14	2.2	0	0	0	0
9	15	1.2	0	0	0	0
9	16	0.6	0	0	0	0
9	17	0.3	0	0	0	0
9	18	1.5	0	0	0	0
9	19	5.1	0	0	0	0
10	0	7	1	0	0	100
10	1	6.6	1	0	0	100
10	2	7.8	1	0	0	100
10	3	6.4	1	0	0	100
10	4	5.9	0	0	0	0
10	5	5.8	0	0	0	0
10	6	9.1	1	0	0	100
10	7	9.9	1	0	0	100
10	8	6	0	0	0	0
10	9	3.1	0	0	0	0
10	10	2.1	0	0	0	0
10	11	2.5	0	0	0	0
10	12	3.2	0	0	0	0
10	13	3.5	0	0	0	0
10	14	2.9	0	0	0	0
10	15	1.8	0	0	0	0
10	16	0.7	0	0	0	0
10	17	0.2	0	0	1	1
10	18	0.7	0	0	1	1
10	19	3.2	0	0	0	0
10	20	3.8	0	0	0	0
10	21	3	0	0	0	0
11	0	8.9	1	0	0	100
11	1	8.1	1	0	0	100
11	2	8.4	1	0	0	100
11	3	7	1	0	0	100
11	4	5.2	0	0	0	0
11	5	4.2	0	0	0	0
11	6	6.9	1	0	0	100
11	7	8.5	1	0	0	100
11	8	6.6	1	0	0	100
11	9	4.7	0	0	0	0
11	10	3.5	0	0	0	0
11	11	2.9	0	0	0	0
11	12	2.5	0	0	0	0
11	13	2.8	0	0	0	0
11	14	3.3	0	0	0	0
11	15	2.6	0	0	0	0
11	16	2.1	0	0	0	0
11	17	1.5	0	0	1	1

11	18	1.3	0	0	1	1
11	19	2.6	0	0	1	1
11	20	3.7	0	0	0	0
11	21	3.6	0	0	0	0
11	22	4.1	0	0	0	0
11	23	3	0	0	0	0
12	0	9.2	1	0	0	100
12	1	8.8	1	0	0	100
12	2	9.4	1	0	0	100
12	3	8.5	1	0	0	100
12	4	5.5	0	0	0	0
12	5	2.1	0	0	0	0
12	6	4.5	0	0	0	0
12	7	7	1	0	0	100
12	8	6.4	1	0	0	100
12	9	5.7	0	0	0	0
12	10	5.2	0	0	0	0
12	11	3.8	0	0	0	0
12	12	2.4	0	0	0	0
12	13	2.3	0	0	0	0
12	14	3.9	0	0	0	0
12	15	3.3	0	0	0	0
12	16	3.7	0	0	0	0
12	17	3.2	0	0	1	1
12	18	1.9	0	0	1	1
12	19	2.7	0	0	0	0
12	20	4.2	0	0	0	0
12	21	4.2	0	0	0	0
12	22	4.9	0	0	0	0
12	23	3.8	0	0	0	0
12	24	2.9	0	0	0	0
12	25	4.8	0	0	0	0
13	0	7.2	1	0	0	100
13	1	10	1	0	0	100
13	2	9.5	1	0	0	100
13	3	9.6	1	0	0	100
13	4	7.5	1	0	0	100
13	5	3.6	0	0	0	0
13	6	2.8	0	0	0	0
13	7	5.7	0	0	0	0
13	8	5.5	0	0	0	0
13	9	5.6	0	0	0	0
13	10	6.4	1	0	0	100
13	11	5.4	0	0	0	0
13	12	3.7	0	0	0	0
13	13	3.1	0	0	0	0
13	14	3.7	0	0	0	0
13	15	3.4	0	0	0	0
13	16	4	0	0	0	0
13	17	3.9	0	0	0	0
13	18	2.9	0	0	0	0
13	19	3.3	0	0	0	0
13	20	4.1	0	0	0	0
13	21	4.7	0	0	0	0
13	22	6.7	1	0	0	100
13	23	4	0	0	0	0
13	24	8	1	0	0	100
13	25	10	1	0	0	100
13	26	9.7	1	0	0	100
13	27	9.5	1	0	0	100
14	0	7.2	1	0	0	100
14	1	6.1	1	0	0	100
14	2	6.4	1	0	0	100
14	3	7.1	1	0	0	100
14	4	8.1	1	0	0	100
14	5	6.5	1	0	0	100
14	6	5.9	0	0	0	0
14	7	6.6	1	0	0	100
14	8	6.5	1	0	0	100
14	9	6.3	1	0	0	100
14	10	6.5	1	0	0	100
14	11	6.3	1	0	0	100
14	12	6.2	1	0	0	100
14	13	5.5	0	0	0	0

14	14	4	0	0	0	0
14	15	2.5	0	0	0	0
14	16	2.8	0	0	0	0
14	17	2.9	0	0	0	0
14	18	3.1	0	0	0	0
14	19	3.6	0	0	0	0
14	20	3.4	0	0	0	0
14	21	5	0	0	0	0
14	22	5.1	0	0	0	0
14	23	6.1	1	0	0	100
14	24	11.6	1	0	0	100
14	25	12.8	1	0	0	100
14	26	11.4	1	0	0	100
14	27	9.7	1	0	0	100
14	28	8.4	1	0	0	100
14	29	8.9	1	0	0	100
14	30	9.9	1	0	0	100
15	0	6.6	1	0	0	100
15	1	7.8	1	0	0	100
15	2	6.4	1	0	0	100
15	3	5.7	0	0	0	0
15	4	6.6	1	0	0	100
15	5	6.7	1	0	0	100
15	6	6.4	1	0	0	100
15	7	6.9	1	0	0	100
15	8	7.4	1	0	0	100
15	9	7.3	1	0	0	100
15	10	6.4	1	0	0	100
15	11	5.9	0	0	0	0
15	12	6.3	1	0	0	100
15	13	6.1	1	0	0	100
15	14	5	0	0	0	0
15	15	3.6	0	0	0	0
15	16	3.1	0	0	0	0
15	17	4.2	0	0	0	0
15	18	5.4	0	0	0	0
15	19	5	0	0	0	0
15	20	4.7	0	1	0	10
15	21	5.1	0	1	0	10
15	22	5.4	0	0	0	0
15	23	8.5	1	0	0	100
15	24	12.9	1	0	0	100
15	25	11.3	1	0	0	100
15	26	8.8	1	0	0	100
15	27	9	1	0	0	100
15	28	9.2	1	0	0	100
15	29	9.4	1	0	0	100
15	30	9.2	1	0	0	100
15	31	9.6	1	0	0	100
15	32	7	1	0	0	100
16	0	4.8	0	0	0	0
16	1	10.7	1	0	0	100
16	2	7.1	1	0	0	100
16	3	4.8	0	0	0	0
16	4	5.8	0	0	0	0
16	5	6.8	1	0	0	100
16	6	5.8	0	0	0	0
16	7	6.3	1	0	0	100
16	8	7.8	1	0	0	100
16	9	8.5	1	0	0	100
16	10	5.7	0	0	0	0
16	11	4.5	0	0	0	0
16	12	5.7	0	0	0	0
16	13	6.2	1	0	0	100
16	14	5.9	0	0	0	0
16	15	5	0	0	0	0
16	16	3.9	0	0	0	0
16	17	6.4	1	0	0	100
16	18	8.5	1	0	0	100
16	19	6.7	1	0	0	100
16	20	6.2	1	1	0	110
16	21	6	1	1	0	110
16	22	5.1	0	0	1	1
16	23	9.4	1	0	1	101

16	24	15	1	0	0	100
16	25	8.9	1	0	0	100
16	26	4.3	0	0	0	0
16	27	8	1	0	0	100
16	28	10.1	1	0	0	100
16	29	10	1	0	0	100
16	30	9	1	0	0	100
16	31	10.7	1	0	0	100
16	32	6.6	1	0	0	100
17	0	2.6	0	0	0	0
17	1	9.5	1	0	0	100
17	2	7.2	1	0	0	100
17	3	6.4	1	0	0	100
17	4	8.2	1	0	0	100
17	5	7.9	1	0	0	100
17	6	5.2	0	0	0	0
17	7	4.2	0	0	0	0
17	8	6.5	1	0	0	100
17	9	10.4	1	0	0	100
17	10	4.9	0	0	0	0
17	11	3.2	0	0	0	0
17	12	5.2	0	0	0	0
17	13	5.2	0	0	0	0
17	14	6	1	0	0	100
17	15	6.6	1	0	0	100
17	16	5.4	0	0	0	0
17	17	8.8	1	0	0	100
17	18	8.5	1	0	0	100
17	19	7.6	1	0	0	100
17	20	6.9	1	1	0	110
17	21	8.8	1	1	1	111
17	22	6.1	1	0	1	101
17	23	6.6	1	0	1	101
17	24	15.7	1	0	0	100
17	25	9.4	1	0	0	100
17	26	1.5	0	0	0	0
17	27	7.8	1	0	0	100
17	28	10.7	1	0	0	100
17	29	8.5	1	0	0	100
17	30	11.1	1	0	0	100
17	31	13.1	1	0	0	100
17	32	10.6	1	0	0	100
18	0	4.5	0	0	0	0
18	1	9.8	1	0	0	100
18	2	6.9	1	0	0	100
18	3	8.4	1	0	0	100
18	4	8.8	1	0	0	100
18	5	9.6	1	0	0	100
18	6	6.1	1	0	0	100
18	7	3.4	0	0	0	0
18	8	5.8	0	0	0	0
18	9	9.8	1	0	0	100
18	10	5.2	0	0	0	0
18	11	6.2	1	0	0	100
18	12	6.9	1	0	0	100
18	13	3.9	0	0	0	0
18	14	4.4	0	0	0	0
18	15	6.1	1	0	0	100
18	16	7.3	1	0	0	100
18	17	8.5	1	0	0	100
18	18	6.8	1	0	0	100
18	19	7.8	1	1	0	110
18	20	9.8	1	0	0	100
18	21	8.8	1	0	0	100
18	22	4.4	0	0	1	1
18	23	7.5	1	0	1	101
18	24	12.2	1	0	0	100
18	25	11.7	1	0	0	100
18	26	7	1	0	0	100
18	27	7.6	1	0	0	100
18	28	9	1	0	0	100
18	29	6.9	1	0	0	100
18	30	8.9	1	0	0	100
18	31	10.9	1	0	0	100

18	32	8.4	1	0	0	100
19	0	6.9	1	0	0	100
19	1	9.8	1	0	0	100
19	2	7.4	1	0	0	100
19	3	9	1	0	0	100
19	4	9.1	1	0	0	100
19	5	8.7	1	0	0	100
19	6	6.9	1	0	0	100
19	7	4.7	0	0	0	0
19	8	6	0	0	0	0
19	9	8	1	0	0	100
19	10	7	1	0	0	100
19	11	7.3	1	0	0	100
19	12	7.6	1	0	0	100
19	13	3.8	0	0	0	0
19	14	3	0	0	0	0
19	15	3.7	0	0	0	0
19	16	4.7	0	0	0	0
19	17	5.1	0	0	0	0
19	18	4.7	0	0	0	0
19	19	6.7	1	1	0	110
19	20	9	1	0	0	100
19	21	8.1	1	0	0	100
19	22	5.5	0	0	0	0
19	23	8.7	1	0	0	100
19	24	11.3	1	0	0	100
19	25	12.3	1	0	0	100
19	26	8.8	1	0	0	100
19	27	7.1	1	0	0	100
19	28	6.8	1	0	0	100
19	29	6.4	1	0	0	100
19	30	7.7	1	0	0	100
19	31	9	1	0	0	100
19	32	8	1	0	0	100
20	0	6.4	1	0	0	100
20	1	10	1	0	0	100
20	2	5.6	0	0	0	0
20	3	9	1	0	0	100
20	4	8.3	1	0	0	100
20	5	7.6	1	0	0	100
20	6	7.4	1	0	0	100
20	7	4.8	0	0	0	0
20	8	5.4	0	0	0	0
20	9	6.5	1	0	0	100
20	10	7.4	1	0	0	100
20	11	7.8	1	0	0	100
20	12	9.3	1	0	0	100
20	13	3.8	0	0	0	0
20	14	2.4	0	0	1	1
20	15	1.7	0	0	1	1
20	16	2.3	0	0	1	1
20	17	2.6	0	0	1	1
20	18	2.8	0	0	0	0
20	19	6.1	1	1	0	110
20	20	9.4	1	0	0	100
20	21	8.2	1	0	1	101
20	22	4.9	0	0	1	1
20	23	10	1	0	0	100
20	24	10.3	1	0	0	100
20	25	12.8	1	0	0	100
20	26	8.6	1	0	0	100
20	27	5.4	0	0	0	0
20	28	4.8	0	0	0	0
20	29	6.3	1	0	0	100
20	30	7.6	1	0	0	100
20	31	8.6	1	0	0	100
20	32	8.6	1	0	0	100
21	0	4.4	0	0	0	0
21	1	4.8	0	0	0	0
21	2	4.1	0	0	0	0
21	3	7.6	1	0	0	100
21	4	5.1	0	0	0	0
21	5	7.5	1	0	0	100
21	6	6.6	1	0	0	100

21	7	3.4	0	0	0	0
21	8	3.1	0	0	0	0
21	9	3.9	0	0	0	0
21	10	5	0	0	0	0
21	11	8.8	1	0	0	100
21	12	9	1	0	0	100
21	13	7.1	1	0	0	100
21	14	5.5	0	0	1	1
21	15	1.4	0	0	1	1
21	16	2.4	0	0	1	1
21	17	4	0	0	1	1
21	18	5.8	0	0	0	0
21	19	8.1	1	1	0	110
21	20	12.1	1	0	0	100
21	21	9.2	1	0	1	101
21	22	3.2	0	0	1	1
21	23	10.6	1	0	0	100
21	24	7.8	1	0	0	100
21	25	10.1	1	0	0	100
21	26	9.1	1	0	0	100
21	27	1.1	0	0	0	0
21	28	3.2	0	0	0	0
21	29	7.5	1	0	0	100
21	30	10.6	1	0	0	100
21	31	9.5	1	0	0	100
21	32	9.9	1	0	0	100
22	0	5.8	0	0	0	0
22	1	5	0	0	0	0
22	2	4.2	0	0	0	0
22	3	4.6	0	0	0	0
22	4	3.3	0	0	0	0
22	5	4.7	0	0	0	0
22	6	4.9	0	0	0	0
22	7	2.9	0	0	0	0
22	8	1.1	0	0	0	0
22	9	0.6	0	0	0	0
22	10	1.1	0	0	0	0
22	11	5.6	0	0	0	0
22	12	7.6	1	0	0	100
22	13	9.6	1	0	0	100
22	14	8.2	1	0	0	100
22	15	4.7	0	0	0	0
22	16	5.5	0	0	0	0
22	17	7.2	1	0	0	100
22	18	8	1	0	0	100
22	19	8.5	1	0	0	100
22	20	13.3	1	0	0	100
22	21	11.1	1	0	0	100
22	22	6	0	0	0	0
22	23	10.3	1	0	1	101
22	24	12.4	1	0	1	101
22	25	9.7	1	0	0	100
22	26	7.3	1	0	0	100
22	27	3.7	0	0	0	0
22	28	6.9	1	0	0	100
22	29	10.6	1	0	0	100
22	30	11.3	1	0	0	100
22	31	9.7	1	0	0	100
22	32	6.6	1	0	0	100
23	0	5	0	0	0	0
23	1	4.6	0	0	0	0
23	2	4.1	0	0	0	0
23	3	3.9	0	0	0	0
23	4	3.5	0	0	0	0
23	5	4.4	0	0	0	0
23	6	5.3	0	0	0	0
23	7	3.9	0	0	0	0
23	8	1.8	0	0	0	0
23	9	0.3	0	0	0	0
23	10	0	0	0	0	0
23	11	2	0	0	0	0
23	12	4.7	0	0	0	0
23	13	8.7	1	0	0	100
23	14	8.6	1	0	1	101

23	15	7.8	1	0	1	101
23	16	9.7	1	0	0	100
23	17	10.4	1	0	0	100
23	18	9.5	1	0	0	100
23	19	9.8	1	0	0	100
23	20	11	1	0	0	100
23	21	9.8	1	0	0	100
23	22	8.8	1	0	1	101
23	23	10.8	1	0	1	101
23	24	14.5	1	0	1	101
23	25	12.2	1	0	0	100
23	26	7.6	1	0	0	100
23	27	6.8	1	0	0	100
23	28	9.7	1	0	0	100
23	29	11.6	1	0	0	100
23	30	10.5	1	0	0	100
23	31	7.5	1	0	0	100
23	32	3.3	0	0	0	0
24	0	3	0	0	0	0
24	1	3.8	0	0	0	0
24	2	3.8	0	0	0	0
24	3	3.8	0	0	0	0
24	4	3.6	0	0	0	0
24	5	4.6	0	0	0	0
24	6	6.9	1	0	0	100
24	7	6.1	1	0	0	100
24	8	4	0	0	0	0
24	9	1.9	0	0	0	0
24	10	0.3	0	0	0	0
24	11	-0.3	0	0	0	0
24	12	1.7	0	0	0	0
24	13	8.3	1	0	1	101
24	14	8.3	1	0	1	101
24	15	9.6	1	1	1	111
24	16	14.1	1	0	0	100
24	17	12.9	1	0	0	100
24	18	10.4	1	0	0	100
24	19	11.3	1	0	0	100
24	20	9.3	1	0	0	100
24	21	8.2	1	0	0	100
24	22	9.8	1	0	1	101
24	23	9.1	1	0	1	101
24	24	15.4	1	0	1	101
24	25	13.8	1	0	0	100
24	26	7.4	1	0	0	100
24	27	9.4	1	0	0	100
24	28	12.1	1	0	0	100
24	29	12.2	1	0	0	100
24	30	9.4	1	0	0	100
24	31	5.9	0	0	0	0
24	32	2.9	0	0	0	0
25	0	1.6	0	0	0	0
25	1	2.3	0	0	0	0
25	2	2.8	0	0	0	0
25	3	3.1	0	0	0	0
25	4	2.6	0	0	0	0
25	5	3.7	0	0	0	0
25	6	6.7	1	0	0	100
25	7	8.3	1	0	0	100
25	8	7.3	1	0	0	100
25	9	6	1	0	0	100
25	10	2.6	0	0	0	0
25	11	0.4	0	0	0	0
25	12	2.3	0	0	0	0
25	13	6.7	1	0	1	101
25	14	7.6	1	0	1	101
25	15	11.1	1	0	1	101
25	16	20	1	0	0	100
25	17	9.5	1	0	0	100
25	18	12.7	1	0	0	100
25	19	15.9	1	0	0	100
25	20	9.1	1	0	0	100
25	21	9.9	1	0	0	100
25	22	8.4	1	0	0	100

25	25	8	1	0	0	100
25	26	10.9	1	0	0	100
25	27	14.4	1	0	0	100
25	28	12.4	1	0	0	100
25	29	11.1	1	0	0	100
25	30	8.2	1	0	0	100
25	31	6.8	1	0	0	100
25	32	9.1	1	0	0	100
26	0	5	0	0	0	0
26	1	3.7	0	0	0	0
26	2	4.3	0	0	0	0
26	3	4.7	0	0	0	0
26	4	4	0	0	0	0
26	5	4.4	0	0	0	0
26	6	7.3	1	0	0	100
26	7	8.9	1	0	0	100
26	8	8.6	1	0	0	100
26	9	8.6	1	0	0	100
26	10	6.3	1	0	0	100
26	11	2.8	0	0	0	0
26	12	2	0	0	1	1
26	13	4.5	0	0	1	1
26	14	6.5	1	0	0	100
26	15	11.5	1	0	0	100
26	16	16	1	0	0	100
26	17	7	1	0	0	100
26	18	10.9	1	0	0	100
26	19	13.5	1	0	0	100
26	20	9.9	1	0	0	100
26	25	6.2	1	0	0	100
26	26	11.3	1	0	0	100
26	27	12.5	1	0	0	100
26	28	12.6	1	0	0	100
26	29	14.8	1	0	0	100
26	30	14.3	1	0	0	100
26	31	13.1	1	0	0	100
26	32	13.8	1	0	0	100
27	0	6.4	1	0	0	100
27	1	6.8	1	0	0	100
27	2	6.8	1	0	0	100
27	3	6.4	1	0	0	100
27	4	6	0	0	0	0
27	5	6.2	1	0	0	100
27	6	7.6	1	0	0	100
27	7	8.9	1	0	0	100
27	8	9.8	1	0	0	100
27	9	9.2	1	1	0	110
27	10	8.3	1	1	0	110
27	11	5.4	0	0	0	0
27	12	3.2	0	0	1	1
27	13	3.3	0	0	1	1
27	14	5.3	0	0	0	0
27	15	10.7	1	1	0	110
27	16	13	1	0	0	100
27	17	8.6	1	0	0	100
27	18	10.8	1	0	0	100
28	0	7.5	1	0	0	100
28	1	10.7	1	0	0	100
28	2	9.6	1	0	0	100
28	3	7.4	1	0	0	100
28	4	6.8	1	0	0	100
28	5	6.8	1	0	0	100
28	6	7.1	1	0	0	100
28	7	8.4	1	0	0	100
28	8	10.5	1	0	0	100
28	9	8.8	1	0	0	100
28	10	9.9	1	0	0	100
28	11	7.5	1	0	0	100
28	12	4.8	0	0	0	0
28	13	3.4	0	0	0	0
28	14	4.3	0	0	0	0
28	15	11.4	1	1	0	110
28	16	13.5	1	0	0	100
28	17	8.2	1	0	0	100

28	18	11.8	1	0	0	100
29	0	9.1	1	0	0	100
29	1	17.3	1	0	0	100
29	2	13.1	1	0	0	100
29	3	5.4	0	0	0	0
29	4	3.9	0	0	0	0
29	5	4.6	0	0	0	0
29	6	4.9	0	0	0	0
29	7	7.7	1	0	0	100
29	8	10.1	1	0	0	100
29	9	8.6	1	0	0	100
29	10	9.1	1	0	0	100
29	11	8.4	1	0	0	100
29	12	8	1	1	0	110
29	13	6.6	1	1	0	110
29	14	6	0	0	0	0
29	15	13.1	1	1	0	110
29	16	16.6	1	0	0	100
29	17	5.4	0	0	0	0
29	18	12.5	1	0	0	100
30	0	10.2	1	0	0	100
30	1	8.8	1	0	0	100
30	2	10.3	1	0	0	100
30	3	7.8	1	0	0	100
30	4	7.2	1	0	0	100
30	5	7.3	1	0	0	100
30	6	6.2	1	0	0	100
30	7	4.9	0	0	0	0
30	8	8.2	1	0	0	100
30	9	8.3	1	0	0	100
30	10	10.8	1	0	0	100
30	11	8.7	1	0	0	100
30	12	7.1	1	1	0	110
30	13	6.4	1	1	0	110
30	14	6.6	1	0	0	100
30	15	8.3	1	1	0	110
30	16	11.8	1	1	0	110
30	17	2.6	0	0	0	0
30	18	12.1	1	0	0	100
31	0	6.1	1	0	0	100
31	1	7.2	1	0	0	100
31	2	9.1	1	0	0	100
31	3	8	1	0	0	100
31	4	6.9	1	0	0	100
31	5	7.7	1	0	0	100
31	6	8.3	1	0	0	100
31	7	5.4	0	0	0	0
31	8	5.1	0	0	0	0
31	9	6.8	1	0	0	100
31	10	8.7	1	0	0	100
31	11	7.5	1	0	0	100
31	12	6.2	1	1	0	110
31	13	5.7	0	1	0	10
31	14	4.7	0	1	0	10
31	15	4.8	0	1	0	10
31	16	9.4	1	0	0	100
31	17	4.6	0	0	0	0
31	18	11	1	0	0	100
31	28	6.1	1	1	0	110
31	29	1.3	0	1	0	10
32	0	6.1	1	0	0	100
32	1	7.9	1	0	0	100
32	2	8.1	1	0	0	100
32	3	6.5	1	0	0	100
32	4	4.7	0	0	0	0
32	5	6	0	0	0	0
32	6	8.1	1	0	0	100
32	7	7.4	1	0	0	100
32	8	4.7	0	0	0	0
32	9	4.6	0	0	0	0
32	10	6.4	1	0	0	100
32	11	7.5	1	0	0	100
32	12	7.1	1	1	0	110
32	13	6.8	1	1	0	110

32	14	5.4	0	0	0	0
32	15	3.7	0	1	0	10
32	16	6.9	1	1	0	110
32	17	6.8	1	0	0	100
32	18	8.3	1	0	0	100
32	27	5.9	0	0	0	0
32	28	4.3	0	1	0	10
32	29	1.1	0	1	0	10
32	30	0.1	0	1	0	10
32	31	0.6	0	1	0	10
32	32	1.4	0	0	0	0
33	0	5.9	0	0	0	0
33	1	8.6	1	0	0	100
33	2	7.9	1	0	0	100
33	3	5.4	0	0	0	0
33	4	2.2	0	0	0	0
33	5	4	0	0	0	0
33	6	8.1	1	0	0	100
33	7	9.5	1	0	0	100
33	8	3.6	0	0	0	0
33	9	2.2	0	0	0	0
33	10	4.2	0	0	0	0
33	11	7.6	1	0	0	100
33	12	7.6	1	0	0	100
33	13	8.6	1	0	0	100
33	14	7.5	1	0	0	100
33	15	1.8	0	1	0	10
33	16	5.3	0	0	0	0
33	17	7	1	0	0	100
33	18	6	0	0	0	0
33	27	3.9	0	0	0	0
33	28	2.8	0	1	0	10
33	29	0.3	0	1	0	10
33	30	0.2	0	1	0	10
33	31	1.5	0	1	0	10
33	32	3.2	0	0	0	0
34	0	2.6	0	0	0	0
34	1	5.2	0	0	0	0
34	2	8.3	1	0	0	100
34	3	7	1	0	0	100
34	4	3.7	0	0	0	0
34	5	4.4	0	0	0	0
34	6	8.2	1	0	0	100
34	7	7.5	1	0	0	100
34	8	2.4	0	0	0	0
34	9	0.3	0	0	0	0
34	10	2.2	0	0	0	0
34	11	5	0	0	0	0
34	12	5.7	0	0	0	0
34	13	9.4	1	1	0	110
34	14	10.6	1	0	0	100
34	15	1.4	0	0	0	0
34	16	2.2	0	0	0	0
34	17	3.1	0	0	0	0
34	18	2.5	0	0	0	0
34	27	0.4	0	0	0	0
34	28	0.3	0	1	0	10
34	29	0	0	1	0	10
34	30	0.3	0	1	0	10
34	31	2.5	0	1	0	10
34	32	5.4	0	0	0	0
35	0	1.4	0	0	0	0
35	1	3.8	0	0	0	0
35	2	6.3	1	0	0	100
35	3	6.5	1	0	0	100
35	4	4.8	0	0	0	0
35	5	5.1	0	0	0	0
35	6	8	1	0	0	100
35	7	7	1	0	0	100
35	8	2.6	0	0	0	0
35	9	0.2	0	0	0	0
35	10	0.4	0	0	0	0
35	11	1.9	0	0	0	0
35	12	5.5	0	0	0	0

35	13	8.7	1	0	0	100
35	14	7.4	1	0	0	100
35	15	1.6	0	1	0	10
35	16	0.5	0	0	0	0
35	17	0.7	0	0	0	0
35	18	0.6	0	0	0	0
35	19	0.6	0	0	0	0
35	20	2	0	1	0	10
35	21	4.7	0	1	0	10
35	27	-0.1	0	0	0	0
35	28	0	0	0	0	0
35	29	0	0	0	0	0
35	30	0.3	0	0	0	0
35	31	2.5	0	0	0	0
35	32	6.4	1	0	0	100
36	0	1.9	0	0	0	0
36	1	3.8	0	0	0	0
36	2	5.3	0	0	0	0
36	3	5.5	0	0	0	0
36	4	4.5	0	0	0	0
36	5	4.6	0	0	0	0
36	6	6.9	1	0	0	100
36	7	7.3	1	0	0	100
36	8	4.6	0	0	0	0
36	9	2	0	0	0	0
36	10	0.7	0	0	0	0
36	11	1.6	0	0	0	0
36	12	6.5	1	0	0	100
36	13	8.9	1	0	0	100
36	14	6.6	1	0	0	100
36	15	2.1	0	0	0	0
36	16	0.4	0	0	0	0
36	17	0.1	0	0	0	0
36	18	0.1	0	0	0	0
36	19	0.6	0	1	0	10
36	20	2.3	0	1	1	11
36	21	4.4	0	1	1	11
36	27	-0.2	0	0	0	0
36	28	-0.2	0	0	0	0
36	29	-0.1	0	0	0	0
36	30	0.4	0	1	0	10
36	31	2.3	0	0	0	0
36	32	5.5	0	1	0	10
37	0	3.8	0	0	0	0
37	1	4.6	0	0	0	0
37	2	5.1	0	1	0	10
37	3	5	0	1	0	10
37	4	4.1	0	0	0	0
37	5	3.4	0	0	0	0
37	6	5.7	0	0	0	0
37	7	8.1	1	0	0	100
37	8	6.6	1	0	0	100
37	9	4.3	0	1	0	10
37	10	1.7	0	1	0	10
37	11	0.9	0	0	0	0
37	12	8	1	1	0	110
37	13	10.1	1	0	0	100
37	14	7.1	1	0	0	100
37	15	2.4	0	0	0	0
37	16	0.6	0	1	0	10
37	17	0.1	0	1	0	10
37	18	0.1	0	0	0	0
37	19	0.4	0	1	0	10
37	20	2.3	0	1	1	11
37	21	4.1	0	0	1	1
37	22	4.6	0	0	1	1
37	23	5.2	0	0	0	0
37	24	4.8	0	0	0	0
37	25	3.5	0	0	0	0
37	26	1.6	0	0	0	0
37	27	0	0	0	0	0
37	28	-0.1	0	0	0	0
37	29	0	0	1	0	10
37	30	0.2	0	1	0	10

37	31	1.5	0	0	0	0
37	32	3.9	0	1	0	10
38	0	6.6	1	0	0	100
38	1	5.9	0	0	0	0
38	2	4.9	0	0	0	0
38	3	4.7	0	1	0	10
38	4	6	0	0	0	0
38	5	4.9	0	0	0	0
38	6	2.9	0	0	0	0
38	7	5.7	0	0	0	0
38	8	7.2	1	0	0	100
38	9	6.5	1	0	0	100
38	10	3.8	0	1	0	10
38	11	0.7	0	1	0	10
38	12	5.6	0	1	0	10
38	13	8.2	1	0	0	100
38	14	9	1	1	0	110
38	15	3.2	0	0	0	0
38	16	0.8	0	0	0	0
38	17	0	0	1	0	10
38	18	0.2	0	1	0	10
38	19	0.2	0	1	0	10
38	20	1.5	0	0	0	0
38	21	2.9	0	0	0	0
38	22	4.2	0	0	0	0
38	23	6.2	1	0	0	100
38	24	7.8	1	0	0	100
38	25	6.6	1	0	0	100
38	26	3.6	0	0	0	0
38	27	-0.1	0	0	0	0
38	28	-0.1	0	0	0	0
38	29	0	0	1	0	10
38	30	0	0	1	0	10
38	31	0.3	0	0	0	0
38	32	2.3	0	1	0	10
39	0	4.3	0	0	0	0
39	1	3.9	0	0	0	0
39	2	3.5	0	1	0	10
39	3	3.4	0	1	0	10
39	4	6.1	1	1	0	110
39	5	5.5	0	0	0	0
39	6	5.3	0	0	0	0
39	7	4.2	0	0	0	0
39	8	5.6	0	1	0	10
39	9	8.2	1	0	0	100
39	10	7	1	1	0	110
39	11	6.2	1	0	0	100
39	12	7.3	1	0	0	100
39	13	8.2	1	0	0	100
39	14	7.4	1	1	0	110
39	15	2.7	0	0	0	0
39	16	0.5	0	0	0	0
39	17	-0.1	0	1	0	10
39	18	-0.1	0	0	0	0
39	19	0.2	0	0	0	0
39	20	2.9	0	0	0	0
39	21	5.4	0	0	0	0
39	22	8.6	1	0	0	100
39	23	10.3	1	0	0	100
39	24	12.1	1	0	0	100
39	25	11.5	1	0	0	100
39	26	6.4	1	0	0	100
39	27	2.1	0	0	0	0
39	28	-0.1	0	0	0	0
39	29	-0.1	0	1	0	10
39	30	0	0	1	0	10
39	31	0	0	0	0	0
39	32	0.3	0	1	0	10
40	0	2.1	0	0	0	0
40	1	2.4	0	0	0	0
40	2	2.1	0	1	0	10
40	3	2.6	0	0	0	0
40	4	5.3	0	1	0	10
40	5	5.8	0	0	0	0

40	6	5.5	0	0	0	0
40	7	3.3	0	1	0	10
40	8	4.2	0	1	0	10
40	9	6.9	1	0	0	100
40	10	8.4	1	1	0	110
40	11	8.3	1	0	0	100
40	12	9.1	1	0	0	100
40	13	10.1	1	1	0	110
40	14	8.7	1	1	0	110
40	15	5	0	0	0	0
40	16	1.5	0	0	0	0
40	17	-0.2	0	0	0	0
40	18	0.3	0	0	0	0
40	19	3.5	0	0	0	0
40	20	7.9	1	0	0	100
40	21	11.5	1	0	0	100
40	22	14.9	1	0	0	100
40	23	15.6	1	0	0	100
40	24	16.1	1	0	0	100
40	25	14.6	1	0	0	100
40	26	9.6	1	0	0	100
40	27	4.1	0	0	0	0
40	28	0.5	0	0	0	0
40	29	-0.2	0	0	0	0
40	30	-0.1	0	1	0	10
40	31	-0.1	0	0	0	0
40	32	0.1	0	1	0	10
41	0	1.1	0	0	0	0
41	1	1.6	0	0	0	0
41	2	1	0	0	0	0
41	3	1.1	0	0	0	0
41	4	4.6	0	0	0	0
41	5	5.5	0	0	0	0
41	6	5.5	0	0	0	0
41	7	1.4	0	1	0	10
41	8	2.2	0	0	0	0
41	9	5.6	0	1	0	10
41	10	8.9	1	1	0	110
41	11	8.3	1	0	0	100
41	12	9.3	1	0	0	100
41	13	11.9	1	1	0	110
41	14	10.4	1	1	0	110
41	15	7.9	1	0	0	100
41	16	3.3	0	0	0	0
41	17	0.2	0	0	0	0
41	18	0.9	0	0	0	0
41	19	7.6	1	0	0	100
41	20	14.4	1	0	0	100
41	21	18.3	1	0	0	100
41	22	21.2	1	0	0	100
41	23	19.7	1	0	0	100
41	24	19.8	1	0	0	100
41	25	17.3	1	0	0	100
41	26	11.7	1	0	0	100
41	27	5.1	0	0	0	0
41	28	0.5	0	0	0	0
41	29	-0.2	0	0	0	0
41	30	-0.1	0	0	0	0
41	31	0	0	0	0	0
41	32	0.5	0	0	0	0
42	0	2	0	0	0	0
42	1	1.6	0	0	0	0
42	2	1.2	0	0	0	0
42	3	0.3	0	0	0	0
42	4	3	0	0	0	0
42	5	4.3	0	0	0	0
42	6	3.8	0	1	0	10
42	7	0.5	0	1	0	10
42	8	1.8	0	0	0	0
42	9	6.1	1	0	0	100
42	10	8.2	1	1	0	110
42	11	6.9	1	0	0	100
42	12	7	1	0	0	100
42	13	9.9	1	0	0	100

42	14	8.5	1	1	0	110
42	15	10.5	1	1	0	110
42	16	7.1	1	0	0	100
42	17	1.1	0	0	0	0
42	18	2	0	0	0	0
42	19	10.8	1	0	0	100
42	20	20.4	1	0	0	100
42	21	25.2	1	0	0	100
42	22	23	1	0	0	100
42	23	19.3	1	0	0	100
42	24	25.5	1	0	0	100
42	25	17.2	1	0	0	100
42	26	10.1	1	0	0	100
42	27	5.7	0	0	0	0
42	28	0.6	0	0	0	0
42	29	-0.1	0	0	0	0
42	30	0	0	0	0	0
42	31	0	0	0	0	0
42	32	0.5	0	0	0	0
43	0	6.4	1	0	0	100
43	1	3.4	0	0	0	0
43	2	2	0	0	0	0
43	3	0.7	0	0	0	0
43	4	0.7	0	0	0	0
43	5	1	0	0	0	0
43	6	0.8	0	1	0	10
43	7	-0.1	0	0	0	0
43	8	2.6	0	1	0	10
43	9	8.5	1	0	0	100
43	10	7.1	1	1	0	110
43	11	7.4	1	1	0	110
43	12	6.7	1	0	0	100
43	13	6.3	1	0	0	100
43	14	5.6	0	0	0	0
43	15	9.5	1	0	0	100
43	16	9.9	1	0	0	100
43	17	4	0	0	0	0
43	18	3.3	0	0	0	0
43	19	11.5	1	0	0	100
43	20	22.4	1	0	0	100
43	21	28.8	1	0	0	100
43	22	12.6	1	0	0	100
43	23	24.6	1	0	0	100
43	24	32.3	1	0	0	100
43	25	21.4	1	0	0	100
43	26	10.3	1	0	0	100
43	27	5.4	0	0	0	0
43	28	1.8	0	0	0	0
43	29	0.3	0	0	0	0
43	30	-0.1	0	0	0	0
43	31	0	0	0	0	0
43	32	1.4	0	0	0	0
44	0	8.1	1	0	0	100
44	1	4.5	0	0	0	0
44	2	2.6	0	0	0	0
44	3	0.8	0	0	0	0
44	4	0.1	0	0	0	0
44	5	-0.1	0	0	0	0
44	6	-0.1	0	0	0	0
44	7	0.3	0	1	0	10
44	8	3.6	0	0	0	0
44	9	8.2	1	0	0	100
44	10	6.8	1	0	0	100
44	11	5.4	0	1	0	10
44	12	4.5	0	1	0	10
44	13	4.3	0	0	0	0
44	14	5.5	0	0	0	0
44	15	8.5	1	0	0	100
44	16	10.5	1	0	0	100
44	17	7.4	1	0	0	100
44	18	6.4	1	0	0	100
44	19	11.6	1	0	0	100
44	20	19.5	1	0	0	100
44	21	24.1	1	0	0	100

44	22	18.9	1	0	0	100
44	23	24.1	1	0	0	100
44	24	26.4	1	0	0	100
44	25	17.9	1	0	0	100
44	26	9.4	1	0	0	100
44	27	5.7	0	0	0	0
44	28	2.8	0	0	0	0
44	29	0.6	0	0	0	0
44	30	-0.2	0	0	0	0
44	31	0	0	0	0	0
44	32	1.5	0	0	0	0
45	0	8.2	1	0	0	100
45	1	5.4	0	0	0	0
45	2	3.8	0	0	0	0
45	3	1.4	0	0	0	0
45	4	0.2	0	0	0	0
45	5	0	0	0	0	0
45	6	0.7	0	0	0	0
45	7	1	0	0	0	0
45	8	4.2	0	1	0	10
45	9	9.3	1	0	0	100
45	10	7	1	0	0	100
45	11	4.4	0	1	0	10
45	12	3.7	0	1	0	10
45	13	4.1	0	0	0	0
45	14	6.4	1	0	0	100
45	15	8.1	1	0	0	100
45	16	12.3	1	0	0	100
45	17	10	1	0	0	100
45	18	7.7	1	0	0	100
45	19	10.3	1	0	0	100
45	20	15.6	1	0	0	100
45	21	20	1	0	0	100
45	22	20.4	1	0	0	100
45	23	21.4	1	0	0	100
45	24	19.8	1	0	0	100
45	25	11.5	1	0	0	100
45	26	6.5	1	0	0	100
45	27	6.2	1	0	0	100
45	28	3.7	0	0	0	0
45	29	0.7	0	0	0	0
45	30	-0.2	0	0	0	0
45	31	0	0	0	0	0
45	32	2.3	0	0	0	0
46	0	6.4	1	0	0	100
46	1	9.3	1	0	0	100
46	2	6.2	1	0	0	100
46	3	2.4	0	0	0	0
46	4	0.4	0	0	0	0
46	5	0.3	0	0	0	0
46	6	3.3	0	0	0	0
46	7	4.3	0	0	0	0
46	8	3.3	0	0	0	0
46	9	9.2	1	0	0	100
46	10	9	1	0	0	100
46	11	8.6	1	1	0	110
46	12	8.2	1	0	0	100
46	13	7.2	1	0	0	100
46	14	9.9	1	0	0	100
46	15	7.5	1	0	0	100
46	16	12.6	1	0	0	100
46	17	11.4	1	0	1	101
46	18	9.2	1	0	1	101
46	19	9.3	1	0	0	100
46	20	12.2	1	0	0	100
46	21	13.3	1	0	0	100
46	22	14.2	1	0	0	100
46	23	15.7	1	0	0	100
46	24	13	1	0	0	100
46	25	7.9	1	0	0	100
46	26	6.7	1	0	0	100
46	27	7.1	1	0	0	100
46	28	3.8	0	0	0	0
46	29	0.6	0	0	0	0

46	30	0.2	0	0	0	0
46	31	1.3	0	0	0	0
46	32	4	0	0	0	0
47	0	5	0	1	0	10
47	1	8.4	1	0	0	100
47	2	7.5	1	0	0	100
47	3	3.4	0	0	0	0
47	4	1.6	0	0	0	0
47	5	2.2	0	0	0	0
47	6	5.2	0	0	0	0
47	7	6.6	1	0	0	100
47	8	6.8	1	0	0	100
47	9	9.4	1	0	0	100
47	10	13.6	1	0	0	100
47	11	18	1	0	0	100
47	12	9.8	1	0	0	100
47	13	10.3	1	0	0	100
47	14	10.5	1	0	0	100
47	15	6.2	1	0	0	100
47	16	10.5	1	0	0	100
47	17	11.6	1	0	1	101
47	18	12.3	1	0	1	101
47	19	11.5	1	0	0	100
47	20	11	1	0	0	100
47	21	7.5	1	0	0	100
47	22	6	1	0	0	100
47	23	8.6	1	0	0	100
47	24	7.2	1	0	0	100
47	25	6.8	1	0	0	100
47	26	7.7	1	0	0	100
47	27	6.8	1	0	0	100
47	28	3.5	0	0	0	0
47	29	2.1	0	0	0	0
47	30	1.9	0	0	0	0
47	31	3.9	0	0	0	0
47	32	7.4	1	0	0	100
48	0	7.6	1	0	0	100
48	1	8.2	1	0	0	100
48	2	6.3	1	0	0	100
48	3	3.3	0	0	0	0
48	4	3.4	0	0	0	0
48	5	4.4	0	0	0	0
48	6	6.1	1	0	0	100
48	7	8.2	1	0	0	100
48	8	9.4	1	0	0	100
48	9	13.7	1	0	0	100
48	10	16.2	1	0	0	100
48	11	15.3	1	0	0	100
48	12	9.5	1	0	0	100
48	13	10.4	1	0	0	100
48	14	9.5	1	0	0	100
48	15	9.3	1	0	0	100
48	16	8.5	1	0	0	100
48	17	10.9	1	0	1	101
48	18	13.9	1	0	1	101
48	19	16.3	1	0	0	100
48	20	15	1	0	0	100
48	21	11.3	1	0	0	100
48	22	6.7	1	0	0	100
48	23	6.4	1	0	0	100
48	24	4.5	0	0	0	0
48	25	4.1	0	0	0	0
48	26	5.7	0	0	0	0
48	27	6.4	1	0	0	100
48	28	5.6	0	0	0	0
48	29	5.2	0	0	0	0
48	30	5.5	0	0	0	0
48	31	9	1	0	0	100
48	32	12.3	1	0	0	100
49	0	13.1	1	0	0	100
49	1	8.7	1	0	0	100
49	2	5.3	0	0	0	0
49	3	3	0	0	0	0
49	4	4.7	0	0	0	0

49	5	6	1	0	0	100
49	6	7.4	1	0	0	100
49	7	9.6	1	0	0	100
49	8	10.6	1	0	0	100
49	9	11.2	1	0	0	100
49	10	11.1	1	0	0	100
49	11	9.4	1	0	0	100
49	12	6.9	1	0	0	100
49	13	8.1	1	0	0	100
49	14	8.5	1	0	0	100
49	15	7.4	1	0	0	100
49	16	5.5	0	0	0	0
49	17	7	1	0	1	101
49	18	10.6	1	0	1	101
49	19	14.1	1	0	0	100
49	20	13.7	1	0	0	100
49	21	11.8	1	0	0	100
49	22	9	1	0	0	100
49	23	7.3	1	0	0	100
49	24	5.1	0	0	0	0
49	25	3.7	0	0	0	0
49	26	4.1	0	0	0	0
49	27	5.5	0	0	0	0
49	28	6.1	1	0	0	100
49	29	6.4	1	0	0	100
49	30	8.4	1	0	0	100
49	31	11.7	1	0	0	100
49	32	14.2	1	0	0	100
50	0	16.6	1	0	0	100
50	1	9.8	1	0	0	100
50	2	5.6	0	0	0	0
50	3	2.9	0	0	0	0
50	4	7	1	0	0	100
50	5	8.1	1	0	0	100
50	6	8.6	1	0	0	100
50	7	10.7	1	0	0	100
50	8	10.3	1	0	0	100
50	9	6.8	1	0	0	100
50	10	4.7	0	0	0	0
50	11	3.1	0	0	0	0
50	12	2.4	0	0	0	0
50	13	4.9	0	0	0	0
50	14	6.5	1	0	0	100
50	15	4.9	0	0	0	0
50	16	2.2	0	0	0	0
50	17	3.4	0	0	0	0
50	18	6.6	1	0	0	100
50	19	10.6	1	1	0	110
50	20	9.8	1	1	0	110
50	21	10.6	1	0	0	100
50	22	9.9	1	0	0	100
50	23	8.4	1	0	0	100
50	24	6.6	1	0	0	100
50	25	4	0	0	0	0
50	26	2.7	0	0	0	0
50	27	4.5	0	0	0	0
50	28	5.5	0	0	0	0
50	29	5.5	0	0	0	0
50	30	9.3	1	0	0	100
50	31	12.6	1	0	0	100
50	32	12	1	0	0	100
51	0	12	1	0	0	100
51	1	13.6	1	0	0	100
51	2	9.9	1	1	0	110
51	3	6.7	1	0	0	100
51	4	8.4	1	0	0	100
51	5	11.8	1	0	0	100
51	6	11.8	1	0	0	100
51	7	10.3	1	0	0	100
51	8	7.7	1	0	0	100
51	9	4.1	0	0	0	0
51	10	1.4	0	0	0	0
51	11	0.2	0	0	0	0
51	12	0	0	0	0	0

51	13	0.4	0	0	0	0
51	14	0.8	0	0	0	0
51	15	3.1	0	0	0	0
51	16	4.8	0	0	0	0
51	17	6.4	1	0	0	100
51	18	7.6	1	0	0	100
51	19	6.5	1	1	1	111
51	20	4.4	0	1	1	11
51	21	7.3	1	0	1	101
51	22	8.1	1	0	0	100
51	23	5.9	0	0	0	0
51	24	8.2	1	0	0	100
51	25	7.2	1	0	0	100
51	26	1.2	0	0	0	0
51	27	3.2	0	0	0	0
51	28	2.8	0	0	0	0
51	29	2.9	0	0	0	0
51	30	8.2	1	0	0	100
51	31	10.7	1	0	0	100
51	32	6.7	1	0	0	100
52	0	8.7	1	1	0	110
52	1	14.3	1	1	1	111
52	2	13.3	1	1	0	110
52	3	11.8	1	0	0	100
52	4	11	1	0	0	100
52	5	12.6	1	0	0	100
52	6	10.5	1	0	0	100
52	7	8	1	0	0	100
52	8	5.2	0	0	0	0
52	9	2.6	0	0	0	0
52	10	0.6	0	0	0	0
52	11	-0.2	0	0	0	0
52	12	1.6	0	0	0	0
52	13	2.8	0	0	0	0
52	14	4.7	0	0	0	0
52	15	6.8	1	0	0	100
52	16	7.7	1	0	0	100
52	17	7.9	1	0	0	100
52	18	7.4	1	0	0	100
52	19	5.7	0	0	1	1
52	20	6.7	1	0	1	101
52	21	9.2	1	0	1	101
52	22	10.1	1	0	0	100
52	23	10.6	1	0	0	100
52	24	8.9	1	0	0	100
52	25	5	0	0	0	0
52	26	1.8	0	0	0	0
52	27	4.6	0	0	0	0
52	28	4.9	0	0	0	0
52	29	6.1	1	0	0	100
52	30	9.4	1	0	0	100
52	31	10.4	1	0	0	100
52	32	9.5	1	0	0	100
53	0	11.4	1	0	0	100
53	1	14.5	1	0	1	101
53	2	13.8	1	0	1	101
53	3	12.3	1	0	1	101
53	4	11.3	1	0	1	101
53	5	11.1	1	0	0	100
53	6	9.8	1	0	0	100
53	7	6.5	1	0	0	100
53	8	4	0	0	0	0
53	9	2.1	0	0	0	0
53	10	0.9	0	0	0	0
53	11	2	0	0	0	0
53	12	4.2	0	0	0	0
53	13	6.3	1	0	0	100
53	14	8.8	1	0	0	100
53	15	11	1	0	0	100
53	16	11.5	1	0	0	100
53	17	10.5	1	0	1	101
53	18	8.9	1	0	1	101
53	19	8.5	1	1	0	110
53	20	10.8	1	0	0	100

53	21	13.7	1	0	0	100
53	22	15.7	1	0	0	100
53	23	16	1	0	0	100
53	24	12.5	1	0	0	100
53	25	7.8	1	0	0	100
53	26	3.9	0	0	0	0
53	27	5.2	0	0	0	0
53	28	6.5	1	0	0	100
53	29	6.8	1	0	0	100
53	30	9.4	1	0	0	100
53	31	10.3	1	0	0	100
53	32	10.5	1	0	0	100
54	0	16	1	0	0	100
54	1	16.4	1	0	1	101
54	2	13	1	0	1	101
54	3	10.5	1	0	1	101
54	4	10.1	1	0	1	101
54	5	8.6	1	0	0	100
54	6	10.9	1	0	0	100
54	7	4.3	0	0	0	0
54	8	3	0	0	0	0
54	9	1.6	0	0	0	0
54	10	0.3	0	0	0	0
54	11	4.6	0	0	0	0
54	12	7.8	1	0	0	100
54	13	10.1	1	0	0	100
54	14	13.4	1	0	0	100
54	15	16.8	1	0	0	100
54	16	16.7	1	0	0	100
54	17	14.1	1	0	1	101
54	18	10.2	1	0	1	101
54	19	10.7	1	1	0	110
54	20	15.8	1	0	0	100
54	21	19.9	1	0	0	100
54	22	24.1	1	0	0	100
54	23	25.4	1	0	0	100
54	24	18.1	1	0	0	100
54	25	12.2	1	0	0	100
54	26	2.9	0	0	0	0
54	27	5.7	0	0	0	0
54	28	8.9	1	0	0	100
54	29	4.9	0	0	0	0
54	30	9.8	1	0	0	100
54	31	10.2	1	0	0	100
54	32	10.4	1	0	0	100

APPENDIX B. Listing of Selected Survey Quadrats in the Study Universe (n=151)

Listing of Selected Survey Quadrats in Study Universe (n=151; sorted by Quadrat No.)

Quadrat No.	% Grade	Slope	Toolstone	Water	Combined Score
		0 <=6%	0-has no ts.	0-water>560m	(slope,ts,water)
		1 >6%	1-has ts.	1-water<560m	
N3E1	4.5	0	0	0	0
N8E3	9.9	1	0	0	100
N8E5	5.5	0	0	0	0
N8E10	3.6	0	0	0	0
N8E16	0.8	0	0	0	0
N9E3	8.1	1	0	0	100
N10E16	0.7	0	0	0	0
N10E17	0.2	0	0	1	1
N11E23	3	0	0	0	0
N12E19	2.7	0	0	0	0
N13E13	3.1	0	0	0	0
N13E15	3.4	0	0	0	0
N13E16	4	0	0	0	0
N13E25	10	1	0	0	100
N14E10	6.5	1	0	0	100
N14E16	2.8	0	0	0	0
N14E18	3.1	0	0	0	0
N14E24	11.6	1	0	0	100
N15E1	7.8	1	0	0	100
N15E11	5.9	0	0	0	0
N15E16	3.1	0	0	0	0
N15E22	5.4	0	0	0	0
N16E4	5.8	0	0	0	0
N16E7	6.3	1	0	0	100
N16E8	7.8	1	0	0	100
N16E19	6.7	1	0	0	100
N16E26	4.3	0	0	0	0
N16E27	8	1	0	0	100
N16E31	10.7	1	0	0	100
N17E6	5.2	0	0	0	0
N17E9	10.4	1	0	0	100
N17E10	4.9	0	0	0	0
N17E16	5.4	0	0	0	0
N17E21	8.8	1	1	1	111
N17E24	15.7	1	0	0	100
N18E6	6.1	1	0	0	100
N18E28	9	1	0	0	100
N18E30	8.9	1	0	0	100
N20E5	7.6	1	0	0	100
N20E9	6.5	1	0	0	100
N20E17	2.6	0	0	1	1
N21E30	10.6	1	0	0	100
N22E2	4.2	0	0	0	0
N22E3	4.6	0	0	0	0
N22E12	7.6	1	0	0	100
N23E11	2	0	0	0	0
N23E24	14.5	1	0	1	101
N23E25	12.2	1	0	0	100
N24E4	3.6	0	0	0	0
N24E7	6.1	1	0	0	100
N24E15	9.6	1	1	1	111
N24E20	9.3	1	0	0	100
N24E32	2.9	0	0	0	0
N25E0	1.6	0	0	0	0
N25E2	2.8	0	0	0	0
N25E5	3.7	0	0	0	0
N25E15	11.1	1	0	1	101
N26E8	8.6	1	0	0	100
N26E12	2	0	0	1	1
N27E16	13	1	0	0	100
N29E4	3.9	0	0	0	0
N29E8	10.1	1	0	0	100
N29E15	13.1	1	1	0	110
N31E17	4.6	0	0	0	0
N31E29	1.3	0	1	0	10
N32E1	7.9	1	0	0	100
N33E9	2.2	0	0	0	0
N33E17	7	1	0	0	100
N34E0	2.6	0	0	0	0

N34E1	5.2	0	0	0	0
N34E4	3.7	0	0	0	0
N34E11	5	0	0	0	0
N35E8	2.6	0	0	0	0
N35E10	0.4	0	0	0	0
N35E13	8.7	1	0	0	100
N35E15	1.6	0	1	0	10
N35E29	0	0	0	0	0
N35E32	6.4	1	0	0	100
N36E2	5.3	0	0	0	0
N36E12	6.5	1	0	0	100
N36E20	2.3	0	1	1	11
N36E21	4.4	0	1	1	11
N36E29	-0.1	0	0	0	0
N37E12	8	1	1	0	110
N37E18	0.1	0	0	0	0
N37E19	0.4	0	1	0	10
N37E20	2.3	0	1	1	11
N37E31	1.5	0	0	0	0
N37E32	3.9	0	1	0	10
N38E1	5.9	0	0	0	0
N38E14	9	1	1	0	110
N38E19	0.2	0	1	0	10
N38E23	6.2	1	0	0	100
N38E29	0	0	1	0	10
N39E7	4.2	0	0	0	0
N39E14	7.4	1	1	0	110
N39E23	10.3	1	0	0	100
N39E26	6.4	1	0	0	100
N39E28	-0.1	0	0	0	0
N41E5	5.5	0	0	0	0
N41E12	9.3	1	0	0	100
N41E19	7.6	1	0	0	100
N42E12	7	1	0	0	100
N43E22	12.6	1	0	0	100
N43E25	21.4	1	0	0	100
N43E28	1.8	0	0	0	0
N44E10	6.8	1	0	0	100
N44E13	4.3	0	0	0	0
N45E12	3.7	0	1	0	10
N45E13	4.1	0	0	0	0
N45E14	6.4	1	0	0	100
N46E0	6.4	1	0	0	100
N46E2	6.2	1	0	0	100
N46E4	0.4	0	0	0	0
N46E13	7.2	1	0	0	100
N46E22	14.2	1	0	0	100
N47E1	8.4	1	0	0	100
N47E5	2.2	0	0	0	0
N47E11	18	1	0	0	100
N47E18	12.3	1	0	1	101
N47E19	11.5	1	0	0	100
N47E26	7.7	1	0	0	100
N48E0	7.6	1	0	0	100
N48E2	6.3	1	0	0	100
N48E5	4.4	0	0	0	0
N48E8	9.4	1	0	0	100
N48E12	9.5	1	0	0	100
N48E23	6.4	1	0	0	100
N48E31	9	1	0	0	100
N48E32	12.3	1	0	0	100
N49E4	4.7	0	0	0	0
N49E11	9.4	1	0	0	100
N50E9	6.8	1	0	0	100
N50E11	3.1	0	0	0	0
N50E18	6.6	1	0	0	100
N51E7	10.3	1	0	0	100
N51E17	6.4	1	0	0	100
N51E19	6.5	1	1	1	111
N51E20	4.4	0	1	1	11
N51E22	8.1	1	0	0	100
N51E23	5.9	0	0	0	0
N51E24	8.2	1	0	0	100
N52E1	14.3	1	1	1	111

N52E4	11	1	0	0	100
N52E31	10.4	1	0	0	100
N53E2	13.8	1	0	1	101
N53E5	11.1	1	0	0	100
N53E12	4.2	0	0	0	0
N53E19	8.5	1	1	0	110
N54E26	2.9	0	0	0	0
N54E28	8.9	1	0	0	100

APPENDIX C. Attributes of Projectile Points Observed During Survey

Key:

Condition 1 = Incomplete
2 = Complete

If Unit_No blank, item not on transect

id	unit_no	specimen	style	material	condition	lt	la	lm	wm	wb	neck_width	thickness	weight	dsa	psa	noi	la_lt	lt_wm	wb_wm	lm_lt
N24E15		14	NOTTYPABL	OBSIDIAN	2	21.3	21.3	0.0	8.1	1.8	0.0	3.0	0.0	0	0	0	1.00	2.62	0.22	0.00
N24E15		15	OUTOFKEY	OPALITE	1	32.4	0.0	9.2	23.2	10.0	12.2	5.0	0.0	185	107	78	0.00	3.52	0.43	0.00
N24E15		17	HUMBOLDT	OPALITE	1	45.9	44.5	0.0	23.5	8.4	0.0	6.0	0.0	0	0	0	0.97	1.95	0.36	0.00
N38E29		25	GATECLIFF	OPALITE	1	40.1	39.0	5.1	23.4	10.3	9.3	9.0	0.0	160	97	63	0.97	1.71	0.44	0.13
N38E29		27	LSN	OPALITE	1	31.2	31.2	0.0	17.8	12.9	9.1	7.0	0.0	232	141	91	1.00	1.75	0.73	0.00
N35E8		31	NOTTYPABL	OPALITE	1	39.2	0.0	0.0	22.1	0.0	0.0	5.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N35E8		32	STEMMED	OPALITE	2	61.8	61.8	26.7	27.3	15.9	17.8	6.0	9.9	0	0	0	1.00	2.26	0.58	0.43
KC-4		43	NOTTYPABL	OPALITE	1	19.5	19.5	0.0	13.4	0.0	5.4	3.0	0.0	132	108	24	0.00	0.00	0.00	0.00
KC-4		44	ELKO	OPALITE	1	36.2	36.2	3.0	26.1	14.7	14.5	3.9	0.0	142	132	10	1.00	0.00	0.00	0.00
KC-3		45	NOTTYPABL	OPALITE	1	35.2	0.0	0.0	19.2	0.0	0.0	3.0	0.0	122	0	0	0.00	0.00	0.00	0.00
KC-3		46	ELKO	OPALITE	2	32.3	32.3	5.5	21.0	12.4	10.3	6.1	0.0	153	110	43	1.00	0.00	0.00	0.00
KC-3		47	GATECLIFF	OPALITE	1	46.7	43.1	12.5	24.9	11.0	15.9	4.5	0.0	149	72	77	0.92	0.00	0.00	0.00
N4546800E536500-UTM		48	STEMMED	BASALT	2	52.3	52.3	30.2	27.0	17.1	19.6	7.7	9.7	0	0	0	1.00	1.94	0.63	0.58
ML-3		49	ROSEGATE	OBSIDIAN	2	25.9	25.9	9.2	13.1	7.9	5.8	2.0	0.0	152	119	33	1.00	1.98	0.60	0.36
ML-3		50	ROSEGATE	OPALITE	1	25.2	25.2	2.2	19.7	9.1	7.3	3.0	0.0	115	103	12	1.00	1.28	0.46	0.09
N15E22	N15E22	51	NOTTYPABL		0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N18E30	N18E30	41	GATECLIFF	OPALITE	2	31.6	30.3	4.5	23.4	9.0	0.0	5.0	0.0	160	56	104	0.96	0.00	0.00	0.00
N24E7	N24E7	38	ROSEGATE	OPALITE	1	17.8	17.8	3.3	16.9	6.9	6.1	4.0	0.0	123	112	11	1.00	1.06	0.41	0.19
N26E12	N26E12	37	ELKO	OPALITE	1	38.8	35.5	7.1	24.4	16.0	13.8	5.0	0.0	154	110	44	0.92	1.59	0.66	0.19
N33E9	N33E9	33	DSN	OPALITE	2	23.0	19.6	0.0	13.3	13.3	7.8	2.5	0.0	185	153	30	0.00	0.00	1.00	0.00
N33E9	N33E9	34	NOTTYPABL	OPALITE	1	31.3	0.0	0.0	16.2	0.0	0.0	4.0	0.0	125	102	24	0.00	1.94	0.00	0.00
N33E9	N33E9	36	NOTTYPABL	OBSIDIAN	1	21.5	0.0	0.0	13.6	0.0	0.0	5.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N35E10	N35E10	30	NOTTYPABL	OPALITE	1	47.0	47.0	0.0	24.3	24.3	0.0	7.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N35E29	N35E29	52	ELKO	OPALITE	1	30.1	30.1	0.7	20.8	20.0	13.2	7.0	0.0	160	130	30	1.00	1.44	0.96	0.02
N36E12	N36E12	29	GATECLIFF	OPALITE	1	30.3	27.1	13.0	17.8	14.9	11.2	6.0	0.0	303	61	242	0.90	0.00	0.00	0.00
N37E12	N37E12	28	OUTOFKEY	OPALITE	1	23.3	23.3	1.7	15.8	10.0	6.7	3.0	0.0	163	56	107	1.00	1.48	0.64	0.08
N38E29	N38E29	23	OUTOFKEY	OPALITE	2	37.8	34.2	0.0	14.1	13.6	0.0	5.0	0.0	0	0	0	0.90	2.68	0.96	0.00
N38E29	N38E29	24	NOTTYPABL	BASALT	1	18.0	0.0	0.0	30.7	0.0	0.0	7.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N38E29	N38E29	26	NOTTYPABL	OPALITE	1	36.4	0.0	0.0	10.5	0.0	0.0	5.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N39E23	N39E23	40	ELKO	OPALITE	1	36.1	32.1	10.9	26.5	17.0	13.5	4.0	0.0	198	117	81	0.89	0.00	0.65	0.00
N47E26	N47E26	13	ELKO	OPALITE	1	0.0	0.0	5.7	0.0	17.9	12.0	4.0	0.0	146	135	11	1.00	0.00	0.00	0.00
N47E5	N47E5	22	NOTTYPABL	OPALITE	1	0.0	0.0	6.2	24.5	14.0	13.6	6.0	0.0	164	102	62	0.00	0.00	0.57	0.00
N48E0	N48E0	12	HUMBOLDT	OPALITE	1	44.6	39.1	0.0	24.4	10.0	0.0	6.0	0.0	0	0	0	0.87	1.83	0.41	0.00
N48E12	N48E12	21	NOTTYPABL	OPALITE	1	50.4	50.4	0.0	22.1	13.1	0.0	11.0	0.0	0	0	0	1.00	2.28	0.59	0.00
N48E8	N48E8	39	LSN	OPALITE	2	38.2	38.2	11.0	18.4	18.4	10.3	2.0	0.0	0	156	0	0.00	0.00	0.00	0.00
N49E4	N49E4	19	ELKO	OPALITE	1	39.3	35.5	7.0	20.5	13.0	12.3	5.0	0.0	172	133	39	0.90	1.92	0.63	0.18
N49E4	N49E4	20	ELKO	OPALITE	1	0.0	0.0	5.3	20.2	12.5	9.8	5.0	0.0	153	124	29	1.00	0.00	0.62	0.00
N51E19	N51E19	11	NOTTYPABL	OPALITE	1	22.3	0.0	0.0	21.5	0.0	0.0	4.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N51E24	N51E24	10	NOTTYPABL	OPALITE	1	17.0	0.0	0.0	12.4	0.0	0.0	3.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N53E19	N53E19	18	OUTOFKEY	OBSIDIAN	1	35.3	35.3	0.0	19.1	11.0	10.5	4.0	0.0	135	119	16	1.00	1.85	0.58	0.00
N54E26	N54E26	2	OUTOFKEY	OPALITE	2	34.7	32.4	5.7	19.0	10.2	9.0	8.0	0.0	152	114	38	0.94	1.83	0.54	0.16
N54E26	N54E26	3	OUTOFKEY	OPALITE	1	0.0	0.0	0.0	0.0	0.0	9.6	6.0	0.0	0	124	0	0.00	0.00	0.00	0.00
N54E26	N54E26	4	ELKO	OPALITE	1	34.0	29.7	10.5	21.8	15.5	10.2	4.5	2.0	162	140	22	0.87	1.56	0.71	0.31
N54E26	N54E26	5	NOTTYPABL	OPALITE	1	17.0	0.0	0.0	14.5	0.0	0.0	2.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N54E26	N54E26	6	NOTTYPABL	OPALITE	1	34.2	0.0	0.0	19.8	0.0	0.0	4.0	0.0	0	0	0	0.00	0.00	0.00	0.00
N54E26	N54E26	7	ROSEGATE	OPALITE	1	0.0	0.0	0.0	19.8	9.4	8.8	6.0	0.0	165	129	35	0.00	0.00	0.00	0.00
N54E26	N54E26	8	ROSEGATE	OBSIDIAN	2	27.1	27.1	4.5	15.7	8.5	6.7	4.0	0.0	175	116	59	0.00	0.00	0.00	0.00
N54E26	N54E26	9	HUMBOLDT	OPALITE	2	33.4	31.8	0.0	13.6	12.3	0.0	3.5	0.0	0	0	0	0.95	2.46	0.90	0.00
N54E28	N54E28	1	ROSEGATE	OPALITE	2	32.1	32.1	5.6	15.2	8.7	6.4	3.0	0.0	134	119	15	1.00	2.11	0.57	0.17
N8E5	N8E5	42	NOTTYPABL	OBSIDIAN	1	31.7	0.0	0.0	16.7	0.0	0.0	1.0	0.0	0	0	0	0.00	0.00	0.00	0.00

APPENDIX D. Listing of Artifacts Observed During Survey

Key:

Bif	= Biface
Prfrm	= Preform
Asscob	= Assayed Cobble
ModChunk	= Modified Chunk
Percstls	= Percussion Tools
Flktls	= Flake Tools
Exoticma	= Exotic Material
Botglass	= Bottle Glass
Histcera	= Historic Ceramics
Ammu	= Ammunition
Minequip	= Mining Equipment
Otherhis	= Other Historic

unit_no	slope	stone	water	bif	point	prefrm	cores	asscob	modchnk	metate	mano	mortar	pestle	percstls	flktls	exoticmat	botglass	cans	histceram	ammu	autopart	minequip	otherhist
N37E31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N37E32	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N38E1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N38E14	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N38E19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N38E23	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N38E29	0	1	0	16	3	1	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0
N39E14	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N39E23	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N39E26	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
N39E28	0	0	0	8	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0
N39E7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	4	20	20
N3E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N41E12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N41E19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N41E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0
N42E12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N43E22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N43E25	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N43E28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N44E10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N44E13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N45E12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N45E13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
N45E14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
N46E0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N46E13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N46E2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N46E22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
N46E4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	44	0	0	0	0	1
N47E1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	0	0	0	1	0
N47E11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N47E18	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N47E19	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N47E26	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N47E5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	18	0	5	2	36	56
N48E0	1	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
N48E12	1	0	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N48E2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
N48E23	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
N48E31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N48E32	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N48E5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	20	1	0	0	0	2
N48E8	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N49E11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	2	1
N49E4	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
N50E11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N50E18	1	0	0	0	0	1	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0
N50E9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N51E17	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
N51E19	1	1	1	3	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
N51E20	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N51E22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N51E23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N51E24	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0
N51E7	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N52E1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N52E31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N52E4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
N53E12	0	0	0	1	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N53E19	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N53E2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N53E5	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N54E26	0	0	0	14	8	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
N54E28	1	0	0	7	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
N8E10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
N8E16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N8E3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N8E5	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1
N9E3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

unit_no	slope	stone	water	bif	point	prefrm	cores	asscob	modchnk	metate	mano	mortar	pestle	percstls	flktls	exoticmat	botglass	cans	histceram	ammu	autopart	minequip	otherhist
N10E16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N10E17	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N11E23	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
N12E19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
N13E13	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N13E15	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N13E16	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N13E25	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N14E10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N14E16	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N14E18	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N14E24	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N15E1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N15E11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N15E16	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N15E22	0	0	0	5	1	0	2	9	8	0	0	0	0	2	2	0	0	0	0	0	0	0	0
N16E19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N16E26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N16E27	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N16E31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N16E4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N16E7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N16E8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N17E10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N17E16	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N17E21	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
N17E24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N17E6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N17E9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N18E28	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N18E30	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N18E6	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N20E17	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
N20E5	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N20E9	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
N21E30	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N22E12	1	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
N22E2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
N22E3	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2
N23E11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N23E24	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N23E25	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N24E15	1	1	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N24E20	1	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N24E32	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N24E4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N24E7	1	0	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N25E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
N25E15	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N25E2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N25E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N26E12	0	0	1	13	1	2	0	0	0	0	0	0	0	1	3	0	5	0	0	0	0	0	0
N26E8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N27E16	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N29E15	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N29E4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N29E8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
N31E17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N31E29	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N32E1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N33E17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N33E9	0	0	0	12	3	0	2	4	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0
N34E0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N34E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N34E11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
N34E4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N35E10	0	0	0	15	1	3	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1
N35E13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N35E15	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
N35E29	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N35E32	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N35E8	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N36E12	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N36E2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N36E20	0	1	1	6	0	0	0	6	6	0	0	0	0	0	0	2	0	0	0	0	0	0	0
N36E21	0	1	1	29	0	0	2	50	6	0	0	0	0	2	0	0	1	0	0	0	0	0	1
N36E29	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N37E12	1	1	0	3	1	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N37E18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
N37E19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
N37E20	0	1	1	6	0	0	0	20	16	0	0	0	0	2	0	2	0	3	0	0	0	0	0

APPENDIX E. Listing of Prehistoric, Historic, and Modern Features Observed During Survey

unit_no	slope	stone	water	featid	type2	dim1	dim2	comments	continued
N11E23	0	0	0	1	REDUCTION SC	5.00	10.00	EARLY REDUCTION LRG. FLKS. WT/BG VERY DIFFUSE *	AND MELTS INTO BACKGROUND
N12E19	0	0	0	1	MINING FTR	10.00	2.50	HISTORIC BULLDOZER CUT	
N12E19	0	0	0	2	MINING FTR	12.00	5.00	HISTORIC BULLDOZER CUT	
N12E19	0	0	0	3	REDUCTION SC	1.00	1.00	AREA OF OPALITE COBBLES, INTERMIXED W/ JASPER *	AND BASALT NO CULTURAL MATERIAL OBSERVED 2 BANDED TRANSULCENT BLACK CHERT FLKS AND 1 OPALITE, 1 INTERIOR FLAKE, 2 MED. STG. B.T.F.'S NO HT
N13E15	0	0	0	1	REDUCTION SC	45.00	20.00	VERY DIFFUSE INTER/MIDD BT SOME HT	
N13E16	0	0	0	1	REDUCTION SC	6.00	6.00	DIVERSE MATERIAL COBBLE REDUCTION OF GREY BRECCIA*	SOME FLAKE HEAT
N13E25	1	0	0	1	MINING FTR	20.00	5.00	BULLDOZER CUT/OPALITE OUTCROP	
N13E25	1	0	0	2	MINING FTR	30.00	10.00	DOZIER PUSH	
N14E18	0	0	0	1	REDUCTION SC	35.00	10.00	VERY DIFFUSE TOTAL FLKS 10 TO 15 HT LATE BFT FLKS*	AND 1 (4E) BIFACE FRAG
N14E18	0	0	0	2	REDUCTION SC	30.00	40.00	VERY SPARSE L.S. W/ STG. 4 BIF. MID. STG. RED.	125 FLKS NO HT
N14E24	1	0	0	1	MINING FTR	10.00	4.00	BULLDOZER CUT	
N15E16	0	0	0	1	OUTCROP QURR	50.00	30.00	JASPER COBBLE, BOULDER QUARRY EAR. STG. RED. ONLY*	3 HAMMERSTONE SPALLS PURPLE/BROWN BANDED
N15E16	0	0	0	2	REDUCTION SC	3.00	7.00	EARLY STG. RED. LRG. FLKS. PURPLE RED JASPER	
N15E16	0	0	0	3	OUTCROP QURR	20.00	50.00	ASSAYING AND MINIMAL REDUCTION OF JASPER COBBLES*	ERODING OUT OF HILLSIDE PROBABLY PART OF MELINDA'S TRANSECT 3 FEATURE
N15E22	0	0	0	1	COBBLE QURRY	15.00	10.00	EARLY REDUCTION OF COBBLE	
N16E19	1	0	0	1	MINING FTR	20.00	10.00	DOZER CUT, OPALITE BOULDERS, TUFF	
N16E4	0	0	0	1	REDUCTION SC	10.00	10.00	EARLY TO MID. RED. SCATTER SOME HT*	LESS THAN 50 FLKS PER METER SQ
N16E4	0	0	0	2	REDUCTION SC	20.00	20.00	LATE STG. RED. BIF. FRAG (M4) HT*	UP TO 50 FLKS PER METER SQ
N16E4	0	0	0	3	HISTRC DUMP	10.00	8.00	6 HOLE IN TOP 1 FRUIT AND VEG. CIRCULAR CUT	
N16E4	0	0	0	4	REDUCTION SC	20.00	0.00	LIGHT TO SPARSE DENSITY SCATTER	
N17E10	0	0	0	1	REDUCTION SC	0.00	0.00	SPARSE, NO HT, MID. THINNING	
N17E16	0	0	0	1	REDUCTION SC	1.00	0.00	SPARSE OPLAITE LATE BFT, HT FLK. SCATTER	
N17E16	0	0	0	2	HISTRC DUMP	0.00	0.00	HOLE IN TOP CAN PUNCH OPEN	
N17E24	1	0	0	1	ROCK RING	8.00	5.00	POSS. 3 ROCK BLINDS/RINGS WITHIN A NATURAL TALUS*	(RHYOLITE) POCKET, OVERLOOKING DRAINAGE TO SOUTH
N18E28	1	0	0	1	ROCKSHELTER	70.00	70.00	WET MOSS AND ROCK FLOORED *	LITHICS: VERY LATE BIF. THINNING, WHITE OPALITE ONLY NO HT, ONE TYPE INCLUDES PRESSURE. CA 10 CM DEEP CULT BEARING, SILT IN REAR BUT WET, MOSS COVERED, MUCH ROOF SPILL.
N18E30	1	0	0	1	REDUCTION SC	5.00	8.00	SPARSE SCATTER BEIGE, LATE STG. BIF. RED. DEB. HT	
N18E30	1	0	0	2	HISTRC WALL	0.00	0.00	HISTORIC ROCK FENCE W/ ASSOC. BARBED WIRE *	HW2A PROBABLY DAM. ASSOC. W/ ROCK FENCE BARBS= FLAT GALVANIZED TWO PRONGED, MACHINE CUT.
N18E30	1	0	0	3	HISTRC WALL	0.00	0.00	CAUSED SOME DAMING/ BACKING 1M DEPOSITION *	BEHIND DAM
N18E6	1	0	0	1	REDUCTION SC	4.00	15.00	LIGHT DENSITY OF SMALL MED. STG./HT UNKNOWN	
N18E6	1	0	0	2	REDUCTION SC	3.00	0.00	1 BIFACE AND SPARSE FLAKES	
N20E17	0	0	1	1	REDUCTION SC	2.00	2.00	BASALT LARGE PRIMARY	
N20E17	0	0	1	2	REDUCTION SC	15.00	10.00	WHITE OPALITE MID-LATE SPARSE HT	
N20E5	1	0	0	1	REDUCTION SC	4.00	25.00	SPARSE OPALITE FLKS CH BIFACE	
N20E9	1	0	0	1	REDUCTION SC	10.00	10.00	AT CONFLUENCE OF DRAINAGE 3 MID. STG. OPALITE FLKS	PROBABLY BIFACE THINNING HEAT TREATED
N20E9	1	0	0	2	OTHER,MODRN	20.00	10.00	SMALL EARTH DAM AND DRY POND OR PROSPECT	
N21E30	1	0	0	1	REDUCTION SC	4.00	3.00	SMALL REDUCTION STATION, HT, LATE BIF. REDUCTION*	MOD. DENSITY POSSIBLE SINGLE EVENT LOCUS ONE BIFACE FRAG
N21E30	1	0	0	2	REDUCTION SC	10.00	10.00	SMALL LS, LATE REDUCTION, SOME HT	
N22E12	1	0	0	1	REDUCTION SC	20.00	20.00	VERY SPARSE LATE STG. RED. SCATTER*	SOME PRESSURE FLAKING. TWO METATE FRAGS AND A LATE STG. 4 BIFACE FRAG. 1 TABULAR BASALT, 1 DENSE BASALT.
N22E2	0	0	0	1	REDUCTION SC	10.00	10.00	VERY DIFFUSE SCATTER 5.2 flakes/m2	
N22E2	0	0	0	2	REDUCTION SC	10.00	3.00	LIGHT DENSITY, EXCLUSIVELY THIN LARGE, OPALITE*	FLAKES, EARLY THINNING STG.
N22E2	0	0	0	3	REDUCTION SC	20.00	7.00	OPALITE (LIGHT DENSITY) CHUNKY AND EARLY *	THINNING STG. W/ SMALL FLAKES W/ BATTERED EDGES
N22E2	0	0	0	4	REDUCTION SC	50.00	20.00	TWO OPALITE TOOLS (BIFACE STG. 4 AND *	LIZARD SHAPED UNIFACE) LIGHT DENSITY MID TO LATE THINNING STG. FLAKES.
N22E3	0	0	0	1	REDUCTION SC	36.00	30.00	EXTENDS NORTH OUT OF QUAD.	
N22E3	0	0	0	2	REDUCTION SC	40.00	30.00	MIX OF OPALITE AND JASPER AND OBSIDIAN *	LATE STG. RED DOMINANT, EARLY STG. SOME HEAT TREATMENT, LIGHT DENSITY
N22E3	0	0	0	3	REDUCTION SC	80.00	0.00	OPALITE/JASPER SPARSE DENSITY CHUNKS AND MED. FLKS	
N24E15	1	1	1	1	REDUCTION SC	20.00	20.00	DENSE BASE CAMP?*	SEVERAL UNTYPEABLE POINTS; OTHERS ARE TYPEABLE; BASALT CORES; 4 METATE FRAGS, OBSIDIAN LATE PROJECTILE POINT HEAT TREATMENT, A NUMBER OF STG. 4 BIFACES (ALSO HT); OBSIDIAN, BASALT, MULTIPLE OPALITE COLORED DEBITAGE MID. TO LATE STG.; BASALT HAMMERSTONE, OPALITE DRILL.
N24E15	1	1	1	2	REDUCTION SC	0.00	0.00	MID TO LATE BIF. REDUCTION*	WHITE OPALITE, ON SLOPE; RARER SLATE GREY OPALITE; STG. 5 BIFACE ON TRANSECT 10 FLKS PER METER SQ
N24E15	1	1	1	3	MINING FTR	30.00	6.00	BULLDOZER CUT PROSPECT	
N24E15	1	1	1	4	REDUCTION SC	0.00	0.00	SEE TRANSECT 3-5	
N24E15	1	1	1	5	REDUCTION SC	55.00	45.00	+STG. 5 BIF., OBSIDIAN, 45% SMALL BASALT*	MULTI COLORED OPALITE, LIGHT DENSITY 80% HEAT TREATED MAX DENSITY PER METER SQ
N24E15	1	1	1	6	REDUCTION SC	45.00	20.00	2 BIF. STG. 4, MULTI COLORED OPALITE*	36/sq.m MAX DENSITY; 40% SMALL, 85% HEAT TREATED
N24E15	1	1	1	7	REDUCTION SC	15.00	10.00	2 BIF. TIP FRAGS; WHITE OPALITE*	MED. TO SMALL SIZE (60% SMALL) 80% NOT HEAT TREATED; MORE BIFACES OFF 4m TRANSECT LINE.
N24E15	1	1	1	8	REDUCTION SC	15.00	0.00	SPARSE LITHIC SCATTER WHITE, NO HT, MED-SMALL FLKS	

unit_no	slope	stone	water	featid	type2	dim1	dim2	comments	continued
N24E20	1	0	0	1	REDUCTION SC	2.00	2.00	LIGHT DENSITY SCATTER OF PREDOMINANT WT/OPALITE*	LATE, HT, SMALL-MED. INCLUDES FOUR LRG. BIFACE FRAGS NOTE DEB. IS NOT OF SAME MATERIAL AS BIF. FRAG.
N24E20	1	0	0	2	REDUCTION SC	7.00	5.00	REDUCTION STATION, MID-LATE THINNING, HT.*	MODERATE DENSITY WHITE OPALITE AND PRESSURE FLKS.
N24E20	1	0	0	3	REDUCTION SC	10.00	5.00	25-35 WT/OPALITE BFT MIDDLE NO HT	
N24E20	1	0	0	4	REDUCTION SC	5.00	5.00	10+ FLKS. WT/OPALITE LBFT	
N24E20	1	0	0	5	REDUCTION SC	10.00	15.00	30-40 LBFT FLKS. OF WT/OPALITE, HT	
N24E32	0	0	0	1	REDUCTION SC	10.00	30.00	LIGHT LITHIC SCATTER MID-LATE RED. HT, FEW CHUNKY	
N24E4	0	0	0	1	OUTCROP QURR	30.00	20.00	SOME SILICIFIED MATERIAL BUT LITTLE EVIDENCE USE	
N24E4	0	0	0	2	REDUCTION SC	8.00	30.00	E, L BIFACE THINNING SOME HT DIFFUSE	
N24E4	0	0	0	3	REDUCTION SC	2.00	4.00	INTERIOR LATE BIF. THINNING NHT	
N24E7	1	0	0	1	REDUCTION SC	20.00	30.00	A FEW CULTURAL FLAKES MIXED IN WITH NAT. BROK'N OP	
N24E7	1	0	0	2	REDUCTION SC	6.00	5.00	OPALITE SCATTER OF ca 35 FLAKES; NONE HT*	LATE STG. B.T.F; MEDIUM TO SMALL SIZE
N24E7	1	0	0	3	REDUCTION SC	45.00	30.00	VERY DIFFUSE WT/BG ; BUTTERSCOTCH; LATE	
N24E7	1	0	0	4	REDUCTION SC	65.00	50.00	LIGHT MOD. DENSITY MID-LATE REDUCTION 5 BIF. FRAG*	IN 2 SQ M
N24E7	1	0	0	5	REDUCTION SC	20.00	10.00	MOD. DENSITY MID REDUCTION	
N25E5	0	0	0	1	REDUCTION SC	15.00	15.00	MID TO LATE STG. LITH. SCATTER, STG. 4 BIF. FRAG*	20 FLKS PER METER SQ
N25E5	0	0	0	2	REDUCTION SC	20.00	30.00	LIGHT; OPALITE; HT, 70% SMALL FLKS. *	27 FLKS PER METER SQ
N26E12	0	0	1	1	REDUCTION SC	4.00	3.00	WITHIN MODERATE SCATTER MID/LATE BT; HT	VARIOUS MATERIALS, OBSIDIAN FLK
N26E12	0	0	1	2	MOD ROAD	5.00	0.00	OVERGROWN BULLDOZED ROAD	
N26E12	0	0	1	3	MOD ROAD	5.00	0.00	POSSIBLY BULLDOZED ROAD	
N26E12	0	0	1	4	OTHER,MODRN	0.00	0.00	EARTH DAM; AND DRY CATTLE POND	
N26E12	0	0	1	5	MOD ROAD	5.00	0.00	SEE FEATURE A	
N26E12	0	0	1	6	REDUCTION SC	10.00	10.00	LITHIC WITH ELKO POINT: HT AND BIFACES	
N26E12	0	0	1	7	REDUCTION SC	30.00	30.00	DIFFUSE SCATTER MID TO LATE	
N26E8	1	0	0	1	REDUCTION SC	50.00	50.00	SPARSE L.S MID TO LATE STG. RED. SCATTER*	METATE TABULAR BASALT FRAG. 2 STG. 4 BIF. TIP; MINOR HTREATMENT
N27E16	1	0	0	1	QUARRY PIT	70.00	100.00	REDUCTION NO BIFACES MED. QUALITY*	MOSTLY CREAM RASPBERRY BANDING. PIT INTERCEPTS SLOPE 40m SURFACE OUTCROP TO ACCESS BETTER STUFF.
N27E16	1	0	0	2	QUARRY PIT	20.00	20.00	LOW GRADE PINK CREAM REDUCTION *	POSSIBLE INTRUSION INTO SLOPE 20m BELOW SMALL OUTCROP PIT IS EPHEMERAL IF THERE AT ALL.
N27E16	1	0	0	3	REDUCTION SC	20.00	20.00	BIF. THINNING FLKS. WT/ OPALITE, 200 FLKS.	
N29E4	0	0	0	1	HISTRC ROAD	4.00	0.00	PROBABLE HISTORIC ROAD	
N29E4	0	0	0	6	MOD ROAD	5.00	0.00	PROBABLY LESS THAN 50 YEARS OLD	
N31E17	0	0	0	1	MINING FTR	10.00	20.00	RECTANGULAR BULLDOZED TRENCH	
N31E17	0	0	0	2	MINING FTR	10.00	20.00	RECTANGULAR BULLDOZED TRENCH	
N31E17	0	0	0	3	REDUCTION SC	20.00	20.00	LIGHT EARLY STG. REDUCTION WT/ OPALITE *	NO ACUTE PLATFORM
N31E17	0	0	0	4	REDUCTION SC	50.00	50.00	WT/OPALITE SRG. 3 50% HEAT TREATMENT	
N31E17	0	0	0	5	MINING FTR	10.00	25.00	NO OPALITE OUTCROP	
N31E17	0	0	0	6	MINING FTR	20.00	10.00	NO OPALITE OUTCROP	
N31E17	0	0	0	7	MINING FTR	10.00	0.00	BULLDOZER SCRAPE	
N31E29	0	1	0	1	OUTCROP QURR	120.00	90.00	EXTENSIVE OQ OF LOW BG/WT/OP OF BOULDERS*	LIGHT-MED. HEAVY DEB. SCATTER. MIX BIF. RED. MUCH DEBRIS
N31E29	0	1	0	2	OUTCROP QURR	30.00	50.00	OUTCROP QUARRY OF OLD BOULDERS QUADRANT*	SOUTH BOUNDRY UNKNOWN. MOD-HEAVY MIXED BIF. REDUCTION W/ABUNDANT?
N32E1	1	0	0	1	REDUCTION SC	1.00	0.00	MINIMAL ASSAY OF LOW QUALITY WT/OPALITE *	10 EARLY FLKS. AND ANGULAR DEBRIS
N33E17	1	0	0	1	MINING FTR	15.00	5.00	DOZER CUT	
N33E17	1	0	0	2	MINING FTR	10.00	20.00	DOZER TRENCH SHALLOW	
N33E17	1	0	0	3	MINING FTR	15.00	10.00	DOZER TRENCH SHALLOW	
N33E17	1	0	0	4	MINING FTR	15.00	15.00	PIT	
N33E17	1	0	0	5	MINING FTR	15.00	5.00	TRENCH	
N33E9	0	0	0	1	COBBLE QURRY	110.00	60.00	GOES BEYOND QUADRANT TO SOUTH COMPRISED OF*	GOOD QUALITY BASALT COBBLES; NUMEROUS ONES (>10) ASSAYED, AT LEAST ONE CORE. SOME OPALITE FLAKES NEAR ASSAYED COBBLE CONCENTRATION.
N33E9	0	0	0	2	REDUCTION SC	2.00	2.00	DENSER CONS. W/ A 2M x 2M M/L BIF. THINNING *	NHT, DISCRETE REDUCTION, VARIETY OF NEW MATERIAL
N33E9	0	0	0	3	REDUCTION SC	0.00	0.00	MOSTLY WHITE NON-HT LRG. TO MED.	
N34E11	0	0	0	1	MOD ROAD	2.00	0.00	NOT ON TOPO	
N34E11	0	0	0	2	REDUCTION SC	3.00	3.00	SMALL	
N34E11	0	0	0	3	MINING FTR	5.00	10.00	BULLDOZER CUT OR MINNING PIT	
N34E11	0	0	0	4	REDUCTION SC	20.00	20.00	DIFFUSE MID TO LATE WHITE HT	
N34E11	0	0	0	5	MINING FTR	10.00	13.00	1M DEEP MAYBE MERCURY MINNING PROSPECT PIT*	LOOKS TOO OLD FOR RECENT GOLD WORKS
N34E11	0	0	0	6	REDUCTION SC	10.00	13.00	LRG TO SMALL FLK SCATTER; WHITISH GREY B.T.F'S *	NO HEAT TREATMENT, SPARSE SCATTER
N34E4	0	0	0	1	MOD ROAD	4.00	0.00		
N35E10	0	0	0	1	REDUCTION SC	3.00	3.00	HT, BIF.	
N35E10	0	0	0	2	REDUCTION SC	5.00	5.00	LOTS OF HT LRG. BIF. EML MED. SEV. OP. VARIETIES	
N35E10	0	0	0	3	REDUCTION SC	20.00	50.00	LRG. LITHIC SCATTER EXTENDING WELL OUT OF QUAD.*	(WEST) AND INTO HEAVY SAGE; MID TO LATE; LOTS OF HT; PRIMARILY WHITE/ BEIGE
N35E10	0	0	0	4	REDUCTION SC	20.00	30.00	LRG, MED, SMALL, B.T.F'S OF WT/ TRANSLUCENT GREY	
N35E10	0	0	0	5	REDUCTION SC	0.00	0.00	OPALITE FLKS SPARSE TO LIGHT DENSITIES NO HT*	ONE EARLY STG. 4 BIF. FRAG
N35E10	0	0	0	6	REDUCTION SC	5.00	5.00	SCATTER OF 30 LRG. MED. B.T.F. NO HT LIGHT DENSITY	
N35E10	0	0	0	7	REDUCTION SC	12.00	10.00	SEE N35 E10 LRS CONT. WRKSHT P. 2 OF 2	
N35E10	0	0	0	8	REDUCTION SC	10.00	10.00	SEE N35 E10 LRS CONT. WRKSHT P. 2 OF 2	
N35E13	1	0	0	1	MINING FTR	10.00	5.00	PROBABLE PROSPECT	
N35E15	0	1	0	1	MINING FTR	5.00	10.00	RECENT DOZER PROSPECT	
N35E15	0	1	0	2	MINING FTR	10.00	7.00	PROSPECT	
N35E15	0	1	0	3	MINING FTR	4.00	40.00	BULLDOZER CUT	

unit_no	slope	stone	water	featid	type2	dim1	dim2	comments	continued
N35E29	0	0	0	1	REDUCTION SC	0.00	0.00	GENERAL DIFFUSE FLK SCAT. IN BIG SAGE BRUSH COVER*	SEE MAP FOR DIAMETER
N35E29	0	0	0	2	REDUCTION SC	0.00	0.00	GENERAL DIFFUSE FLK SCAT. IN BIG SAGE BRUSH COVER*	SEE MAP FOR DIAMETER
N35E29	0	0	0	3	REDUCTION SC	0.00	0.00	GENERAL DIFFUSE FLK SCAT. IN BIG SAGE BRUSH COVER*	SEE MAP FOR DIAMETER
N35E32	1	0	0	1	CAIRN	0.00	0.00	2 CAIRNS-5 COURSE + 3 COURSE-HISTORIC?	
N35E8	0	0	0	1	REDUCTION SC	40.00	0.00	NHT M-L BIFACE THINNING	
N35E8	0	0	0	2	REDUCTION SC	5.00	5.00	HT BIF. E4	
N35E8	0	0	0	3	MINING FTR	20.00	6.00	MINING PROSPECTS (PROBABLE)	
N35E8	0	0	0	4	MINING FTR	15.00	5.00	MINING PROSPECTS (PROBABLE)	
N35E8	0	0	0	5	REDUCTION SC	20.00	10.00	WHITE OPALITE CHUNKY SHATTER AND THINNING FLKS*	OF MEDIUM TO SMALL SIZE. LIGHT DENSITY 100 TOTAL PIECES
N35E8	0	0	0	6	REDUCTION SC	120.00	90.00	SPARSE TO LIGHT DENSITY SCATTER OF WT/TAN/PURP*	OPALITE, MOSTLY MEDIUM SIZE, MID STG. REDUCTION FLKS., THIN AND FEW CHUNKY PIECES
N36E12	1	0	0	1	MINING FTR	15.00	6.00	PROSPECT	
N36E12	1	0	0	2	MOD ROAD	4.00	0.00	UN-MAPPED ROAD	
N36E12	1	0	0	3	REDUCTION SC	5.00	5.00	DIFFUSE ; MIDDLE; 50/50 HT	
N36E12	1	0	0	4	MOD ROAD	2.50	0.00	TWO TRACK	
N36E12	1	0	0	5	REDUCTION SC	40.00	10.00	SPARSE SCATTER OF WHITE GREY OPALITE SOME MED.FLK*	HEAT TREATED SHATTER, HEAT TREATED B.T.F. MID STG., 15 TOTAL
N36E12	1	0	0	6	MINING FTR	2.00	20.00	BULLDOZER CUT	
N36E12	1	0	0	7	MINING FTR	7.00	2.00	BULLDOZER CUT	
N36E12	1	0	0	8	COBBLE QURRY	40.00	30.00	GOOD QAULITY OPALITE	
N36E2	0	0	0	1	REDUCTION SC	2.00	2.00	WT/OPALITE LIGHT SCAATER OF FLKS. *	ASSAYED EARLY REDUCTION RAW
N36E20	0	1	1	1	REDUCTION SC	50.00	50.00	VERY OCCASIONAL SMALL TO MED. RED. AT LEDGE OPAL.*	SILICIFICATION ZONE 80
N36E20	0	1	1	2	QUARRY PIT	20.00	60.00	AT LEAST 2 SMALL Q PITS W/ MODERATE L.S. *	SURROUNDING THEM. GOOD QUALITY CREAM/ GREY (PITS - 3M X 2M X .5 DEEP)
N36E20	0	1	1	3	MINING FTR	0.00	0.00	PROBABLE MODERN MINING PIT IN DRAINAGE*	NICHE IN LOW CANYON WALL
N36E20	0	1	1	4	MINING FTR	20.00	10.00	DOZER TRENCHES*	10X15M
N36E20	0	1	1	5	MINING FTR	10.00	10.00	RECENT BULLDOZED PROSPECT	
N36E20	0	1	1	6	MOD ROAD	0.00	3.00	MODERN DOZER SCRAPE ROAD	
N36E20	0	1	1	7	MINING FTR	10.00	15.00	BULLDOZER CUT	
N36E20	0	1	1	7	QUARRY PIT	30.00	60.00	QUARRY PIT CONTAINING 6 QUARRY PITS *	DENSITY MODERATE; COLOR VARIATION MODERATE: MOSTLY WHITE, SOME RED, SOME BLUE AND WHITE,BANANA. OUTCROPPING OPALITE W/ QUARRING DEBRIS TO THE NORTH
N36E21	0	1	1	1	QUARRY PIT	60.00	143.00	SEE COMMENTS ON INVENTORY FORM CONT. SHEET*	TOO COMPLEX
N36E21	0	1	1	2	QUARRY PIT	30.00	15.00	SEE COMMENTS ON INVENTORY FORM CONT. SHEET*	TOO COMPLEX
N36E21	0	1	1	3	QUARRY PIT	10.00	15.00	SEE COMMENTS ON INVENTORY FORM CONT. SHEET*	TOO COMPLEX
N36E21	0	1	1	4	CAIRN	1.50	50.00	CAIRN OF OP. ADJACENT TO QP IN FEATURE A	
N36E21	0	1	1	5	QUARRY PIT	8.00	50.00	DIRT AND OPALITE PIT W/ BERM	
N36E21	0	1	1	6	MOD ROAD	0.00	0.00	RECENT DRILLERS ROAD AROUND ENTIRE PIT*	HIGH NUMBER OF BIFACES JUST EAST OF PIT
N36E21	0	1	1	7	CAIRN	1.50	1.50	CAIRN OF LESS THAN 50 SMALL OPALITE BOULDERS	
N36E21	0	1	1	8	REDUCTION SC	30.00	20.00	DENSE HEAVY SCATTER EAST QUARRY PIT AT S. EDGE	
N36E21	0	1	1	9	QUARRY PIT	3.00	2.00	SMALL PIT AND BOULDER BERM VERY SHALLOW *	1% PRIMARY REDUCTION
N36E29	0	0	0	1	REDUCTION SC	10.00	10.00	DIFFUSE LATE BIF. FLKS. AND 1 STG. 2 BIF. FRAG	
N36E29	0	0	0	2	REDUCTION SC	0.00	0.00	GENERAL DIFFUSE BIF. FLKS. IN SAGE COVERED AREA*	MIDDLE AND LATE BIFACE REDUCTION
N37E12	1	1	0	1	REDUCTION SC	11.00	7.00	LIGHT SCATTER OF WT/TAN OPALITE FLKS. *	SHATTER AND BIF. FRAGS; ONE SMALL EARLY STG. 4 BIF. FRAG; TWO LATE STG. 3 BIF. FRAGS; 30 MED. TO SMALL SIZE FLKS, MID TO LATE STG. REDUCTION
N37E18	0	0	0	1	MINING FTR	20.00	7.00	DEEP MOD. PROSPECT TRENCH COVERED W/RHYOLITE TUFF	
N37E18	0	0	0	2	OUTCROP QURR	10.00	25.00	POOR QUALITY WT/GREY OPALITE W/ SOME REAL FLKS.*	ASSOC. COBBLE CAIRN ON TOP OF OUTCROP
N37E18	0	0	0	3	MINING FTR	5.00	25.00	MODERN DOZER PROSPECT, CA 1M DEEP	
N37E18	0	0	0	4	MOD ROAD	3.00	0.00		
N37E18	0	0	0	5	PIT,UNK	7.00	7.00		
N37E18	0	0	0	6	MOD ROAD	3.00	0.00	TWO-TRACK ROAD REMAINS	
N37E18	0	0	0	7	MINING FTR	30.00	12.00	BULLDOZER CUT	
N37E18	0	0	0	8	MINING FTR	15.00	7.00	BULLDOZER CUT	
N37E19	0	1	0	1	OUTCROP QURR	14.00	20.00	OUTCROP QUARRY W/LITHIC SCATT; CHUNKY; PRIM. RED.*	LOW BOULDERS ONLY, NOT FINE QUALITY. LITHIC SCATTER 60M X 90M
N37E19	0	1	0	2	MINING FTR	7.00	12.00	DOZER PROSPECT PIT AND BERM	
N37E19	0	1	0	3	REDUCTION SC	40.00	0.00	AT NORTH END OF FEATURE*	HAVE SPARSE TO LIGHT SCATTER OF WHITE/BLUE OPALITE, MOSTLY LARGE TO MEDIUM B.T.F.'S EARLY STAGE TO MIDDLE. 200 FLAKES NEAR TRANSECT 4. ALSO1 EARLY STAGE 2 BIFACE FRAG. EST 1,000 FLAKES TOTAL.
N37E19	0	1	0	4	MINING FTR	20.00	8.00	HISTORIC MERCURY MINING PROSPECT PIT*	3 CIRCULAR RANGING FROM 2 TO 4 M IM DIAMETER ONE ROCK CAIRN ASSOC. TO EAST OF PITS. MILLED WOOD AND REBARB.
N37E19	0	1	0	5	REDUCTION SC	20.00	20.00	10 TO 15 FLKS ADMIST ALOT OF NATURAL COLLUVIUM	
N37E19	0	1	0	6	MINING FTR	5.00	5.00	HISTORIC PIT	
N37E20	0	1	1	1	MINING FTR	5.00	15.00	DOZER SCRAPE	
N37E20	0	1	1	2	QUARRY PIT	100.00	75.00	COMPLEX*	18+ PITS; INTENSE PRIMARY REDUCTION; SEVERAL PITS A METER PLUS DEEP. DISTURBED BADLY BY A BULLDOZER CUT THROUGH ITS DENSEST QUATER; 1000'S OF COBBLES.
N37E20	0	1	1	3	MINING FTR	40.00	20.00	DEEP DOZER PIT *	APPARENTLY THROUGH QUARRY PIT; LOTS OF WORKED COBBLES
N37E20	0	1	1	4	CAIRN	1.00	0.60	MINING CLAIM MARKER CAIRN?	
N37E20	0	1	1	5	MINING FTR	8.00	10.00	RECENT DOZER PROSPECT	

unit_no	slope	stone	water	featid	type2	diml	dim2	comments	continued
N37E20	0	1	1	6	OTHER,MODRN	20.00	25.00	EARTH DAM (2M TALL) SMALL RESERVIOR IN DRAINAGE	
N37E20	0	1	1	7	CAIRN	0.90	0.70	HISTORIC CAIRN	
N37E20	0	1	1	8	QUARRY PIT	105.00	30.00	TOO COMPLEX SEE FEATURE FORM	
N37E20	0	1	1	9	QUARRY PIT	60.00	15.00	QUARRY PIT COMPLEX CONTAINING OUTCROP*	QUARRIES TO THE NORTH AND 3 QUARRY PIT TO THE SOUTH . WHITE OPALITE AND TRANSLUCENT GREY/BLUISH
N37E20	0	1	1	10	OUTCROP QURR	15.00	30.00	OUTCROP QUARRY *	QUARRY PIT BERMS CONTAINING CHUNKY PRIMARY REDUCTION DEBRIS AND EARLY STAGE BIFACES. CONTAINING OF A LARGE LITHIC SCATTER. A QUARTZITE HAMMERSTONE AND AN UNASSOCIATED METATE FRAG. DEBITAGE WAS MODERATE AND SUGGESTIVE OF PRIMARY REDUCTION.
N37E32	0	1	0	1	QUARRY PIT	15.00	20.00	INSET INTO SLOPE AMID ABUNDANT OP COBBLES/*	BOULDERS WHICH MAY ALSO HAVE BEEN TOOLSTONE SOURCE
N37E32	0	1	0	2	OUTCROP QURR	20.00	0.00	SMALL MINIMAL USED OUTCROPS HARD MILK WT/OP*	LIGHT TO MEDIUM SCATTER LATE DEB. AND EARLY RED. DEB.
N38E14	1	1	0	1	MINING FTR	5.00	3.00	MINING PROBE	
N38E14	1	1	0	2	OUTCROP QURR	60.00	30.00	OUTCROP QUARRY; SOME COBBLE QUARRYING*	EVIDENCED AS WELL
N38E14	1	1	0	3	MINING FTR	28.00	10.00	BULLDOZER PUSH	
N38E14	1	1	0	4	MINING FTR	5.00	10.00	DOZER PROSPECT TRENCH/ BERM	
N38E14	1	1	0	5	MINING FTR	5.00	15.00	DOZER PROSPECT TRENCH/ BERM	
N38E29	0	1	0	1	REDUCTION SC	12.00	10.00	LBT NO HT ONE CONCENTR. EARLY BIF. TH.;	SINGLE BLADE
N38E29	0	1	0	2	REDUCTION SC	20.00	5.00	MID LATE BIF. RED. NO HT ALSO EARLY BIF. FLK TOOL	
N38E29	0	1	0	3	REDUCTION SC	5.00	5.00	VARIOUS MATERIALS; EARLY, LATE NO HT BIF RED.	
N38E29	0	1	0	4	REDUCTION SC	2.00	2.00	SMALL RED. GREY OPALITE MID TO LATE NO HT	
N38E29	0	1	0	5	REDUCTION SC	3.00	3.00	LRG. NO HT BIF. RED. EARLY LATE-MIDDLE	
N38E29	0	1	0	6	REDUCTION SC	2.00	3.00	MORE THAN ONE? HT PRESENT EARLY-MIDDLE-LATE	
N38E29	0	1	0	7	REDUCTION SC	3.00	4.00	BIF. RED. E,M.L WHT DIVERSE MAT.	
N38E29	0	1	0	8	REDUCTION SC	15.00	9.00	RED. OF LRG. FLK. OR BLK. STG. 2-3 RED. AND*	ADDTION MID-LATE BIF. RED. AT LEAST TWO DISTINCT MATERIALS; WHITE OPALITE
N38E29	0	1	0	9	REDUCTION SC	10.00	7.00	EARLY-MID-LATE STG. 3 BIF. FLK PINK GREY WHITE OP*	SOME HT ON LATE THINNING FLKS AN EARLY 4 BIF. FRAG
N38E29	0	1	0	10	MOD ROAD	5.00	0.00		
N38E29	0	1	0	11	REDUCTION SC	3.00	2.00	EARLY STG. 2-3 THINNING FLKS IN SMALL FEATURE	
N38E29	0	1	0	12	MOD ROAD	5.00	0.00		
N38E29	0	1	0	13	MOD ROAD	30.00	3.00	DOZER CUT	
N38E29	0	1	0	14	REDUCTION SC	15.00	10.00	LITHIC SCATTER ASSOC. W/ CUT MID TO LATE RED. *	WHITE NON HT OPALITE
N38E29	0	1	0	15	MOD ROAD	45.00	3.00	EXTEND OUT OF QUADRANT	
N38E29	0	1	0	16	REDUCTION SC	15.00	15.00	DIFFUSE SCATTER OF EARLY MID BIF. RED. NOT MUCH HT	
N38E29	0	1	0	17	REDUCTION SC	20.00	10.00	DIFFUSE SCATTER OF EARLY MID BIF. RED.*	MULTIPLE COLORS (GREY, BUTTERSCOTCH, AND WHITE) NOT MUCH HT
N38E29	0	1	0	18	REDUCTION SC	15.00	10.00	DIFFUSE SCATTER E,M AND LATE, *	BUT PRIMARILY EARLY RED. WHITE BEIGE OPALITE HT W/ LATE RED. ONE HT BIF. FRAG
N38E29	0	1	0	19	REDUCTION SC	30.00	45.00		
N38E29	0	1	0	20	MINING FTR	10.00	5.00	BLADE CUT PROSPECT	
N38E29	0	1	0	21	CAIRN	0.00	0.00		
N38E29	0	1	0	22	REDUCTION SC	2.00	2.00	WT/BG OPALITE OUTREH EARLY RED. NON HT	
N38E29	0	1	0	23	MOD ROAD	4.00	90.00	UN-MAPPED ROAD OF UNKNOWN AGE	
N39E14	1	1	0	1	MINING FTR	5.00	25.00	MODERN DOZER PROSPECT TRENCH & BERM 1-2CM DEEP	
N39E14	1	1	0	2	MINING FTR	100.00	10.00	BULLDOZER SWATH AND BERM	
N39E14	1	1	0	3	MINING FTR	10.00	20.00	BULLDOZER SWATH AND BERM	
N39E14	1	1	0	4	MINING FTR	15.00	10.00	BULLDOZER CUT INCLUDING BERM	
N39E14	1	1	0	5	MINING FTR	15.00	10.00	BULLDOZER CUT INCLUDING BERM	
N39E26	1	0	0	1	OTHER	0.00	0.00	PITS LRG CHUNKY DEBITAGE BLACK PURPLE NO HT	
N39E26	1	0	0	2	REDUCTION SC	5.00	5.00	DIFFUSE EARLY-LATE THINNING STG. 2 FLK SCATTER	
N39E26	1	0	0	3	REDUCTION SC	3.00	5.00	DIFFUSE LITHIC SCATTER OPALITE	
N39E26	1	0	0	4	OTHER,SOIL	0.00	0.00	EOLIANSILT ACCUMULATION ON LEE OF RIDGE WITH*	UNUSUAL PIT LIKE FEATURES DUG INTO SILTS
N39E26	1	0	0	5	REDUCTION SC	45.00	30.00	EARLY MID LATE STG. FLKS	
N39E26	1	0	0	6	REDUCTION SC	2.50	2.50	VERY DISCRETE TIGHTLY CLUSTERED EARLY LITHIC*	REDUCTION AND MIDDLE OF WHITE OPALITE
N39E26	1	0	0	7	MINING FTR	10.00	6.00	SCATTER OF BOARDS AND HEAP OF DIRT ASSOCIATED *	PROBABLY WITH MINING
N39E26	1	0	0	8	REDUCTION SC	8.00	4.00	SAME AS 3A BUT MIDDLE REDUCTION PRIMARILY NO HT	
N39E26	1	0	0	9	REDUCTION SC	60.00	30.00	LRG. DIFFUSE SCATTER OF WT/OPALITE *	EARLY TO MID. REDUCTION . MOST DENSE AREAS ARE EXPOSED ON THE BARE SAND
N39E26	1	0	0	10	REDUCTION SC	10.00	10.00	DISCRETE SCATTER, EARLY-MID RED. WT/BG NON HT	
N39E28	0	0	0	1	MOD ROAD	60.00	3.00	ROAD OR DOZIER OUT? LITHIC SCATTER IN CUT AREA	
N39E28	0	0	0	2	REDUCTION SC	60.00	45.00	LITHIC SCATTER OF WHITE OPALITE W/ASSOC. BIF. FRAG	
N39E28	0	0	0	3	HISTRC DUMP	0.00	0.00	ONE SHEET TIN ROOFING	
N39E28	0	0	0	4	REDUCTION SC	4.00	3.00	APPROX. 14 MID STG. BIF. THINNING FLK	
N39E28	0	0	0	5	REDUCTION SC	3.00	3.00	APPROX. 12 LATE STG. BIF. WT/ OPALITE	
N39E7	0	0	0	1	OTHER,HIST	0.00	0.00	WOOD STRUCTURES? PIPES, WIRE, CORRUGATED TIN	
N39E7	0	0	0	2	MINING FTR	0.00	0.00	IRREGULAR CUTS INTO BEDROCK	
N39E7	0	0	0	3	MINING FTR	0.00	0.00	IRREGULAR CUTS INTO BEDROCK	
N39E7	0	0	0	4	MINING FTR	30.00	15.00	DOZER CUT	
N39E7	0	0	0	5	MINING FTR	50.00	10.00	DOZER CUT/ 1920'S AUTO PARTS ON EAST SIDE	
N39E7	0	0	0	6	MINING FTR	30.00	10.00	DOZER CUT	
N39E7	0	0	0	7	MINING FTR	75.00	5.00	DOZER CUT	
N39E7	0	0	0	8	MINING FTR	60.00	7.00	DOZER CUT	
N39E7	0	0	0	9	MINING FTR	6.00	0.00	SHAFT SHALLOW	

unit_no	slope	stone	water	featid	type2	dim1	dim2	comments	continued
N39E7	0	0	0	10	MINING FTR	15.00	5.00	DOZER CUT	
N39E7	0	0	0	11	COBBLE AGGRN	30.00	2.00	SILICIOUS BOULDER OUTCROP UNUSED	
N39E7	0	0	0	12	MINING FTR	30.00	5.00	DOZER CUT	
N39E7	0	0	0	13	MINING FTR	10.00	5.00	SCRAPE	
N41E12	1	0	0	1	MINING FTR	15.00	50.00	MODERN DOZER SCRAPE THROUGH OPALITE OUTCROP*	NO PREHISTORIC USE
N41E12	1	0	0	2	MINING FTR	60.00	5.00	DOZER CUT	
N41E12	1	0	0	3	MINING FTR	5.00	30.00	DOZER PROSPECT SCRAPE 1M DEEP	
N41E19	1	0	0	1	REDUCTION SC	3.00	0.00	3 LARGE OPALITE FLAKES*	EARLY STAGE REDUCTION- CREAM OPALITE NON HEAT TREATED ON SLOPE AT EDGE IF TERRACE
N41E19	1	0	0	2	REDUCTION SC	7.00	5.00	3 LRG. BTF. NOT HT 1 PIECE OF CHUNKY OP. NOT HT	
N41E19	1	0	0	3	REDUCTION SC	10.00	10.00	5-10 FLKS. MED. TO SMALL BTF	
N41E5	0	0	0	1	MINING FTR	50.00	50.00	PIT IN HILLSIDE; BARRELS, TIMBER, CANS	
N41E5	0	0	0	2	MINING FTR	15.00	15.00	MODERN MINING PIT & DOZER SCRAPE	
N41E5	0	0	0	3	MINING FTR	15.00	5.00	DOZER CUT	
N41E5	0	0	0	4	MINING FTR	20.00	3.00	DOZER SCRAPE; TOBACCO POCKET TIN	
N42E12	1	0	0	1	MINING FTR	20.00	30.00	MODERN DOZER PROSPECTING*	MOSTLY RHYOLITE OUTCROP; SEVERAL CUTS AND BERMS
N43E22	1	0	0	1	CAIRN	0.50	0.50	THREE ROCKS STACKED	
N43E22	1	0	0	2	ROCKSHELTER	20.00	7.00	ROCK SHELTER WITH FLKS	
N44E10	1	0	0	1	MINING FTR	5.00	10.00	MODERN DOZER PROSPECT AND BERM	
N44E10	1	0	0	2	MINING FTR	3.00	40.00	BULLDOZER CUT	
N44E13	0	0	0	1	MOD ROAD	2.00	0.00	OVERGROWN ROAD	
N44E13	0	0	0	2	MOD ROAD	4.00	0.00	UN-MAPPED ROAD	
N45E13	0	0	0	1	MOD ROAD	5.00	0.00	BULLDOZED ROAD	
N45E13	0	0	0	2	MOD ROAD	5.00	0.00	BULLDOZED ROAD	
N45E13	0	0	0	3	MOD ROAD	5.00	0.00	BULLDOZED ROAD	
N45E14	1	0	0	1	MOD ROAD	4.00	180.00	UN-MAPPED ROAD	
N45E14	1	0	0	2	MOD ROAD	5.00	0.00	BULLDOZED ROAD	
N45E14	1	0	0	3	MOD ROAD	5.00	0.00	SEE FEATURE A	
N45E14	1	0	0	4	MOD ROAD	20.00	0.00		
N45E14	1	0	0	5	MINING FTR	50.00	6.00	BULLDOZER CUT	
N46E0	1	0	0	1	MINING FTR	30.00	15.00	DOZER SCRAPE INTO OPALITE DEPOSIT; *	MOST TUFF COBBLES, NO PREHISTORIC USE
N46E0	1	0	0	2	MINING FTR	30.00	50.00	DOZER SCRAPE INTO OPALITE DEPOSIT; *	MOST TUFF COBBLES, NO PREHISTORIC USE
N46E0	1	0	0	3	MINING FTR	10.00	100.00	DOZER SCRAPE SHALLOW	
N46E0	1	0	0	4	MINING FTR	50.00	20.00	BACKHOE TRENCHES	
N46E0	1	0	0	5	MINING FTR	8.00	30.00	DOZER SCRAPE	
N46E0	1	0	0	6	MINING FTR	5.00	15.00	DOZER CUT	
N46E0	1	0	0	7	MINING FTR	7.00	20.00	DOZER CUT 1 HIST QT. JAR CLEAR GLASS SCREW TOP IN	
N46E13	1	0	0	1	MINING FTR	4.00	4.00	MINING CLAIM	
N46E13	1	0	0	2	MOD ROAD	5.00	0.00	BULLDOZER ROAD	
N46E13	1	0	0	3	MINING FTR	30.00	10.00	BULLDOZER CUT	
N46E2	1	0	0	1	REDUCTION SC	15.00	15.00	ABOUT 15 OPALITE PRIMARY FLKS. CHUNKY*	POOR QUALITY; 1 CHUNKY GOOD QUALITY OPALITE PIECE OF SHATTER
N46E4	0	0	0	1	HISTRC DUMP	0.00	0.00		
N46E4	0	0	0	2	MINING FTR	5.00	15.00	MODREN PROSPECT PIT PLATFORM	
N46E4	0	0	0	3	REDUCTION SC	35.00	35.00	SPARSE WT/BG LATE THIN	
N46E4	0	0	0	4	HISTRC DUMP	1.00	7.00	CANS	
N46E4	0	0	0	5	HISTRC DUMP	10.00	15.00	CANS AND GLASS	
N46E4	0	0	0	6	REDUCTION SC	0.00	0.00	VERY SPARSE LITHIC SCATTER	
N46E4	0	0	0	7	HISTRC CAMP	0.00	0.00	LRG. SCATTER OF CANS ONE BOTTLE *	AND A PLATFORM ON TRANSECT STOVEPIPE
N46E4	0	0	0	8	MINING FTR	20.00	5.00	BLADE CUT W/ LRG. BERM	
N47E1	1	0	0	1	COBBLE AGGRN	100.00	0.00	CLIFFTOP OUTCROP CRUDDY OPALITE	
N47E1	1	0	0	2	MINING FTR	15.00	0.00	DOZER CUTS	
N47E1	1	0	0	4	MOD ROAD	0.00	6.00		
N47E1	1	0	0	5	MINING FTR	30.00	30.00	DOZER CUTS EXPOSING OPALITE BEDROCK	
N47E1	1	0	0	6	MINING FTR	0.00	0.00	OLD MINE SHAFT; BARRELS, CANS	
N47E1	1	0	0	7	HISTRC DUMP	20.00	0.00	4 SANITARY CANS , 1 WASHBASIN, 1 GLASS BOTTLE	
N47E11	1	0	0	1	MINING FTR	90.00	60.00	MINING DISTURBANCE	
N47E11	1	0	0	2	MOD ROAD	4.00	220.00	ROAD TO PLATFORM	
N47E11	1	0	0	3	MOD ROAD	4.00	90.00	ROAD	
N47E11	1	0	0	4	MINING FTR	10.00	40.00	BULLDOZER CUT	
N47E18	1	0	1	1	REDUCTION SC	7.00	2.00	12 MEDIUM MIDDLE STG. WT/OPALITE FLK NO HT	
N47E19	1	0	0	1	REDUCTION SC	20.00	10.00	SMALL LATE STG. RED. SCATTER IN RHYOLITE BOULDERS*	ON SMALL BENCH. NO HT 6 METER SQ 200 IN TOTAL VERY INTERESTING SPOT; ELEVATED, DAN HAS FOUND TWO TRANSPORTED COBBLES 35M N.E. AND THERE IS A FLAT ROCK DELIBERATELY STACKED ON A RHYOLITE BOULDER SOUTH OF L.S. BY 20M
N47E26	1	0	0	1	OTHER,MODRN	5.00	0.00	BRUSH AND DIRT DOZER PILE 3 FT TALL	
N47E5	0	0	0	1	HISTRC DUMP	55.00	25.00	ASSOCIATED WITH PLATFORM TO S.E.	
N47E5	0	0	0	2	MOD ROAD	45.00	7.00	ROAD	
N47E5	0	0	0	3	MOD ROAD	170.00	7.00	ROAD	
N47E5	0	0	0	4	MINING FTR	15.00	20.00	HISTORIC MINING PLATFORM	
N47E5	0	0	0	5	MOD ROAD	80.00	7.00	ROAD	
N47E5	0	0	0	6	OTHER,MODRN	15.00	30.00	HISTORIC/RECENT TURN-OUT/PLATFORM	
N47E5	0	0	0	7	OTHER,MODRN	18.00	20.00	PLATFORM AREA	
N47E5	0	0	0	8	HISTRC DUMP	4.00	7.00	SCATTER OF BRICKS AND WOOD	

unit_no	slope	stone	water	featid	type2	dim1	dim2	comments	continued
N47E5	0	0	0	9	REDUCTION SC	15.00	65.00	SPARSE SCATTER OF 100 FLKS, MOSTLY OUTSIDE *	QUADRAT ALL WHITE OPALITE MOSTLY MED. TO SMALL BIFACE LATE STG. REDUCTION FLKS.
N47E5	0	0	0	10	REDUCTION SC	45.00	30.00	MOSTLY WHITE OPALITE FLKS.*	LIGHT CONCERTRATION LATE STG. B.T.F. ONE PROJECTILE POINT ECN
N47E5	0	0	0	11	HISTRC DUMP	18.00	20.00	INDUSTRIAL MINING DUMP ASSOC. W/ NEARBY MILL*	LUMBER, HUGE HOSES ON WOOD WHEELS, CAST IRON PARTS, BINS, SHOOTS, PLY WOOD, METAL PIPE, HEAVY CABLE.
N47E5	0	0	0	12	MINING FTR	0.00	0.00	WASTE ROCK MOUND 20m DIAM. CA 9' TALL RAW NATURAL*	OPALITE IN LRG. ca. 9' TALL TO SMALL CHUNKS ca.40cm TO 50cm SOME RED, WHITE AND RED LOOKS EXTREMELY SHINEY MAYBE HEATED.
N47E5	0	0	0	13	MINING FTR	30.00	23.00	WASTE ROCK MOUND SAME AS 6B FEATURE	
N47E5	0	0	0	14	MINING FTR	25.00	1.00	RETORT? FOR MERCURY? HORIZONITAL TUBE W/ PULLEY	
N47E5	0	0	0	15	MINING FTR	10.00	5.00	RETORT W/ 72 VERTICLE FLUES ALL IN METAL PAN	
N47E5	0	0	0	16	MINING FTR	25.00	8.00	PLATFORM	
N48E0	1	0	0	1	REDUCTION SC	30.00	30.00	HEAT TREATED MID TO LATE STG. RED. UP TO 30 FLKS.	
N48E0	1	0	0	2	HISTRC DUMP	0.00	0.00	SCATTERED TIN CANS 2 METER SQ	
N48E0	1	0	0	3	CAIRN	1.00	1.00	20 BOULDERS IN COLLASPED PILE	
N48E0	1	0	0	4	MINING FTR	40.00	10.00	DOZER CUT	
N48E0	1	0	0	5	MINING FTR	20.00	10.00	DOZER CUT	
N48E0	1	0	0	6	OTHER,MODRN	30.00	50.00	RESERVOIR AND LRG. BERM	
N48E0	1	0	0	7	REDUCTION SC	0.00	0.00	LS BURIED BY BERM OF MF1 LS 100+OPALITE*	1MF=15NS X 7, 2MF= 5 X 5, LS= 12 X ?
N48E0	1	0	0	8	MINING FTR	20.00	10.00	DOZER CUT	
N48E0	1	0	0	9	ISOLATE	0.00	0.00	PROJECTILE POINT HUMBOLT CONCAVE BASE	
N48E0	1	0	0	10	MINING FTR	5.00	5.00	DOZER SCRAPE W/PILE	
N48E0	1	0	0	11	MINING FTR	10.00	5.00	DOZER CUT	
N48E0	1	0	0	12	MINING FTR	10.00	5.00	DOZER CUT	
N48E0	1	0	0	13	REDUCTION SC	0.00	0.00	GENERAL SCATTER LIGHT DENSITY LS NOT A FEATURE	
N48E0	1	0	0	14	MINING FTR	33.00	45.00	MF-1 BLADE CUT MF-2 DRILL PAD	
N48E12	1	0	0	1	MINING FTR	6.00	0.00	BULLDOZER CUT OR ROAD TO PROSPECT	
N48E12	1	0	0	2	REDUCTION SC	5.00	5.00	MIDDLE REDUCTION; COURSE GRAINED OPALITE	
N48E12	1	0	0	3	REDUCTION SC	15.00	15.00	VERY DIFFUSE, DISTURBED BY CURRENT ROAD	
N48E2	1	0	0	1	HISTRC DUMP	0.00	0.00	ALUMINUM COFFEEPOT	
N48E2	1	0	0	2	MINING FTR	20.00	5.00	BL=BLADE CUT	
N48E31	1	0	0	1	REDUCTION SC	25.00	10.00	6 FKS. 5 ARE INTERIOR FLKS NO HT *	MED. TO LRG. MID BFT W/ ORANGE RIND ON DORSAL SURFACE
N48E31	1	0	0	2	REDUCTION SC	5.00	3.00	OPALITE B.T.F.'S MID TO LATE STAGE REDUCTION*	NO HT GERY/CREAM OPALITE, ONE FACETED PLATFORM. CA. 10 FLAKES TOTAL SPARSE DENSITY
N48E31	1	0	0	3	REDUCTION SC	15.00	15.00	SPARSE TO LIGHT DENSITY OF MED. TO SMALL OPALITE*	THINNING AND INTERIOR FLAKES - MAJORITY ARE SALMON, PINK, TAN, AND CREAM, NOT HEAT TREATED 50 FLAKES TOTAL
N48E32	1	0	0	1	REDUCTION SC	5.00	15.00	SPARSE TAN AND CREAM OPALITE B.T.F*	SCATTER- MED. SIZE MIDDLE STAGE REDUCTION FLAKES 20 TOTAL
N48E32	1	0	0	2	REDUCTION SC	5.00	10.00	SPARSE WHITE OPALITE FLKS. SCATTER*	MED. SIZE-10 FLKS. MOST THIN INTERIOR FLKS. MAYBE 1 IS HEAT TREATED
N48E5	0	0	0	1	MINING FTR	35.00	25.00	TAILINGS WASTE ROCK MOUND*	25X35X15 FT. TALL CONTINUES INTO WEST FROM QUADRANT
N48E5	0	0	0	2	REDUCTION SC	23.00	15.00	MODERATE TO LIGHT OPALITE CLUSTER; *	ONE LATE STG. 3 BIF. FRAG EARLY TO MIDDLE STG. REDUCTION
N48E5	0	0	0	3	HISTRC DUMP	5.00	2.00	ca. 40 HIT/SAM/ POCKET TOB. CANS 2 COCA COLA CANS	
N49E11	1	0	0	1	MINING FTR	4.00	4.00	CUT-BULLDOZER	
N49E11	1	0	0	2	MINING FTR	90.00	5.00	DITCH/BULLDOZER CUT	
N49E11	1	0	0	3	HISTRC ROAD	0.00	5.00	POSSIBLE ROAD OR PATH TO PROSPECT	
N49E11	1	0	0	4	HISTRC ROAD	0.00	6.00	ROAD TO PROSPECT	
N49E11	1	0	0	5	HISTRC DUMP	30.00	30.00	BROKEN GLASS, BUCKET PARTS, WOODEN BOX PARTS, CANS	
N49E11	1	0	0	6	MINING FTR	0.00	15.00	BULLDOZER CUT ASSOC. WITH PROSPECT	
N49E11	1	0	0	7	MINING FTR	25.00	10.00	PROSPECT	
N49E11	1	0	0	8	MINING FTR	7.00	3.00	PROSPECT W/ ASSOC. CLAIM	
N49E11	1	0	0	9	MINING FTR	55.00	35.00	TAILING PILE ASSOC. W/ CUT AND DEBRIS SCATTER	
N49E11	1	0	0	10	MINING FTR	20.00	10.00	PROSPECT	
N50E11	0	0	0	1	MINING FTR	5.00	10.00	PROSPECT	
N50E11	0	0	0	2	HISTRC ROAD	0.00	0.00	ASSOC. W/ PROSPECTS IN AREA	
N50E11	0	0	0	3	MINING FTR	5.00	3.00	PROSPECT	
N50E18	1	0	0	1	REDUCTION SC	3.00	4.00	HT. MIDDLE AND LATE BIF. REDUCTION	
N50E18	1	0	0	2	REDUCTION SC	25.00	5.00	EARLY AND LATE W/ CHUNKY DEBITAGE	
N50E18	1	0	0	3	REDUCTION SC	7.00	7.00	VERY DIFFUSE SCATTER WT/BG EARLY THINNING	
N50E18	1	0	0	4	HISTRC ROAD	100.00	4.00	PROBABLE HISTORIC ROAD RECENT CUT	
N51E17	1	0	0	1	REDUCTION SC	15.00	15.00	RASPBERRY CHEESECAKE COLOR AND WT/BG BIF. FRAGS *	AND DEBITAGE
N51E19	1	1	1	1	REDUCTION SC	0.00	0.00	EARLY STG. OPALITE REDUCTION *	LOTS OF WEATHERED GRAVELS, ANGULAR , NATURAL DEBRIS; PROBABLY RELATES TO KERRY'S LS ON TRANSECT #2 AT LEAST 60M CONTINUES OUT FROM UNIT
N51E19	1	1	1	2	REDUCTION SC	0.00	0.00	WIDE VARIETY OF COLORS LRG. LS HT >25/M2*	THERE OUGHT TO BE GROUNDSTONE HERE
N51E19	1	1	1	3	REDUCTION SC	6.00	3.00	SPARSE SCATTER MED. SIZE MIDDLE SOME HT	
N51E19	1	1	1	4	REDUCTION SC	45.00	30.00	GENERAL VERY SPARSE TO SPARSE FLKS.	
N51E19	1	1	1	5	REDUCTION SC	10.00	6.00	LIGHT SCATTER EARLY/MIDDLE STG.	

unit_no	slope	stone	water	featid	type2	dim1	dim2	comments	continued
N51E19	1	1	1	6	REDUCTION SC	18.00	32.00	PRIMARY REDUCTION, HEAT SPALLS/GLOSS*	WHITE OPALITE - LIGHT DENSITY THE DOTTED LINE INDICATES SPARSE
N51E19	1	1	1	7	REDUCTION SC	5.00	0.00	LIGHT SCATTER; MED. SIZE NO HEAT	
N51E19	1	1	1	8	REDUCTION SC	12.00	10.00	LIGHT SCATTER; NO HT; 70% SMALL 17 SQ METERS	
N51E19	1	1	1	9	REDUCTION SC	77.00	50.00	LAVENDAR POINT; MED. TO SMALL FLKS. MAX DENSITY	
N51E20	0	1	1	1	MOD ROAD	0.00	0.00	BULLDOZED ROAD 6 WIDE	
N51E20	0	1	1	2	MOD ROAD	0.00	0.00	BULLDOZED ROAD 6 WIDE SEE FEAT. A	
N51E20	0	1	1	3	MOD ROAD	0.00	0.00	BULLDOZED ROAD 6 WIDE SEE FEAT. A	
N51E22	1	0	0	1	REDUCTION SC	20.00	20.00	IN SMALL SADDLE BELOW HTG BLINDS; LATE STG. 3MSQ	
N51E23	0	0	0	1	LINROCKALIGN	1.50	0.50	ROCK PILE AT SMALL SADDLE 20 BOULDERS *	ALIGNED AT RIM EDGE FACES 180 DEGREE BOULDER PILE 50 TO 60 BOULDERS ALIGNED ABOVE RIM OVERLOOKING SMALL SADDLE BEHIND RIM ROCK (TO SOUTH)
N51E23	0	0	0	2	LINROCKALIGN	3.00	0.50	SAME AS 1 MLA	
N51E24	1	0	0	1	REDUCTION SC	10.00	20.00	100 FLKS. OPALITE 40% HT EARLY TO MED. STG. RED. *	BIFACE
N51E7	1	0	0	1	REDUCTION SC	2.00	0.00	WT/MID-LATE, RAW DOMINANCE SOME HT LT. SCATTER	
N51E7	1	0	0	2	REDUCTION SC	5.00	5.00	REDUCTION FEATURE 50 FLKS. WT/OP HT LBFT	
N53E12	0	0	0	1	REDUCTION SC	2.00	3.00	SPARSE WHITE OPALITE EARLY LATE BIF. THINNNING	
N53E12	0	0	0	2	MINING FTR	25.00	5.00	BULLDOZER CUT	
N53E19	1	1	0	1	MINING FTR	15.00	4.00	BULLDOZER CUT*	THREE CUTS ; 30X30
N53E19	1	1	0	2	CAIRN	0.75	0.75	PROBABLY RECENT	
N53E19	1	1	0	3	MINING FTR	30.00	30.00	DOZIER CUTS	
N53E19	1	1	0	4	REDUCTION SC	15.00	15.00	VERY DIFFUSE AND DIFFICULT TO DEFINE	
N53E5	1	0	0	1	REDUCTION SC	5.00	7.50	GREY CEMENT OP LATE BTF 30 FLKS. SILVERY	
N53E5	1	0	0	2	HISTRC DUMP	8.00	5.00	SANITARY (KNIFE-CUT) & EVAPORATED MILK CANS 15-20*	EMBOSSED WITH "PUNCH HERE"
N53E5	1	0	0	3	REDUCTION SC	10.00	15.00	HT LATE STG. REDUCTION	
N54E26	0	0	0	1	REDUCTION SC	50.00	30.00	VERY DENSE LOTS OF HT BIF. LATE STG. RED. *	BIF. STG. 5 CREAM, ORANGE 5MSQ
N54E26	0	0	0	2	ROCK RING	2.00	2.00	HUNTING BLIND; 2-4 COURSES; BASALT BOULDERS	
N54E26	0	0	0	3	REDUCTION SC	50.00	60.00	LIGHT TO MODERATE DENSITY OF OPALITE*	JASPER, OBSIDIAN FLKS. MANY COLORS OPALITE 30% HT BIFACES, SHATTER PRESENT, EARLY TO MID B.T.F.'S 3 OPALITE PROJ. POINTS GATECLIFF REWORKED ELKO, THOUSAND OF FLKS.
N54E26	0	0	0	4	REDUCTION SC	45.00	140.00	OPALITE FLK. SCATTER MIDDLE B.T.F.'S*	MANY HT; ONE HT BIF. ALL WT TO TRANSLUCENT GOLD OPALITE 500 FLKS. TOTAL SPARSE TO LIGHT DENSITY PROJ. BIFACES
N54E26	0	0	0	5	REDUCTION SC	80.00	70.00	OPALITE SCATTER SPARSE TO LIGHT DENSITY *	THINNING FLKS. MUCH HT GENERATED SHATTER 300 FLKS. TOTAL
N54E26	0	0	0	6	LINROCKALIGN	3.50	2.00	ALIGNMENT OF RHYO. COBBLE & BOULDERS 0.7 M TALL*	FORMING A HUNTING BLIND, WE SUSPECT ca. 6 SMALL BOULDERS HAVE BEEN PLACED BETWEEN BEDROCK PEAKS TO FORM THE LOW WALL FEATURE IS AT EAST EDGE OF A RHYOLITE OUTCROP.
N54E26	0	0	0	7	REDUCTION SC	7.00	10.00	LIGHT DENSITY SCATTER OF MOSTLY HEAT TREATED*	WT OPALITE MED. TO LATE B.T.F.'S PERHAPS 40 FLKS TOTAL
N54E28	1	0	0	1	REDUCTION SC	1.50	0.75	SINGLE EVENT REDUCTION IN SMALL NICHE AT BASALT*	PINNACLE MID-LATE STG. B.T.F. 10 FLKS 1 HT FLK
N54E28	1	0	0	2	REDUCTION SC	0.00	15.00	HT (50%) MID TO LATE BIF. THINNING 4 PER METER SQ*	CREAM OPALITE 1 ORANGE FLK EARLY BLOCK RED.
N54E28	1	0	0	3	REDUCTION SC	20.00	40.00	OPALITE PREDOMINANTLY CREAMY TAN, SOME TANGERINE*	AND ONE GREY BRECCIA CEMENT FLK MOSTLY MIDDLE B.F.T DEBRIS W/ FEW LATE B.F.T FLKS. HT IS EVIDENCE MAX FLK DENSITY OF 3 PER METER SQ TWO BIF FRAGS ONE EARLY 4 HT ONE MIDDLE 3 HT
N54E28	1	0	0	4	REDUCTION SC	5.00	5.00	4 MIDDLE B.F.T.'S HT	
N54E28	1	0	0	5	REDUCTION SC	10.00	0.00	EDGE OF LITHIC SCATTER CONTANING MID B.F.T. *	OF CREAMY BEIGE OPALITE
N54E28	1	0	0	6	REDUCTION SC	15.00	41.00	25 FLKS. SMALL TO MED. LATE TO MIDDLE *	BFT MAX DENSITY 2 PER METER SQ WT OPALITE SOME POT LID SCARRED DEBRIS
N54E28	1	0	0	7	REDUCTION SC	20.00	25.00	OPALITE CORTICAL FLKS. LRG. CHUNKS OF SHATTER *	AND CA 50% SMALL EARLY FLKS; ONE OBSIDIAN FLK; NATURALLY OCCURRING JASPER CHUNKS NON MODIFIED, ALL SPARSE DENSITY CA 100 FLK TOTAL
N54E28	1	0	0	8	REDUCTION SC	10.00	10.00	SPARSE SCATTER OF MID TO LATE BTF'S*	CA 10% HT ONE HT EARLY TWO BIF FRAG OPALITE ALL WHITE
N8E3	1	0	0	1	REDUCTION SC	5.00	5.00	EARLY BIF RED. WT/OP PURPLE JASPER	

ARCHAEOLOGICAL INVESTIGATIONS AT TOSAWIHI, A GREAT BASIN QUARRY

Part 3: A Perspective from Locality 36

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Errata sheet

May 11, 1992

Re: IMR #639 report: *Archaeological Investigations at Tosawihi, A Great Basin Quarry. Part 3: A Perspective from Locality 36.*

The title page of this report omitted the name of one author.

C. Lynn Rogers should be added to the list of contributors.

ABSTRACT

This report is an archaeological study of one of more than two hundred prehistoric bedrock quarry and quarry-related localities known administratively as the Tosawihi Quarries (26Ek3032). Results are discussed in the context of recent survey, testing, and data recovery in the quarry district. Debates over hunter/gatherer resource acquisition strategies focused investigations on the economic aspects of quarrying and toolstone processing. A cost/benefit model emphasizing return rate maximization is evaluated and the archaeological evidence for a cost/benefit extraction and processing strategy is considered.

The site and its environmental setting are described, and field methods, artifacts, and recovery contexts are discussed. Quarrying processes, site formation, and feature and artifact patterning are addressed. The final chapter summarizes work at Locality 36 in light of information derived from previous studies at and near the Tosawihi Quarries. Issues unresolved by present and previous work are addressed as potential avenues of future inquiry.

The excavation and analysis of Locality 221, a small site located near Locality 36, is included in the report.

CULTURAL RESOURCES MANAGEMENT SUMMARY

Intensive minerals exploration, extraction, processing, and transport are elements of the Ivanhoe Project, currently in progress in Elko County, Nevada. The project is located on public lands administered by the Elko Resource Area of the Bureau of Land Management, and subsumes the Tosawihi Quarries (26Ek3032; cf. map), a portion of a district eligible for nomination to the National Register of Historic Places.

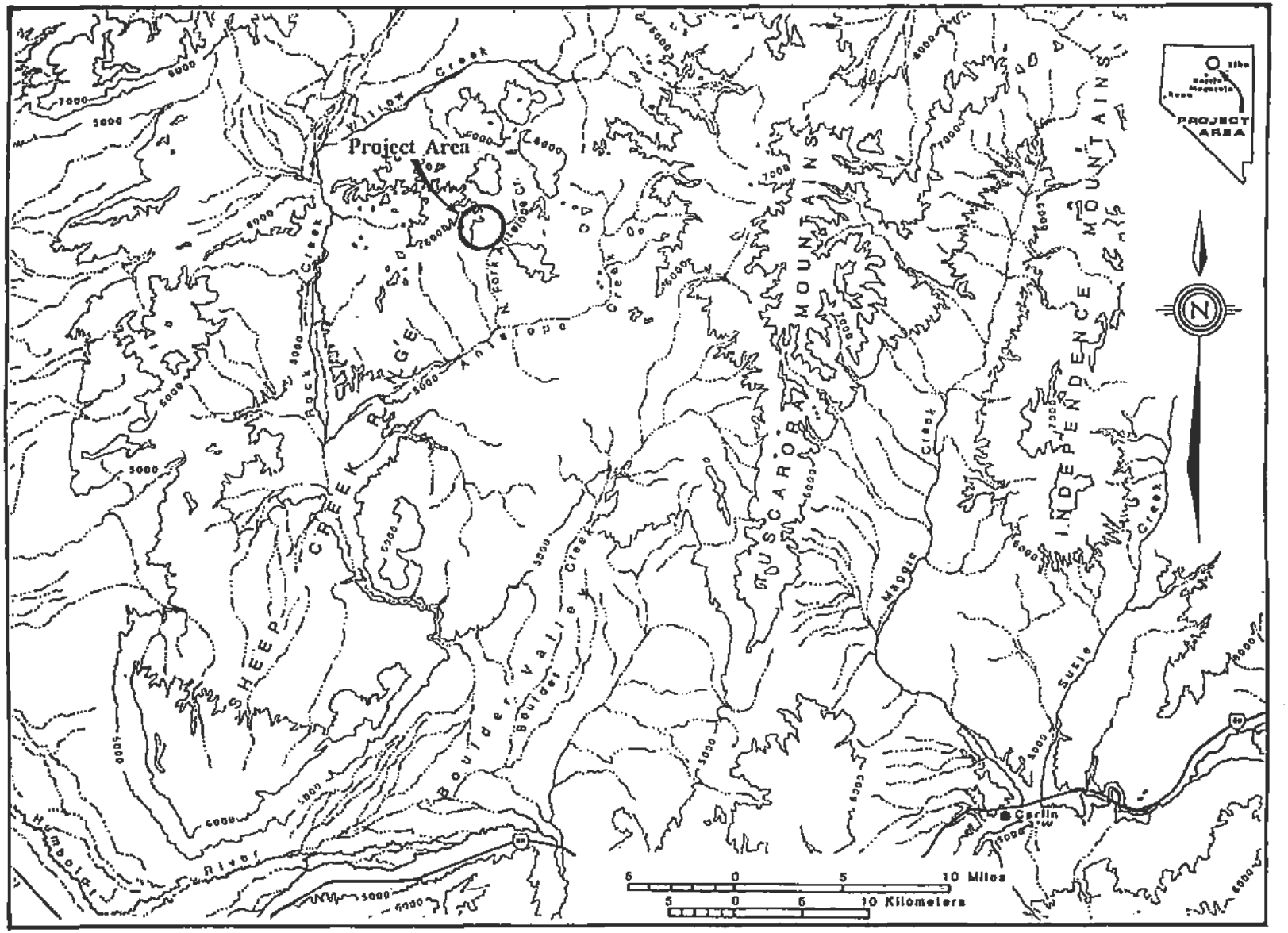
Since 1987, Intermountain Research has conducted archaeological survey, testing, and mitigation (Elston, Raven, and Budy 1987; Intermountain Research 1987, 1988a-d; Zeier 1987; Budy 1988; Drews 1988; Elston 1988a-b, 1989; Raven 1988; Elston 1989; Elston and Raven 1992) triggered by Ivanhoe Project development and funded by the Ivanhoe Gold Company. Proposed development of an access road, an office compound, and a causeway across Little Antelope Creek Canyon prompted development of a data recovery plan for 17 localities in 26Ek3032 (Intermountain Research 1988a, c). Subsequent project design changes removed several of these localities from the plan of operations, however, and their planned mitigation was cancelled. Later, Ivanhoe Gold Company determined that full development of its USX East pit design would intrude the southern margin of one of the most intensively quarried localities at Tosawihi (26Ek3032, Locality 36), and that construction of pit-to-causeway access would obliterate a small reduction locus (26Ek3032, Locality 221). With several years of intensive Tosawihi research completed by this time, it was deemed appropriate to revise the data recovery plan for Locality 36 in light of an evolved understanding of quarry complex archaeology. Thus, an amendment to the original plan was prepared (Intermountain Research 1990a), and a separate data recovery plan was prepared for Locality 221 (Intermountain Research 1990b).

The work reported here refers specifically to the mitigation of Locality 36, a complex of more than 50 prehistoric quarry features in the southeast portion of the Tosawihi Quarries, and of Locality 221. Field work began in late July 1990, and was completed in late September 1990, employing a crew of 20. The crew devoted 744 person days to the field effort. Data recovery at Locality 221 was accomplished concurrently.

The amended data recovery plan called for detailed photogrammetric mapping of the locality using low altitude aerial photographs, close order survey (2 m transect intervals) of the locality, plotting, flagging, and surface collection of formed artifacts, and plotting and inventory of features. At the end of field work, 60 quarry features and 37 reduction features had been mapped and inventoried, and 462 surface artifacts had been plotted and collected.

As directed by the data recovery plan, systematic, judgmental, and probabilistic sampling techniques were employed where appropriate. Surfaces of selected quarry pits were sampled systematically by cruciform transects of small (25 cm^2 or 50 cm^2) surface scrapes. Debitage size, density, and distribution across the locality were sampled by a stratified, random placement of small (25 cm^2) surface scrapes (shovel skimmed to 2 cm below surface). Lithic reduction features, both observed on the surface and exposed during test exercises, were sampled by randomly selected surface scrapes and judgmentally placed excavation units. In order to reduce sample size and the handling of debitage, some lithic samples were split in the field and only the portion needed for further analysis and documentation was transported to the lab and analyzed.

Quarry pit complexes were exposed with relatively short backhoe trenches, subsequently intersected by perpendicular trenches to facilitate segregating quarrying episodes. Profiles and column samples were prepared and qualitative analysis of extraction and reduction debris was conducted.



Ivanhoe Project Area map.

Extensive surface scrapes, accomplished mechanically by a front loader and a road grader, were of two types: deposits of quarrying debris were removed to bedrock at selected quarry pit complexes to check for charcoal deposits and reveal the extent of quarrying in bedrock, and about 30 cm of soil was removed from approximately 3600 m^2 in the northeast (non-quarrying) portion of the locality to expose buried hearths and other features. Revealed hearths were collected for flotation and recovery of charcoal for radiocarbon dating.

Data recovery at Locality 221 was considerably less complex. The site was surveyed, artifacts and features were mapped, and a detailed contour map was prepared. Ten randomly placed 50 cm x 50 cm surface scrapes retrieved a sample of surface artifacts, and three excavation units explored for buried quarry features adjacent and away from the outcropping opalite.

Data recovery procedures proposed in the data recovery plans are compared in Table A to those actually executed. Discrepancies between proposed *minimum* numbers of units and actual units employed are explained in table footnotes.

Table A. Proposed and Actual Data Recovery Procedures Executed at Localities 36 and 221.

Procedure	Proposed Minimum Units	Proposed Maximum Units	Actual Units
Locality 36			
Total Random Sample Surface Scrapes[a]	600 25 cm^2	600 25 cm^2	562 25 cm^2 [b]
Systematic Cruciform Quarry Pit Sample Surface Scrapes	300 25 cm^2	300 25 cm^2	67 50 cm^2 [c]; 57 25 cm^2
Sample Surface Scrapes in Quarry Pit Features		120 50 cm^2	4 1 m^2
Sample Surface Scrapes in Non-quarry Pit Features		120 50 cm^2	56 50 cm^2; 2 1 m^2
Test or Block Excavation of Features in Non-quarry Pit Areas		50 1 x 1 m or 1 x .5 m EUs[d]	25 1 x 1 m EUs; 3 1 x 5 m EUs; 61 5 x 5 m EUs
Backhoe Trenching	150 m		265 m and 3 1 x 5 m EUs at trenches
Locality 221			
Total Random Sample Surface Scrapes[a]	10 50 cm^2		10 50 cm^2
Test Excavation Units adjacent Bedrock Exposure	3 1 x 1 m		3 1 x 1 m

[a]Shovel-skimmed to 2 cm below surface
[b]Final locality boundary definition permitted fewer than the estimated 600 units
[c]25 cm^2 units were inappropriate where reduction debris consisted of very large debitage; thus, 50 cm^2 units were employed where necessary
[d]Excavation Units

In April, Intermountain Research returned to Locality 36 to monitor topsoil removal from the southwestern margin of the site in anticipation of pit excavation by the mining company. The aim was to recover charcoal deposits for radiocarbon assay not encountered during data recovery and to examine subsurface deposits for buried features. No bedrock pits, charcoal, or formed artifacts were revealed, and the observed debitage appeared to occur only in the upper five to ten cm of deposit, probably an artifact of downslope transport.

Commencing in September, 1990, cataloguing, analysis, and draft final report preparation were undertaken; the work was completed in January, 1992.

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A number of Western Shoshone people visiting Tosawihi in the summer of 1991 supplied us with insights from which this report has benefitted.

Chapter 1

RESEARCH DESIGN

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ficta voluptatis causa sint proxima veris.
—Horace

fervet opus
—Virgil

The Tosawihi Quarries complex (26Ek3032) in central northern Nevada is among the largest prehistoric bedrock toolstone quarries in North America. It encompasses more than 800 acres, and at least a thousand more adjoining acres are littered with the detritus of toolstone processing. Volcanic tuff at Tosawihi was transformed by hot spring activity into cryptocrystalline, conchoidally fracturing "opalite", a high quality chert (Elston 1992a). The material was utilized as toolstone over the past 8000 to 10,000 years, and it travelled, by transport or trade, at least 175 km from the quarries.

Our research at Tosawihi began in 1987 with intensive surveys, followed by tests (1988) and a program of data recovery (1989), but until we studied Locality 36 (1990), a component of the sprawling Tosawihi complex, most of our work had been peripheral to the heart of the quarries. Most of the archaeological sites we examined were camps and workshops to which toolstone and partially worked bifaces were transported and further reduced (but not used) before export from Tosawihi, few quarry sites were studied.

We assumed that prehistoric hunters and gatherers generally employed strategies of effort that minimized costs and maximized returns (Elston 1992b), so we pitched our inquiry to consider how those factors might have affected seasonal scheduling, the lengths of visits to the quarries, the structure of subsistence activities supporting the venture, and the reasons for locating particular kinds of sites in particular kinds of places. We also examined the process of biface manufacture and the form of the products exported; we employed various modes of technological and morphological analysis, and we rallied both ethnographic and experimental data to estimate the time and effort required to quarry and process toolstone into exportable form. All this was done from afar, however, and we were aware that our studies were a little like trying to infer something of city life by looking only at the suburbs.

When we came to work at Locality 36, we confronted downtown reality. Perched on a ridge and slope at the southern margin of the Tosawihi complex, the site reflects a tumult of activity stunningly different from any we had studied before (cf. Elston and Raven 1992). Great, deep floods of debitage wash across the surface, emanating from more than fifty prehistoric quarry pits. Over some five acres, splashed with broken opalite, we found the direct record of at least 4000 years of toolstone procurement. A 30 m wide band of shallowly buried opalite bedrock parallels the ridge just below its crest, and the relative ease of access to fine lithic material invited millennia of revisitation; somewhat away from the stone source, up on the flats of the ridge top, we found dozens of reduction stations and even a few hearths.

The present project allowed us not only to evaluate our previous work, but also to build upon it. Here, we look closely at the actual business of quarrying opalite at Tosawihi, discovering which tasks were involved and how they were organized. We also place Locality 36 in larger regional contexts to help understand how quarrying fit into the annual round of prehistoric and protohistoric peoples. Like other researchers, however, we have found that understanding quarries is daunting, especially at large complexes. The sheer volume of artifacts overwhelms the observer. Quarry deposits are often deep, with complicated stratigraphy, and the lack of chronological control impedes interpretation. We are challenged, however, to confront these methodological problems by the great information potential of quarries.

The Importance of Quarries for Prehistoric Archaeology

Hunter-gatherer archaeology frequently and explicitly invokes chipped stone technology to examine trade and exchange, territoriality, group interaction, mobility patterns, and other aspects of prehistoric adaptation (cf. Goodyear 1979; Spiess and Wilson 1989; Morrow and Jeffries 1989). Although the acquisition of toolstone is usually assumed to have been important, such studies seldom consider information from quarry locations or other sources of stone tools. This is regrettable, because quarries are not merely sources of insight into prehistoric lithic technology, but also may inform on prehistoric economics, craft specialization, production organization, technological change, and other substantive issues whose domain extends far beyond the toolstone source itself (Jochim 1989).

Many technological questions that depend on prehistoric technology for answers cannot be addressed *without* reference to quarry data. Often, there is more than one way of producing a particular chipped stone form, so lithic technology cannot be reconstructed entirely from final products (Callahan 1979). Artifacts found most often at sites away from raw material sources are final products, broken in use. Therefore, unfinished tools discarded in manufacture and debitage collected from quarry sites provide technological information often not obtainable elsewhere.

Quarries not only provide necessary technological information, but also can be sources of data on prehistoric organizational patterns. The intensity of toolstone extraction and production, the seasons of quarry use, and the frequency of quarrying forays can, for example, be used to test hypotheses concerning mobility strategies, settlement patterns, labor organization, and trade or exchange. Examining quarries as if they were special cases of "limited activity sites" prematurely ends their utility for archaeological research.

A Brief Survey of Quarry Studies

The following survey is intended to show that, compared to other archaeological phenomena, the relatively few quarry studies almost exclusively employ technological perspectives. A few studies (e.g., Reher 1991; Torrence 1986), however, have tried to link quarries to larger questions of regional economics; we attempt both approaches here.

Much New World descriptive quarry literature dates from the turn of the century, when Holmes (1892, 1897, 1919), Wilson (1897), and Fowke (1928) addressed the antiquity and nature of some of the largest North American quarries. They considered prehistoric quarrying techniques,

tools, and technological organization. There have been few substantive contributions since this early work, although changes in research orientations, the rise of modern dating techniques, and the availability of mechanized earthmoving equipment have swollen the roster of potential questions that can be addressed with data from quarries.

Many North American quarries, unlike Tosawihi, entailed the excavation of raw material blocks from a soil matrix. Studies of quarries relying on easily exploitable surface or near surface deposits (Singer and Ericson 1977; Elston and Zeier 1984; Flenniken and Ozbun 1988) have focused primarily on trade patterns, territorial limits, or lithic production systems; the time, effort, and strategies involved in extraction methods have not been considered.

The situation at Tosawihi differs vastly; toolstone occurs in bedrock deposits, and high quality material is difficult to extract. We did not realize fully the difficulty of bedrock extraction until we performed our own quarrying experiments (Carambelas and Raven 1991; Elston 1992b). While our output doubtless might improve with additional practice, time and effort involved in quarrying clearly are significant factors of bedrock quarrying. This has stimulated our interest in strategies of toolstone extraction and processing, and in the broader economic aspects of quarrying.

Two of the largest prehistoric quarries in North America are the Knife River source in North Dakota and Spanish Diggings in Wyoming, both of which are estimated to cover several million square meters. Artifacts of Knife River chert are found over a wide area of the continent. This high quality toolstone occurs as cobbles in deposits of glacial outwash covered by loess. Studies of the utilization of the Knife River source (Ahler and Christensen 1983; Ahler 1986) are among the most detailed in the literature. Much of this work deals with the problem of analyzing large quantities of debitage to identify reduction stages, distinct lithic industries, technological organization, and the regional travels of the flint through the Plains and Midwest. It also deals with some of the quarry-specific questions we have examined at Tosawihi, such as quantities of extracted material, quarrying techniques employed, and labor requirements for extraction. Since the geologic setting is so different from Tosawihi, however, the data is not directly comparable.

Spanish Diggings in Wyoming is a vast bedrock quarry complex the size of which is estimated in the millions of square meters (Reher 1991:273). This site, larger than Tosawihi, has been examined only superficially, yet the brief descriptions available suggest it has similar quarry features and debitage densities. Questions of fall-off in density and material type, mobility patterns, task organization, and regional patterns of raw material distribution have been proposed (Reher 1991), but their research has not begun.

European quarries are more often similar to Tosawihi, and have undergone extensive study. The Neolithic flint mines of Grimes Graves in Norfolk, England, cover about 34 acres and date to ca. 2500-1400 B.C. The flint in these pits and shafts with radiating pits and adits consists of high quality nodules embedded in a solid chalk matrix. Of three horizontal flint strata, the lowest is of the highest quality, extending to a depth of 12 meters. Grimes Graves was investigated as early as 1870 and as recently as 1972 (Mercer 1976; Sieveking et al. 1972), and several pits and shafts have been archaeologically excavated entirely. Quarrying tools recovered are very similar to those found at Tosawihi and to those replicated and used in our experimental studies (Schmitt 1992a; Carambelas and Raven 1991). The physical constraints of quarrying, at least in the early components of Grimes Graves, probably resembled those encountered by prehistoric quarriers at Tosawihi. Once identified as a quarry complex, the primary questions asked of Grimes Graves involved quarrying techniques, dating and changes in the nature of quarrying through time, task composition, and excavation and productivity rates. There has been little effort, however, to fit intensive quarrying activity into regional settlement patterns and economies.

Tosawihi is the largest known silicified bedrock toolstone source in the Great Basin. Other quarries include the Lake Range quarries in northern Washoe County, Nevada (Pedrick 1985; Clay 1988), the Sinter Hill Quarry near Reno, Nevada (Elston and Turner 1968), chert quarries in the Cortez Mountains, Eureka County, Nevada (Pierce and Chapin 1987; Livingston and Pierce 1988), the Coleman Locality (Tuohy 1970), a basalt quarry and workshop in Washoe County, Nevada, and the Sugarloaf Obsidian Quarry in southeastern California (Elston and Zeier 1984). Numerous other quarries are reported but not described, and others undoubtedly remain undiscovered.

A number of recent edited volumes have addressed various issues of lithic procurement and processing, reflecting increased interest in the subject (Ericson and Purdy 1984; Ellis and Lothrop 1989; Butler and May 1984; Vehik 1985; Sieveking and Newcomer 1987; Hester and Shafer 1991; Henry and Odell 1989; Torrence 1989; Johnson and Morrow 1987), but they include almost no in-depth description of the processes and techniques involved in prehistoric bedrock quarrying. Exchange systems and territoriality, lithic trajectories, mobility strategies, toolstone conservation strategies, and optimization models are addressed and proposed, but without rehearsal of the warranting data. Thus, while our research focuses on the economic aspects of quarrying, the lack of descriptive data in the general literature prompts us to describe in detail the quarrying techniques used by the prehistoric quarriers of Locality 36. We intend to describe toolstone procurement and processing at the locality, test a general model of procurement and processing strategies, and place our results in a regional context.

Previous Research At Tosawihi

Chronological data at Tosawihi are provided by radiocarbon dates and temporally sensitive artifacts such as projectile points and ceramics. Obsidian hydration also is used to suggest artifact dates, but only relative to other artifacts from the site, since there is no effective hydration calibration to absolute age. Hydration and technological studies support the basic chronological validity of western Great Basin point chronologies (Elston 1986a; Thomas 1981; Elston and Drews 1992). These data suggest that the earliest visits to the quarries (represented by stemmed points, thought to have been in use between 10,000 and 8,000 B.P.) were infrequent, and may have been unrelated to toolstone exploitation. The frequency of use and the dominant pattern of use (toolstone exploitation via associated support sites) increased gradually throughout the Archaic and expanded dramatically in the Late Archaic after 1500 B.P.

The geographical sources of temporally diagnostic obsidian artifacts suggest that groups exploiting Tosawihi may have had different geographical ranges or trade networks through time. Pre-Archaic Stemmed Series obsidian points came primarily from the Brown's Bench source in southern Idaho, with a few from rare or unknown sources; Early and Middle Archaic points came almost entirely from Paradise Valley in northwestern Nevada, and Late Archaic Desert Series points came from Brown's Bench, Paradise Valley, and several rare and unknown sources. The wider range of obsidian sources used in the Late Archaic coincides with the more intensive use of the quarries noted above.

Field work has involved intensive survey of the quarries (Elston, Raven, and Budy 1987) and peripheral areas (Budy 1988; Drews 1988; Raven 1988; Zeier 1987), testing of numerous sites (Elston, ed. 1989), and data recovery (surface collections, surface scrapes, and excavations) at 25 sites (Elston and Raven 1992), most in areas peripheral to the main quarries. Recently, a probabilistic sample survey of 115 km^2 in the Tosawihi uplands surrounding the quarries (10.3%

of the landscape) was completed (Leach and Botkin 1992). These studies have revealed much about the quarries and the ways in which they were used; our research has been guided by models of toolstone procurement derived from microeconomics and evolutionary ecology; they provide the theoretical framework that has shaped the present inquiry.

General Theory

Our model focuses on the economics of toolstone procurement (Elston 1992b). For heuristic purposes, we employ an analytical construct, the *lithic production system* (Ericson 1984:3; Elston 1986b:138), representing the body of individual skills, knowledge, activities, and places having to do with lithic procurement. We further abstract the lithic production system into *components*, such as mobility patterns, schedules, labor organizations, technologies, and techniques of extraction, processing, storage, and transportation. We imagine that foragers confronting cultural and environmental variation (such as size of the annual range, distribution of food resources, occurrence of toolstone, season, and competition with other groups) combine lithic production system components into different *lithic procurement strategies*. Economic models (Christenson 1980; Torrence 1986, 1989), including our previous work (Elston 1992c), assume that a general goal of foragers is to maximize the benefit/cost ratio of toolstone procurement, or to achieve the greatest *efficiency* by lowering the time and energy invested in this activity. We have come to realize, however, that if prehistoric foragers were interested *merely* in efficiency, they would have procured toolstone by less labor intensive means that quarrying at Tosawihi. We must suppose, then, that Tosawihi quarriers invested time and effort in bedrock quarrying *in order to* increase their net rate of return, or *profitability* (Stephens and Krebs 1986:9). We further suppose that rate maximizing strategies are most likely employed to procure resources for which fitness requires some minimum amount within a finite time. In this light, it is interesting to reconsider the goal of several strategies of lithic processing and tool production (use of standardized products, specialist quarriers or knappers, simplified production procedures, optimized product design, structured use of space, and organized task groups) that Torrence (1986) identifies as efficiency-increasing. Because these approaches are all labor intensive, or require much material, or both, they can maximize the benefit/cost ratio (efficiency) only under certain conditions; for the most part, their use increases *net return* (profitability). At the same time, we recognize that constraints imposed by the primacy of food and water in subsistence do not always allow either the maximum benefit/cost ratio of lithic procurement or the greater profit to be obtained.

Environmental variation provides both opportunities and constraints for lithic procurement. For instance, the distribution and occurrence of lithic sources in the landscape, or *lithic terrane*, profoundly affects lithic procurement costs. The lithic terrane can vary along several dimensions that affect the benefit/cost ratio of toolstone procurement; a lithic terrane may contain many sources or none at all, sources may be clustered or widely dispersed, and toolstone quality may range from excellent to poor. Several permutations of toolstone abundance, quality, and distribution are diagrammed in Figure 1a-d; each circle represents an annual range, the curved lines are major streams (along which we assume the greatest concentration of food resources), black circles are good quality toolstone sources, and open circles are poor quality sources.

Modeling lithic procurement strategies, we can hold one constraint constant and vary one or more of the others. Consider the implications for mobile hunters and gatherers operating in the lithic terrane depicted in Figure 1a. Toolstone sources are abundant and widely dispersed throughout the range; even if food and lithic resources are not perfectly congruent, it is not far from any place to a lithic source of some kind. Travel and transportation costs of toolstone procurement are low and the

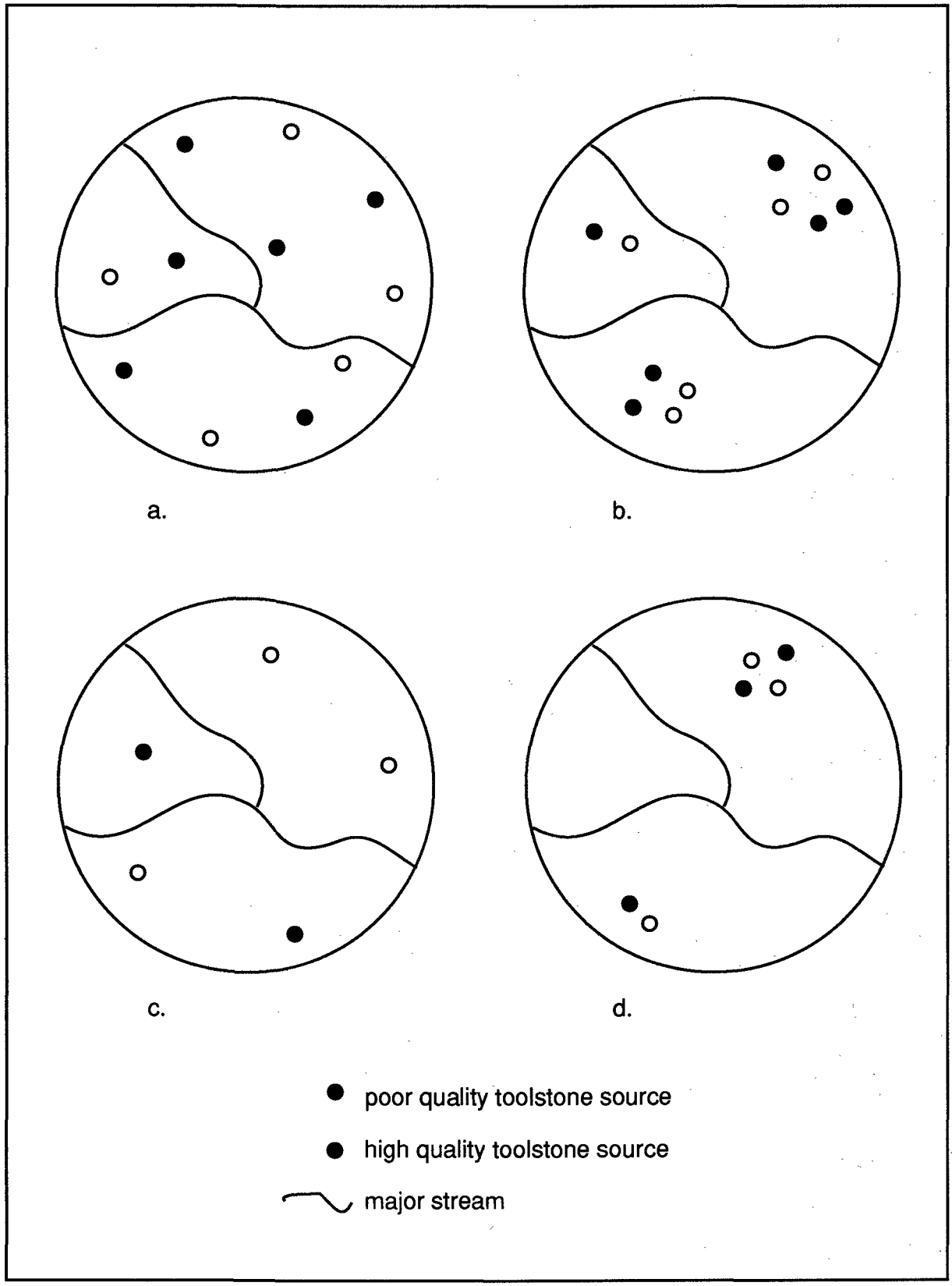


Figure 1. Toolstone distribution models.

need for strategies that minimize procurement costs or extend tool use-life are reduced; lithic procurement frequently can be embedded in forays for other resources. Holding mobility constant, lithic procurement costs, risks, and incongruence between lithic sources and food will tend to increase as lithic sources become more clustered (Figure 1b) and less abundant (Figure 1c), or both (Figure 1d). Foragers operating in poor lithic terranes such as those depicted in Figure 1c-d must plan lithic procurement carefully to ensure adequate toolstone supplies throughout the year. Strategies for dealing with scarce lithic resources dispersed over a large range under conditions of high mobility are exemplified in the portable, flexible lithic toolkits of Paleoindians (Goodyear 1979; Ellis and Lothrop 1989) with design parameters that require the use of high quality toolstone.

Alternatively, we can hold the lithic terrane constant and vary some other factor such as mobility. Consider a highly sedentary group tethered to a small foraging radius around the residential base. Unless a lithic source occurs within that foraging range, lithic procurement will require special logistical forays or must be embedded in forays for other resources. The less abundant and more dispersed the lithic sources, the greater the logistical problems and procurement costs. Even in a rich lithic terrane such as is depicted in Figure 1a, if sedentism results in use of a smaller annual range, access to the best toolstone sources may be limited. Trade may become the only option for procurement of high quality toolstone. Foragers then may choose to use cheaper, lower quality raw materials for most tools while reserving the more costly high quality materials for special purpose tools having high design standards.

Within the broad region east of the Osgood Mountains between the Humboldt River and the Owyhee Plateau, Tosawihi chert is abundant, often dominant, in most Archaic archaeological sites except those near a local toolstone source. All known local sources provided toolstone of quality lower than Tosawihi material, and none was quarried intensively. This suggests a lithic terrane different from any depicted in Figure 1a-d, one containing several dispersed sources of mediocre quality and one source (or clustered group of sources) of superior quality. The lithic procurement strategy employed along the Humboldt River through the Archaic appears to concentrate on Tosawihi chert for most tools when possible. Situational needs, however, often were filled by using local materials, particularly when people occupied a place long enough to consume supplies of tools originally brought there (e.g., James Creek Shelter; cf. Elston and Budy 1990).

By definition, lithic procurement strategies are not invariant. We propose, however, that, other things being equal, the tendency to make similar economic decisions in similar circumstances will result in use of a limited number of strategies in a given region or at a given lithic source, thereby producing a limited number of patterns visible in the archeological record. Nevertheless, specifying the economic factors operating in each element of a procurement strategy is difficult because each may have different currency, constraints, and decision variables. The problem can be simplified by considering the major classes of variables affecting the benefit/cost ratio of toolstone procurement. We define benefits as toolstone returns per procurement foray, and costs as all time and energy expended in travel, extraction, processing, and transportation, as well as lost opportunity. We assume that prudent foragers will seek to improve the benefit/cost ratio of toolstone procurement through strategies that maximize toolstone returns and minimize acquisition costs.

Patterns of Cost Minimization at Tosawihi Quarries

Cost-minimizing goals can be accomplished by manipulating schedules, adjusting organization of labor, locating task sites and residences strategically, and segmenting activities in the interest of efficiency. We thus model cost-minimizing strategies in terms of site placement and

activity segmentation, framing our expectations of assemblage content and location in qualitative or relative expressions that can be tested by statistical pattern recognition. For example, campsite position should tend to occur nearer or farther from toolstone source or subsistence resources (water, plants, animals) as duration of occupation varies; certain artifact or feature types are expected to occur with greater or lesser frequency in functionally different settings. This kind of model guided much of our previous work at Tosawihi, where we were concerned with explaining variability in position and content of several residential and workshop sites in areas peripheral to the main quarries (Elston and Raven 1992), as well as in concurrent study (Leach and Botkin 1992) of uplands surrounding them. In these cases, patterns of site location and assemblage content seem related to strategies that minimize costs not directly associated with quarrying.

Most sites investigated in previous work served as support areas associated with quarrying and processing opalite into bifaces. Most bifaces were processed to middle and late Stage 3 and heat-treated, often within a 1,000 meter radius of the quarries. Nevertheless, even at sites as much as 12 km from toolstone sources, much opalite still was being processed rather than used (Leach and Botkin 1992). Modeling processing and transportation costs (Elston 1992b) suggests that performing most processing at or near the source is a strategy that reduces cost and risk and increases net rate of intake.

Lack of extended occupation was expected, because, compared to lowland areas, food and water are scarce at Tosawihi for much of the year, making it difficult and expensive to stay there for extended periods. Residential sites where toolstone processing was incidental to procurement of other resources are absent or archaeologically invisible. With little archaeological evidence for the procurement or processing of non-lithic resources, we conclude that intensive prehistoric use of the landscape focused almost entirely on the acquisition of toolstone.

Nevertheless, people did linger at Tosawihi to extract and process large quantities of toolstone. Our quarrying and processing experiments indicate that to obtain 10 kg of bifaces (the weight of the largest biface cache so far found at Tosawihi), about 300 kg of toolstone had to be extracted and processed, requiring something like 34 person-hours (Elston 1992b). Assuming that the cached bifaces represent toolstone surplus, the total time for extracting and processing toolstone must have been even greater, to which also must be added time for travel, rest, and foraging. Thus, quarrying forays of several days duration for two or more people do not seem unreasonable.

We recognized two kinds of short term residential site immediately peripheral to the quarries, differentiated by content and location (i.e., domestic reduction sites and domestic quarrying sites; Leach 1992). Domestic reduction sites tend to be located central to water, food resources, and toolstone; diagnostic projectile points suggest they were used from the Early to Middle Archaic, with increasingly frequent occupation. They contain abundant and diverse flaked tools, relatively large numbers of millingstones, ceramics, and functionally diverse features, including hearths. Such sites seem to represent occupation of sufficient duration to require compromise in location, convenient to water and local food resources as well as to toolstone. In contrast, domestic quarrying sites are less common, and tend to be located at or near toolstone sources and reduction localities. Compared to domestic reduction sites, flaked tools are less abundant and assemblage diversity is lower; ground stone and ceramics are rare or absent. These sites may be products of less frequent, shorter term occupation by small groups (perhaps logistical parties) camping at or near toolstone sources. The pattern appears to have increased during the Late Archaic.

In addition to the tendency for domestic reduction sites to be located near diverse resources, and for domestic quarry sites to be located near toolstone, the distribution of non-quarry sites tends

to be distributed to minimize the costs of travel and transport between sources, reduction stations, and base camps (Raven 1992a). In particular, there tends to be a bi-modal, positive relationship between density of reduction stations and distance from quarries and residential sites—high in both the immediate vicinities of the parent quarry and the camp, low in intervening areas. This trend is not always perfectly expressed, however, owing to topography and other extrinsic factors.

We argued that season of use should be influenced by economic factors that determine when it is least costly to be at the quarries (Elston 1992b). For instance, when variance in food patch return rates are low, the added utility of toolstone at Tosawihi may have balanced food resource opportunities elsewhere. The archaeological record, however, so far has revealed few seasonal indicators. Variance in food patch return is low in winter, when quarriers would need to build substantial structures and hearths as protection from the elements; since neither have been observed at Tosawihi, we conclude that winter forays were infrequent. It also can be argued that lack of surface water after mid-August (assuming past conditions like those of today) probably limited the time people could spend at the quarries in late summer and fall. Too, the availability of important food resources elsewhere makes this an unlikely season for visits to Tosawihi. Spring visits to Tosawihi are suggested by the occurrence of hopper mortars and pestles in sites adjacent known bitterroot patches. In fact, we have observed that water is present and the abundance of food resources greatest in late spring and early summer, when regional variance in food patch productivity also seems minimal. In addition, a spring visit to Tosawihi to retool after a long winter in residence on the Humboldt River would position people advantageously for summer foraging in the range described by Steward (1938) for the ethnographic Tosawihi Shoshone. We conclude, therefore, that the most likely season of use for Tosawihi was late spring and early summer; confirmation awaits data more directly reflecting seasonality.

Direct evidence regarding prehistoric task group organization or mobility patterns is lacking. Nevertheless, if most quarrying occurred during the early spring and late summer, when family groups were likely to be foraging in the vicinity, the chances are good that parties were comprised of families or groups of families beginning their summer foraging round. Of course, this does not preclude the use of the quarries in any other season by specialized task groups.

Maximizing Toolstone Returns

Our previous work did not contradict the general lithic procurement and processing benefit/cost model. Concentrating on sites peripheral to quarrying, however, we relied on pattern recognition to elucidate strategies minimizing the indirect costs of toolstone acquisition. But most of the data, too, were peripheral to calculating direct costs of lithic procurement or to addressing the problem of toolstone rate-maximization.

Nevertheless, analysis revealed strong patterning in the distribution of bifaces and debitage, indicating much toolstone processing prior to transport from the quarry vicinity. Our general benefit/cost model suggested that such processing was likely part of a strategy to minimize risk and transportation costs. As a test of this, we modeled the benefits and costs of processing at the source versus deferred processing after transport. The model, using quantitative and experimental data on costs (time and caloric consumption) of lithic extraction, processing, and transportation, suggests that deferred processing is cost effective only under certain conditions. In preparing experimental data, we monitored return rates for both extraction and processing, showing that, since failure rates do not increase proportionally to processing rates, it probably pays to increase processing rates as much as possible.

At Locality 36, a site of intensive quarrying and processing, we extended the quantitative approach to investigate the role of rate-maximizing strategies in toolstone procurement. The goal of maximizing toolstone return is achieved through strategies that improve rates of extraction and processing, enabling the transportation of the greatest quantity of useful toolstone from the source. But bedrock quarrying is costly; we suggest that a prudent quarrier should seek the most cost efficient means of extracting toolstone, perhaps at the expense of maximizing toolstone quality. Relying on ethnographic analogy and data from experimental quarrying and processing, we estimated the time and energy requirements for a number of activities, including excavating quarry pits in various soils and bedrocks, extracting toolstone, and processing toolstone packages of different types and transporting them; we also considered failure and discard rates at different points along the reduction trajectory. Thus we are reasonably confident in framing models of lithic procurement, processing, and transportation in terms of rate-maximizing strategies. We expect to observe the consequences of such strategies in measurable or estimable attributes of features and artifacts in the archeological record. In particular, we looked at the number, size, and type of quarry features relative to toolstone occurrence and quality, proportions of biface blank types, numbers and proportions of bifaces in various reduction stages, and amounts and proportions of flakes and shatter in debitage.

In addition to quantitative expectations, our models of lithic acquisition also generate relative or qualitative expectations, tested here by statistical pattern recognition. For instance, if rate-maximization in toolstone extraction were a goal, we expect quarrying to have focused on toolstone of a particular range of quality. We expect the stage of processing to vary with distance from place of extraction, but we do not specify a particular distance for a particular stage, this remaining to be discovered empirically.

Estimating Benefit/Cost Factors of Toolstone Extraction

Extraction is the process whereby quarriers procure toolstone packages that subsequently are transformed into useful tools; it occurs after a decision has been made to work in a particular context, after prospecting, and it precedes toolstone processing. Since venture risk (the probability of losing time and effort invested in procurement) is at its peak during extraction (cf. Elston 1992c:Figure 11), *strategies* of toolstone extraction should strive toward cost-minimization and rate-maximization. Some factors probably important in keeping extraction costs low and toolstone return rates high include the location of toolstone, the structural features of the bedrock that constrain extraction or make it possible, the slope of opalite beds relative to the surface, the relative quality and the ease of extractability of the toolstone, and the size and form of toolstone packages obtainable.

In order to assess whether extraction at Locality 36 was efficient, we need to determine how each factor mentioned above either constrained or offered opportunities to prehistoric quarriers; we then can generate hypotheses about cost-minimizing/rate-maximizing behaviors that can be tested with archaeological data. To meet these goals we first ascertain where opalite occurs in the locality, since its presence would have determined the placement and development of quarry features. Second, we discuss some structural features of the bedrock that would have inhibited or facilitated toolstone extraction. Third, we explore the relationship between the inclination of bedrock and the methods used in its working. Following this, we consider the relative quality and ease of extraction of opalite across the locality. Finally, we estimate the sizes and the forms of toolstone packages that were taken from Locality 36.

Variability in the geological position of opalite beds at Locality 36 should influence the cost of extraction in different settings, and thus account for much of the observed variation in methods of working. We expect to see specific extraction methods employed in particular bedrock settings in order to maximize return rates under particular conditions. For example, bedrock more or less parallel to the surface seems most amenable to planing or to the formation of vertical quarry pits; as the angle of inclination becomes greater, however, adits or tunnels are likely to be formed. Quarry feature and bedrock studies undertaken in areas exposed by trenching allow us to assess this.

Given how Tosawihi opalite was formed and subsequently altered by faulting and erosion, it is likely that many structural features of the bedrock either facilitated or inhibited toolstone extraction. For example, fractures and tuff stringers and pockets may have been worked in order to free large, homogeneous blocks from parent material; beds of tuff underlying lenses of opalite may have been quarried in order to isolate ledges of toolstone from which flakes or blocks could be removed. On the other hand, massive opalite may have been so dense that aboriginal technology could not free usable pieces from parent material. Relationships between bedrock features and techniques of quarrying should support this; so we examined fractures and the massiveness of bedrock, as well as tuff bands, pockets, and stringers to determine if different extraction strategies may have been followed given variable geological conditions. Extraction techniques used during actualistic quarrying experiments under varying geological conditions also are discussed in order to evaluate which methods of working may have been most productive.

Determining the relative quality and ease of extraction of toolstone from parent material requires study of the structural features of the bedrock. Differential silicification and the degree to which bedrock is fractured determine toolstone quality. By definition, massive opalite is high quality toolstone because it is homogeneous, while unsilicified tuff or opalite with fractures, vugs, or pockets or stringers of unsilicified tuff, is of lower quality. Nevertheless, such structural features may facilitate extraction by providing means of ingress in to the bedrock, whereas massive opalite may not be quarryable by means available to prehistoric foragers. We suppose that the relative ease of extraction varies directly with the relative quality of toolstone (poor to excellent); moreover, toolstone return *rates* are also likely to vary in relation to toolstone quality. Analysis of bedrock quality and ease of extraction allows us to determine relationships between the two variables, and quantitative data obtained from actualistic quarrying experiments allow us to estimate toolstone return rates across various quality grades.

The size and form of packages extracted from bedrock impose limits on the morphology and dimensions of tools that can be produced, as well as on the techniques used to produce them (Jones 1984; cf. below). It is important, therefore, to understand *what* prehistoric quarriers were capable of procuring from parent material. Volumetric estimates obtained from quarry feature studies would offer one venue of investigation, and the sizes and shapes of toolstone packages obtained from actualistic quarrying experiments offer another. Both measures should provide an estimate of minimum and maximum dimensions of toolstone packages, as well as variation in their shape.

Examining Efficiency and Profitability of Toolstone Extraction

If increased return rate was a goal of lithic procurement at Tosawihi, how could be expect to see it played out in the archaeological record? For example, during the initial phases of extraction (e.g., removal of poor quality toolstone from a bedrock outcrop or the excavation of overburden), *where* can we expect quarry working and development to begin, and where should workings proceed thereafter? Once toolstone has been reached, where should extraction be focused if quarriers are to realize the highest rates of return?

The presence or absence of toolstone on the surface (either as clastic materials or outcropping bedrock) must influence the placement and development of quarry features over time; moreover, depth and nature of deposits overlying buried bedrock should influence quarrying behavior. Quarriers first would have pursued stone in those places where toolstone obviously was present and extraction costs were lowest; thereafter, places where costs were higher would have been exploited. Thus we reconstruct where toolstone may have outcropped prior to prehistoric exploitation of Locality 36, and we examine the soils overlying bedrock. Data from actualistic quarrying experiments allow us to estimate rates of excavation in different soils, and radiocarbon dates ordered the sequence of pit placement and development.

Once quarriers reached toolstone-quality bedrock, we suspect that they focused on those areas providing the best extraction returns, even if the highest quality material had to be ignored. We examine data from our actualistic experiments to estimate return rates across different portions of the bedrock and predict where toolstone return rates should have been highest. We drew surface maps of the exposed bedrock and quarry features to determine where toolstone extraction was most intense and if our hypotheses are supported.

Efficiency and Profitability in Toolstone Processing and Tool Production

We have remarked previously on intensification in the use of the Tosawihi Quarries, particularly through the Late Archaic, and speculated on the possibility of increased trade as a driving force. In addition to intensification of bedrock quarrying, what other indications of toolstone production for trade might we look for? Torrence (1986, 1989) suggests that when demand for lithic products is great enough (as in a market economy), producers are more likely to employ such strategies of processing and tool production, as use of standardized products, specialist quarriers or knappers, simplified production procedures, optimized product design, structured use of space, and organized task groups (as noted above, however, we believe these strategies to be rate-maximizing, rather than efficient). Thus, if use of such rate maximizing strategies in toolstone processing and tool production are visible in the archaeological record of Tosawihi, we can consider whether these efforts were beyond what we might reasonably expect of hunters and gatherers producing tools for their own use. If so, we might regard the development of a market for Tosawihi opalite as more likely.

After extraction, the options for processing toolstone are limited by the form of material extracted. Following the logic outlined above, an understanding of prehistoric extraction goals guides our understanding of how toolstone could have been further reduced. Since the production of tools and other transported forms is the goal of lithic procurement, determining *what* was produced and *why* particular technological strategies were followed is important for examining any model of lithic economy.

The high cost of toolstone transport dictates that initial packages be reduced to maximize the amount of *useful* toolstone mass prior to transport. Unfortunately, we cannot determine why a particular form was considered "useful." Rather, we are left to assume that transported forms were, by definition, "useful." For example, bifaces may be transported for use as combined tools and flake cores, simply for use as tools, to serve as cores (Kelly 1988), or even to be traded to someone else. We are forced to rely on evidence of toolstone processing at any given place to determine what such *useful* forms were. Obviously, the usefulness of a tool form may vary depending on many factors. For example, in our earlier research we found a fairly consistent pattern of increase in late stage biface frequency at greater distances from toolstone sources

(Bloomer et al. 1992). At greater distance from opalite sources, then, the "useful form" (as evident archaeologically) increases in reduction stage. However, even 12 km away from toolstone sources, such "useful" items had not yet been utilized to do anything. We examine these issues with reference to the archaeological data from Locality 36 and the Tosawihi area as a whole, our replication data derived from quarrying and processing experiments, and from ethnographic data.

Discovering Toolstone Packages

Determining what was produced at Locality 36 requires estimation of several factors. First, the size and form of packages extracted from bedrock must be determined, since these constituted parameters on the size and forms of tools as well as the techniques used to produce them. Second, the size and form of products must be estimated, as well as the techniques used to bring them about. Third, we seek to estimate what was transported from Locality 36. Finally, since all these factors may have changed through time, we seek also to detect chronological differences among them.

We already have discussed ways to determine the techniques and likely products of toolstone extraction in terms of attributes of opalite occurrence. Analysis of the products derived from extracted blocks also can indicate the initial forms from which tools were fashioned. Thus, we examine the frequency of varieties of biface blanks, the proportional frequency of large debitage (including angular debris), and the incidence of reduction techniques specific to particular reduction strategies. In ensuing chapters, we examine the frequency of attributes indicative of blank form in the biface assemblage, use of specialized biface thinning techniques, debitage size-grade ratios, and debitage type frequencies.

Strategies of Lithic Processing

We looked at strategies of lithic processing through stone tool and debitage studies. We presume that most successful chipped stone reduction sequences terminated when the biface, core, or flake was removed from the site; remnant tools, cores, and flakes are failures and refuse. Bifaces broken in manufacture are one avenue of inquiry into blank forms and lithic reduction techniques (including heat-treatment) used on different blank forms. We examine these in Chapter 5. Debitage from post-extraction processing and reduction retains important data. Comparing Locality 36 debitage samples with experimental control assemblages we can see the range of reduction techniques employed, the dominant reduction stages completed, and the point(s) at which reduction ceased (cf. Chapter 4).

Stone tool and debitage studies are used to estimate the probably successful products of lithic reduction at Locality 36. To do this, we use a simple mathematical model relating observed failure rates to observed biface frequency. Under-represented reduction stages are likely to have been transported; debitage evidence provides an independent examination of the same issue. By examining the frequency of different reduction stages, we can specify whether debitage roughly matches the Locality 36 tool assemblage or shows that some tools are missing. Temporal change in tool production is examined by controlling for time, where possible.

We also address these questions by contrasting Locality 36 with other quarry assemblages from Tosawihi (Elston and Raven 1992). Although no other quarry has been examined as extensively as Locality 36, differences in product form and reduction techniques can provide insight into use of the greater Tosawihi vicinity.

The Structure of Quarrying and Ancillary Activities

Locality 36 is one of the few quarries scrutinized extensively in North America. Scant ethnographic accounts of quarrying emphasize that quarry workers tend to perform particular actions in particular places (e.g., Binford and O'Connell 1984; Jones and White 1988), but these descriptions are difficult to overlay onto archaeological sites, since the archaeological record may represent hundreds or even thousands of individual events like those described ethnographically. This means that seeking individual flint knappers in the pavement of debris at Locality 36 is fruitless. Instead, understanding the spatial organization of the locality requires changing the focus of inquiry from individual events to the aggregate spatial pattern. Where humans can work is determined by the presence of suitable work space; thus we can expect regular spatial patterning at Locality 36 (and many other quarries). These owe to the "messy" nature of quarrying itself. Large blocks of useless tuff, unused opalite, smears and piles of dirt, and other trash, would have made an active quarry pit a poor place to sit and reduce bifaces. Hence, we expect that the incidence of biface reduction at any given moment should be low at or near active quarry features. Abandoned and unused quarry features may present similar, though less hazardous, problems. Large blocks can litter the surfaces of quarry pits and their environs, making them unsuitable work spaces, even though the pits themselves are not in use. So, we further expect that except for extraction, initial assaying, and blank acquisition, most later stage lithic reduction actions *should* occur away from quarry pits. This statement is conditional, however; we examine it in some detail in Chapter 10, where the spatial distributions of features, artifacts, and outcomes of prior analyses are presented and discussed.

We ask, too, if it is possible to discern task group structure from occupational pattern, either generally or at given time periods. We sought evidence of ancillary activities such as food acquisition and preparation, hearth-associated activities, and other non-quarrying tasks. Tools and debitage of exotic material, microwear evidence, flotation analyses, and other studies are brought to bear on the question.

Summary

Locality 36, of many intensively-used quarries at Tosawihi, provides our most direct glimpse into processes of prehistoric toolstone extraction and lithic production in north central Nevada. Employing optimization models that assume prehistoric quarriers were acting to increase their net returns, we evaluate hypotheses about cost-minimizing/rate-maximizing strategies of toolstone procurement and processing. Investigation of site formation processes, examination of geomorphologic characteristics, in-depth technological analyses, actualistic quarrying and replicative studies, and use of economic transport models all will inform the complex system of lithic production witnessed at Tosawihi.

Before sketching the field methods applied at Locality 36 (Chapter 3) and then turning to the technological and theoretical issues outlined above (subsequent chapters), in the next chapter we place Locality 36 and the Tosawihi Quarries in their larger regional, natural, and cultural contexts.

Chapter 2

NATURAL AND CULTURAL SETTING

Kristopher R. Carambelas

The Tosawihi Quarries (26Ek3032) occupy a rocky, gently undulating expanse at the junction of the Sheep Creek Range and the southwestern foothills of the Tuscarora Mountains (Figure 2). Landforms in the area have been moderately dissected by currently seasonal drainages, eroding considerably since their formation. The Tosawihi Quarries encompass elevations between 1675 m and 1860 m amsl, standing some 200 meters above extensive plains to the west and the south, and some 580 meters below the peaks of the Tuscarora Range 19–24 kilometers to the east. The area constitutes a mid-to-upland setting which is transitional between two distinct ecozones, and the biota which it hosts are communities and species that are more dominant in neighboring settings.

Locality 36 lies in the southern reach of the Tosawihi Quarries, one of 225 archaeological localities comprising the site known administratively as 26Ek3032 (Figure 3). The locality occupies a portion of the top and southwestern slope of a northwest-southeast trending ridge at an elevation of 1756 m amsl (Figures 4, 5). Outcrops of silicified lithic material and a complex (n=55) of quarry pits signal a place where superior toolstone was obtained prehistorically (Elston, Raven, and Budy 1987:42).

Geology

Late Miocene or early Pliocene alteration of Tertiary volcanics modified the lithic landscape in the vicinity of the Tosawihi Quarries. Hydrothermally-induced silicification of rhyolitic ashes and tuff left vast beds of a milky, internally homogeneous opalite (Bailey and Phoenix 1944:17-21) that evolved through dehydration and crystallization. Minimal internal structure and relative homogeneity lent the material desirability as toolstone, attracting the attention of prehistoric quarriers; lodes of cinnabar trapped in the upper components likewise attracted the attention of mercury miners early in the 1900s, prompting the initial exploration of the Ivanhoe Mining District (Bailey and Phoenix 1944; Benson 1956; Hollister 1986:4; Smith 1976; Zeier 1987:4-8), an endeavor that continues to the present with gold now the focal point.

Other principal geologic units consist of rhyolite flows dominating the plateaus east of the quarries and massive basalts that outcrop in the red hills to the west. Both materials were transported to Locality 36 by prehistoric quarriers for use as quarrying and reduction tools (cf. Chapter 6).

Water

The Tosawihi Quarries lie entirely within the higher, eastern reaches of the Lahontan hydrographic basin (Mifflin and Wheat 1979:Plate 1); surface waters drain west down the Humboldt River system to their terminal basins in the Humboldt and Carson sinks. Minor tributaries feeding the Humboldt from the flanks of the quarries include perennial streams to the north and west (Willow Creek and Rock Creek, respectively), and to the south (Little Antelope Creek, which flows seasonally). With the exceptions of the seasonal drainages in the gorges of Velvet and Little Antelope Canyons, drainages near the quarries are ephemeral and run-off is rapid.

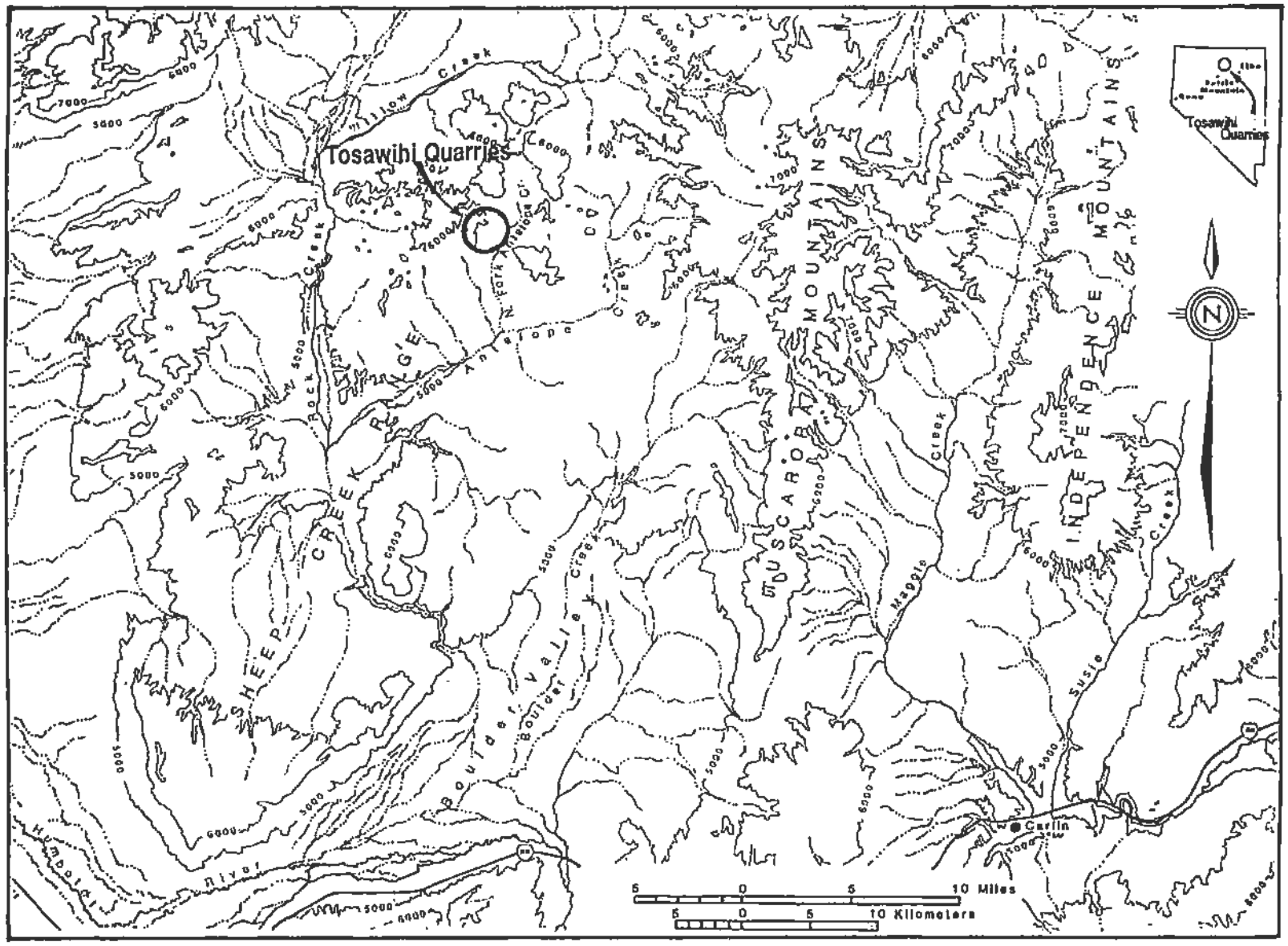


Figure 2. Regional map.

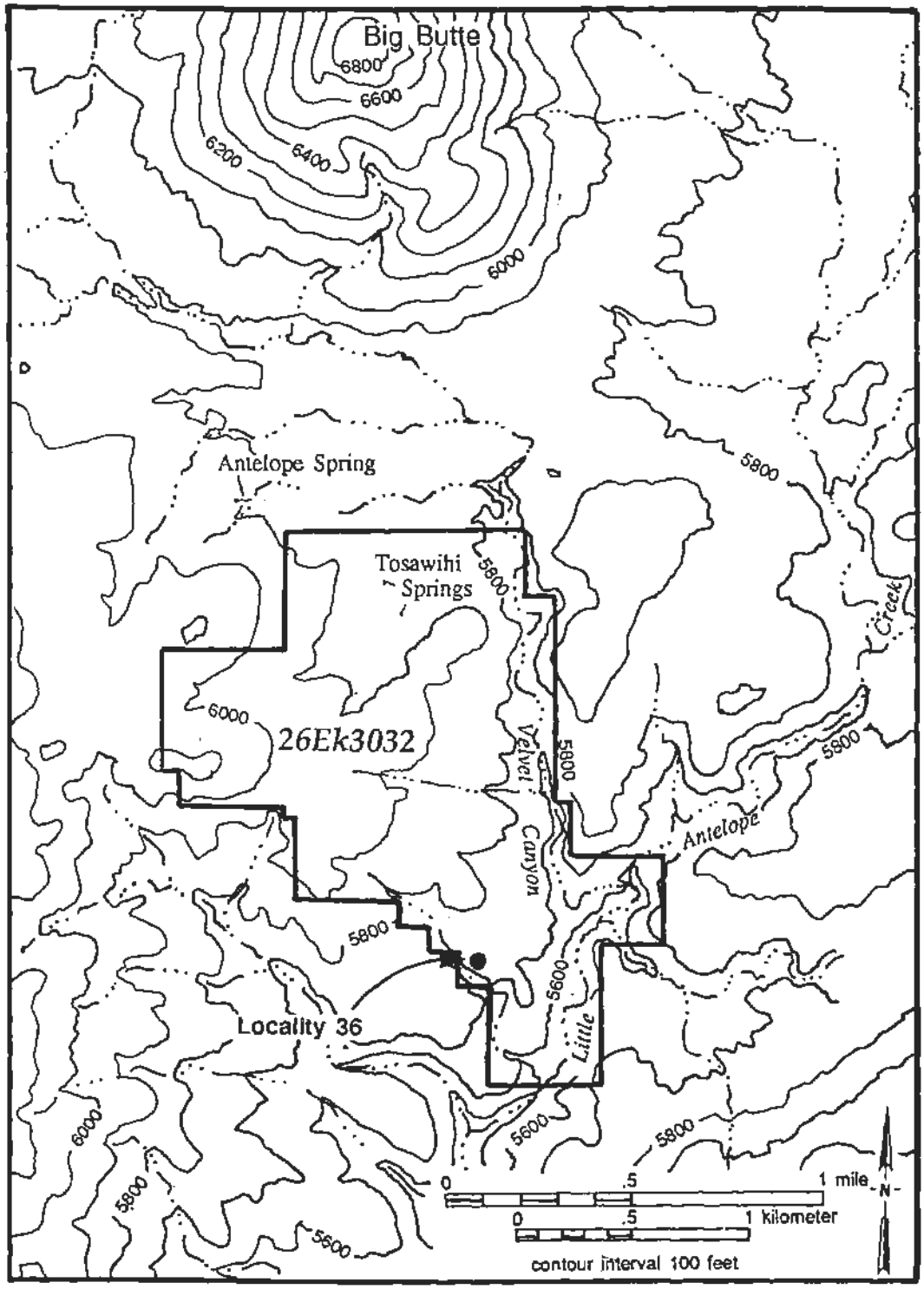


Figure 3. Location of Locality 36 relative to 26Ek3032 site boundaries.

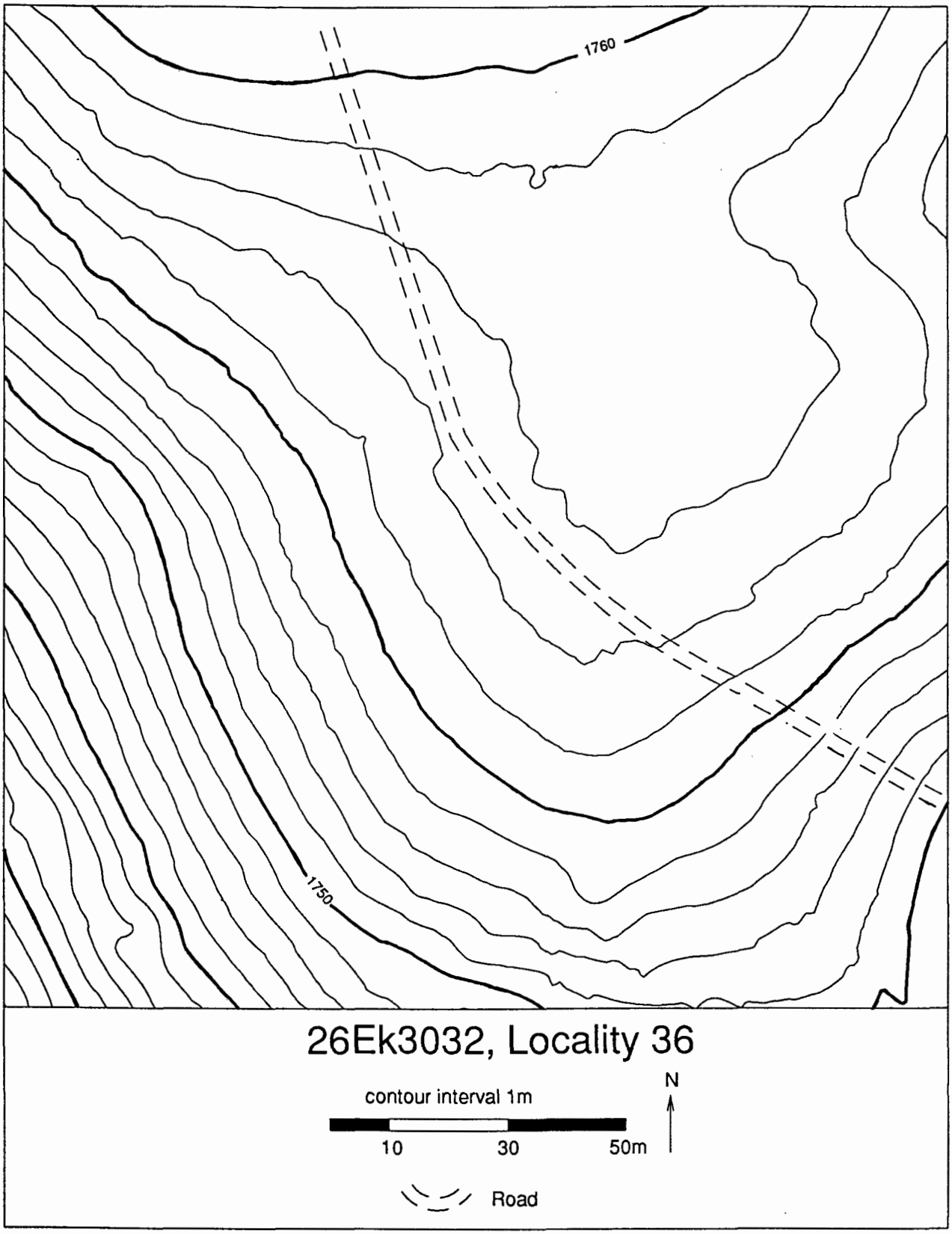


Figure 4. Topographic map of Locality 36.



Figure 5. Locality 36, view of southwest facing slope.

Few springs are generated by the shallow, seasonally depleted aquifers. Ivanhoe and Buttercup Springs to the north of the quarries have yielded water beyond August and, in recent years, have maintained a modest, late-summer flow in Ivanhoe Creek; Tosawihi and Antelope Springs in the main body of the quarries, however, and minor seeps east and west of the quarries, are dry by August. Although various relict spring mounds (chiefly in Big Butte Valley) attest to better water in the past, *access* to water over much of the Holocene almost certainly imposed severe constraints on human exploitation of the quarries (Raven 1992b).

Early in the 1990 and 1991 field seasons (mid May to early June), archaeologists noticed that quarry pits excavated into massive opalite beds at Locality 36 retained water from snow melt and rain showers. Although toolstone probably was the chief attraction at Locality 36, no doubt the gratuitous accumulation of water in opalite reservoirs was an additional benefit to quarriers working at the locality.

Flora and Fauna

Vegetation around Tosawihi is an expression of the Artemisian biotic province, characteristic of the high desert valleys and lower foothills of the northern Great Basin (Billings 1951:110-113; Cronquist, Holmgren, and Reveal 1972). Two communities of this sagebrush-grass zone occupy the area, their incidence conditioned largely by elevation, slope, and aspect. Silty bottom lands and other areas of deeper soils, as well as semi-shadowed northern exposures, are dominated by big sage (*Artemisia tridentata*) and rabbitbrush (*Crysothamnus nauseosus*) in the shrub component, and by Great Basin wildrye (*Elymus cinereus*) and bluebunch wheatgrass (*Agropyron spicatum*) in the grass component. Thin-soiled settings (i.e., knoll-tops, cobble fields,

washes) where seasonal drainage continuously has inhibited soil development tend to be occupied by a community composed primarily of low sage (*Artemisia arbuscula*), phlox (*Leptodactylon* sp.), squirreltail (*Sitanion hystrix*), and Idahoe fescue (*Festuca idahoensis*). Numerous forbs are associated with the two communities, including various buckwheats (*Eriogonum* sp.), globe mallow (*Sphaeralcea* sp.), *Mentzelia*, lupine (*Lupinus* sp.), larkspur (*Delphinium nuttallianum*), and bitteroot (*Lewisia* sp.).

Less prevalent plants are found in the microhabitats of the quarry vicinity. Canyon bottoms and heavily shaded northern exposures support stands of wild rose (*Rosa* spp.), gooseberry (*Ribes aureum*), chokecherry (*Prunus virginiana*), and serviceberry (*Amelanchier alnifolia*); *Artemisia ludoviciana*, an annual sage, occupies the dry sandy floors of some of the gorges, brief strings of willow (*Salix* sp.) are found in moist stream channels, and a few barren exposures east of the quarries host unexpected clumps of *Coryphantha vivipara*, a small cushion cactus. Introduced species including sedge (*Carex* sp.) and curley dock (*Rumex crispus*) occur in a few wet meadows; an additional foreigner, cheatgrass (*Bromus tectorum*), has invaded a recently burned area of Big Butte Valley, along with mustard (*Brassica* sp.) and thistle (*Cirsium* sp.).

The Tosawihi Quarries lie within the Upper Sonoran life zone (Merriam 1889), the largest, most diverse life zone in the region. Water is scarce and seasonal at the quarries, however, and vegetation communities there are neither diverse nor particularly productive; consequently, few animals inhabit the vicinity. Larger mammals seasonally attracted to the area include antelope (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*). Elk (*Cervus canadensis*) have been sighted, and their antlers observed, near the quarries. A sheep horn (*Ovis canadensis*) and bison bones (*Bison bison*) recovered from localities of 26Ek3032 suggest these animals have visited the area in the recent past. Smaller mammals are more numerous; over four seasons of archaeological investigation, field crews have observed pocket gopher (*Thomonys* sp.), wood rat (*Neotoma cinerea*), chipmunk (*Tamias* spp.), various ground squirrels (*Spermophilus* spp.), marmot (*Marmota flaviventris*), cottontail rabbit (*Sylvilagus nutallii*), pigmy rabbit (*Sylvilagus idahoensis*), jackrabbit (*Lepus townsendii* and *L. californicus*), bat (order CHIROPTERA), badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), and coyote (*Canis latrans*).

Observed avifauna include golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), kestrel (*Falco sparveius*), great horned owl (*Bubo virginianus*), common raven (*Corvus corax*), turkey vulture (*Cathartes aura*), sage grouse (*Certrocercus urophasianus*), and chukar partridge (*Alectoris chukar*), an introduced species. Field crews also have noted various reptiles: lizards are represented by the western whiptail (*Cnemidophorus tigris*), horned lizard (*Phrynosoma* sp.), and side-blotched lizard (*Uta stansburiana*), ophidians by garter snakes (*Thamnophis elegans*), gopher snakes (*Pituophis melanoleucus*), and western rattlesnakes (*Crotalus viridis*). The only fish observed at Tosawihi, a few dace (*Rhinichthus* sp.), were seen in spring-head ponds and some pools along Little Antelope Creek.

Additional information on fauna of the Tosawihi vicinity are presented by Hall (1946), who discusses mammals, and by Linsdale (1936) and Ryser (1985), who describe birds; fisheries are reviewed by La Rivers (1962), and reptiles are discussed by Stebbins (1966).

Cultural Environment

The study area is situated in the historical Ivanhoe Mining District (Bailey and Phoenix 1944:17-21). Mercury development at the Clementine, Butte, and Velvet workings dates from about 1929, although mercury ore was discovered there in 1911 (Zeier 1987:6). Through the 1940s, mining continued intermittently, with most production generated by the Butte Quicksilver Mine;

with the advent of World War II, mercury mining intensified until 1947 and a brief resurgence occurred between 1957 and 1962, and again in 1966, probably in response to increased international mercury prices (Zeier 1987:6). Exploratory drilling for other mineral resources was initiated in 1979. Gold associated with the local opalite formation and deposits at Red Hill motivates mining ventures in progress today.

Locality 36 occurs in the area used by the ethnographic Tosawihi, or "White Knife," Shoshone, a group who wintered along the Humboldt River near present-day Battle Mountain and whose foraging range included areas flanking Rock Creek (Steward 1938:162). Unlike other Shoshonean groups, whose group names identified prevalent food resources, the name *Tosawihi* is derived from a locally available white toolstone, almost certainly Tosawihi opalite, but references to ethnographic Shoshone (Harris 1940; Powell and Ingalls 1874; Steward 1937, 1938, 1939, 1941) shed little light on the mechanisms of opalite procurement, transport, and trade, or on their relationships to settlement and subsistence.

Previous Research

Early inquiry into the nature and composition of Tosawihi assemblages, distribution of archaeologically transported Tosawihi opalite across the landscape, and chemical "fingerprinting" of the lithic material was made by Mary Rusco in several unpublished papers (Rusco 1976a, 1976b, 1978, 1979, 1983), and attempts have been made to characterize Tosawihi opalite utilizing X-ray fluorescence (Duffé 1976a, 1976b; Raven 1992b). Intermountain Research initiated intensive investigations at Tosawihi in 1987; since that time, investigations have included survey, testing, and data recovery.

Survey of the main body of the Tosawihi Quarries is reported by Elston, Raven, and Budy (1987), while surveys undertaken adjacent the quarries are reported by Budy (1988) for the Western Periphery, by Raven (1988) for the Eastern Periphery, and by Drews (1988) for the Northern Corridor. Historic sites in the Tosawihi vicinity are reported by Zeier (1987). Following these studies, Elston (1988) drafted *A Theoretical Approach to the Archaeology of the Tosawihi Quarries* to guide subsequent inquiry at Tosawihi, and Intermountain Research (1987) drafted a management plan for the quarries. Sixty-five sites peripheral to the heart of the quarries were tested in 1988 (Elston 1989), and, as a consequence, a detailed data recovery program was proposed (Intermountain Research 1988a-d) and executed in 1989 (Elston and Raven 1992).

The 1989 data recovery program demonstrated that, prehistorically, Tosawihi was a place visited primarily for its opalite, and that tools had been manufactured from its raw material sources for at least 8,000 years. Almost all the sites investigated in 1989 were camps or workshops, places to which toolstone or partially reduced bifaces were transported and reduced prior to their export from the Tosawihi vicinity (cf. Chapter 1). Information provided by 1989 investigations, along with information obtained from a recent probabilistic sample survey in the Tosawihi hinterlands (Leach and Botkin 1992), provides important insights into the lithic production system operative in the Tosawihi vicinity.

The present report is concerned with data recovery conducted in 1990 at Locality 36. Unlike previous investigations, which focused on sites peripheral to the main body of the quarries, investigations at Locality 36 are concerned, for the first time, with a quarry site *within* the heart of Tosawihi.

Cultural Chronology

Syntheses of regional cultural chronology have been offered at various levels of abstraction by James (1981), Rusco (1982), Smith et. al (1983), and Elston (1986a), while Elston and Drews (1992) have outlined the cultural chronology for the Tosawihi Quarries. The reader is referred to Raven (1992b) for a comprehensive review of the ethnographic and the archaeological literature relevant to Tosawihi. Below, a comparison of regional cultural sequences is offered (Figure 6) and a cultural chronology proposed for the upper Humboldt region (Elston and Budy 1990) is summarized.

Dry Gulch Phase (?-6000 B.C.). Regarded as Pre-Archaic in the broader sequence of Great Basin adaptations (Elston 1982), this phase originally was defined as the Western Pluvial Lakes Tradition, assumed to be a lacustrine adaptation (Bedwell 1973). Presently, however, it is observed in both riparian and upland settings. As the earliest phase recognized along the upper Humboldt, it reflects a distinctive lithic technology, a lack of seed grinding implements, and high residential mobility. Diagnostic artifacts include concave-base projectile points, Great Basin Stemmed points, flaked stone crescents, heavy core tools, scrapers, and choppers; some of these have been noted and recovered at Tosawihi (Elston, Raven, and Budy 1987).

No Name Phase (5000-2500 B.C.). The emergence of Early Archaic adaptation along the upper Humboldt River drainage is marked by Northern Side-notched and Humboldt Series projectile points (Heizer and Hester 1973; Thomas 1981, 1983), but few such sites have been observed (Elston and Budy 1990). Elsewhere in the Great Basin, Early Archaic adaptations represent a probable increase in diet breadth (including the intensification of seed use), increased locational diversity in land-use patterns, and logistical structuring of subsistence pursuits (Elston and Budy 1990).

South Fork Phase (2500-850 B.C.). The Middle Archaic on the upper Humboldt is not well characterized by existing data; Humboldt and Gatecliff Series projectile points, however, are considered diagnostic (Elston and Budy 1990).

James Creek Phase (850 B.C.-A.D. 700). Marking the full expression of Archaic adaptations, this phase witnessed the exploitation of an extremely wide range of settings and resources, broadening of the prey-base, and more eclectic use of the environment. Elko Series projectile points are its primary temporally diagnostic artifacts.

Maggie Creek Phase (A.D. 700-1300). Rosegate Series projectile points (and Fremont Grayware ceramics in the eastern Great Basin) are diagnostic of this phase. At James Creek Shelter, the phase is characterized by further intensification of plant use, increased pursuit of small game, and introduction of the bow and arrow (Elston and Budy 1990).

Eagle Rock Phase (A.D. 1300 to protohistoric times). This phase apparently represents the archaeological record of the Numic peoples who occupied the area at historic contact. Along the upper Humboldt, time diagnostic artifacts marking the phase include Desert Side-notched and Cottonwood projectile points and Shoshone Brownware ceramics (Elston and Budy 1990).

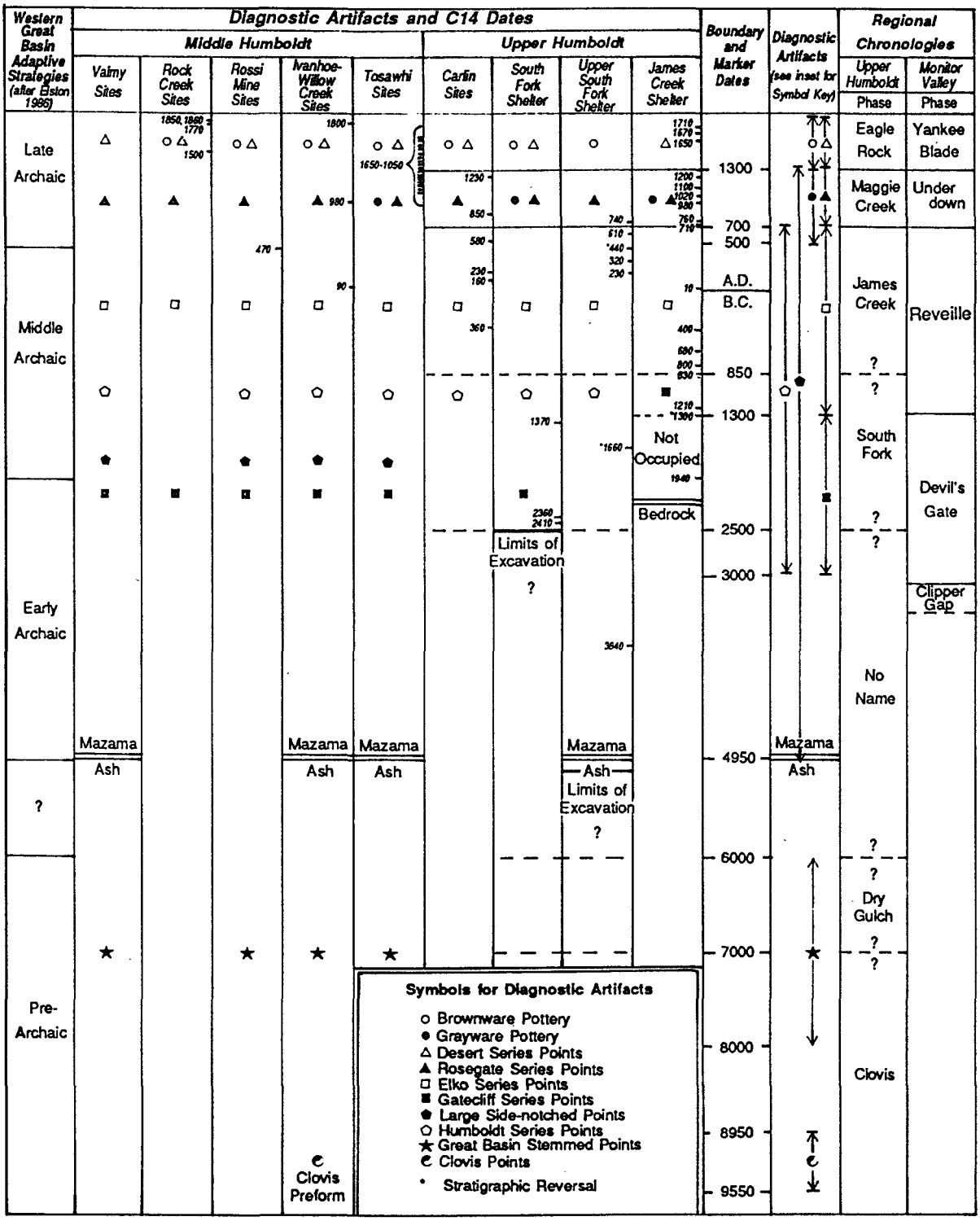


Figure 6. Prehistoric Chronology for the Upper Humboldt Valley, Nevada (after Elston and Drews 1992:Figure 208).

Chapter 3

FIELD METHODS

Dave N. Schmitt, Kathryn Ataman, Kristopher R. Carambelas, Eric E. Ingbar, Melinda Leach, and C. Lynn Rogers

Locality 36 encompasses approximately 5 acres of a ridgetop and west-southwest slope (Figure 7) in the southwest corner of 26Ek3032. Opalite eroding from tuff deposits or occurring within 1.75 m of the surface attracted prehistoric quarriers at least as early as 4000 B.P. The site is covered with a dense blanket of debitage and is pocked with more than fifty depressions produced by prehistoric opalite quarrying. The utilized opalite deposits occur in a 30m wide band that parallels the ridge line 10-30 m below the summit of the ridge. The quarry pits are concentrated in this band, and other, less dense, lithic scatters can be seen in level areas on the hilltop.

Quarry sites often are complex, encompassing large areas, containing concealed but extensive subsurface features, and having voluminous material records. With this in mind, and in light of questions posed by our research design (cf. Chapter 1), diverse field strategies were devised to effect data recovery at Locality 36; these included surface collections, surface scrapes, controlled subsurface excavations, excavation of backhoe trenches, detailed stratigraphic documentation, actualistic quarrying and replication experiments, and in-field debitage analysis. Because the site is so large and so thickly mantled with debitage, sampling was critical to each component of fieldwork; we applied a variety of systematic and judgmental sampling techniques in feature and non-feature contexts.

The Feature Assemblage

Five types of feature were distinguished: quarry pits, reduction features, utilized outcrops, hearths, and possible hearths. Quarry pits were distinguishable in the field as circular to oval depressions; often, but not always, cobble-sized blocks of opalite are associated with them, and debitage almost always is common in and around them. Reduction features, or lithic scatters, are distinct concentrations of debitage not associated with quarry pits. Utilized outcrops consist of opalite exposures that have been battered, flaked, or otherwise manipulated by human action; the five outcrop features observed each consist of the bedrock and an associated lithic scatter. While quarry pits, reduction features, and utilized outcrops were distinguishable on the surface, subsurface quarry pits were discovered during backhoe trenching, and hearths were found only below surface after the central portion of the site had been scraped mechanically. Hearths appeared as ashy, dark, concentrations. Possible hearths also were ashy, and darker than the surrounding matrix, but they were more amorphous and less distinct in color and texture.

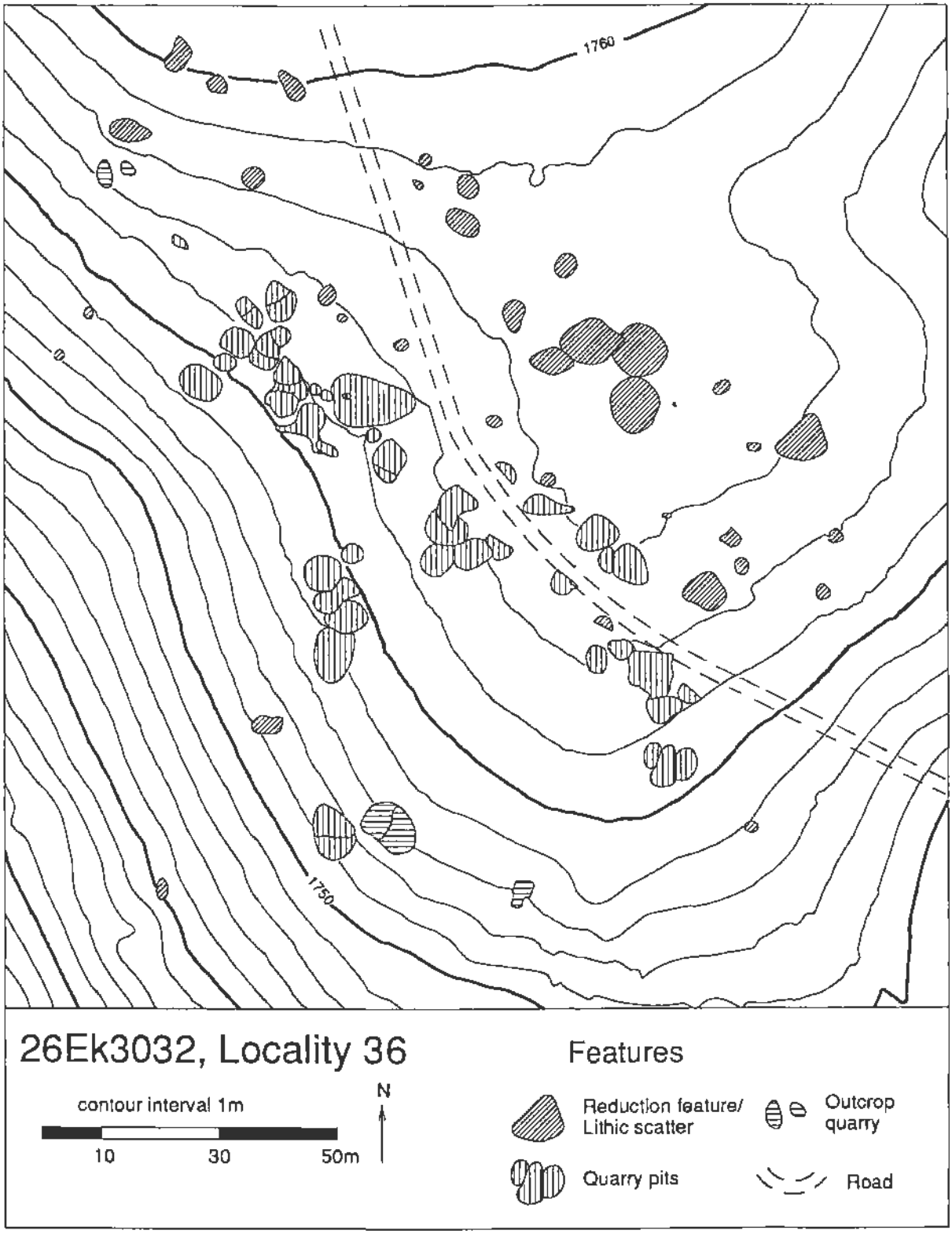


Figure 7. Distribution of features.

Locality 36 contains 108 features. Ninety-seven are surface features, identified by closely spaced transects examined across the site. Five subsurface features were found during backhoe trenching in and around surface quarry pits; all are products of opalite extraction. The other six features were observed during the scraping of approximately 10 cm of the surface mantle from the central portion of the site with a mechanized grader. Five are hearths, the sixth, a possible hearth.

Feature types assigned in the field encompass variation within each type. For example, backhoe trenching of two quarry pits revealed that they also contained adits. Hand and mechanical excavations increased our knowledge of variation within each type. Subsurface examination forced reconsideration of feature type in only one case (Feature 70, a reduction feature adjacent a buried quarry pit).

Our discussions of Locality 36 features rely on the term *debitage aprons*. Debitage aprons are concentrations of chipped stone debris coterminous with the boundaries of most quarry pits at the locality. They are features in their own right, consisting of complex pastiches of formerly discrete reduction features, debris from quarry pits, and things moved downslope by natural processes. The areal extent of debitage aprons precludes their investigation by traditional methods.

Feature type attributes are presented in Table 1, and are summarized below.

Quarry pits—Fifty-five quarry pits appear as surface depressions (Figure 8), often, but not always, filled with rubble (Figure 9). Their depths are variable (cf. Chapter 9). Many, but not all, quarry pits consist of three component areas: pit floor, pit walls, and a berm of debris surrounding the outside of the pit (Figure 10). At Locality 36, quarry pits range in surface area from 2.5 m^2 to a maximum of approximately 88 m^2; over half occupy between 15 and 30 square meters (Figure 11). Five quarry pits were discovered by backhoe trench excavation.

Reduction features—Thirty-seven reduction features were defined in the field as spatially discrete concentrations of chipped stone debitage (Figure 12). Estimates of the number of flakes present on the surfaces of such features range from approximately 100 to more than 2000. At Locality 36, reduction features range in area from 0.1 m^2 to 74 m^2. Reduction features usually are small, encompassing less than a square meter (Figure 13).

Outcrop/reduction features—Five features were defined as lithic scatters associated with opalite outcrops. Examination of the outcrops revealed relatively poor quality opalite, and we infer that little useful toolstone was derived from them. Lithic scatters associated with the outcrops are low in overall density and cover 10 to 40 square meters.

Hearths and possible hearths—These features were encountered after the surface of the ridgetop at Locality 36 had been scraped mechanically. Five hearths (Features 105 to 109; Figure 14) appeared as ashy, dark stains 0.5 to 1.0 m in diameter. Charcoal fragments were present in all, and all but one contained fragments of fire-cracked rock. The hearths were shallow (approximately 10 cm in depth) and lacked prepared collars or edges (Figure 15); perhaps the surface into which they were excavated was removed by the grading. The one possible hearth observed (Feature 110), also exposed by mechanized scraping, was a poorly defined stain, somewhat darker than the surrounding matrix, lacking artifacts.

Table 1. Surface Features.

Feature	Type	Area	Northing	Easting	Investigation Method										
					I	N	T	L	C	S	E	D	F	M	Profile
1	RE	22.9	149.12	21.16	+										
2	OC	19.6	142.15	20.88		+	+								
3	OC	10.5	141.92	17.29		+									
4	RE	3.1	117.73	14.36		+									
5	RE	3.1	110.60	9.46		+									
6	RE	21.6	161.77	29.99	+					+	+				
7	RE	6.6	157.19	35.66		+									
8	BZ	0.0	140.89	24.78											
9	QP	4.9	130.14	30.16	+										
10	BZ	0.0	125.97	27.22											
11	QP	9.4	109.47	37.78	+		+								+
12	QP	24.7	113.68	40.36	+		+								+
13	QP	40.8	105.94	33.48	+		+								+
14	RE	6.3	20.08	26.83		+									
15	QP	24.7	29.80	55.40	+										
16	QP	30.2	31.79	54.75	+										
17	RE	11.8	48.14	44.13		+									
18	QP	30.6	73.05	53.74	+										
19	QP	22.8	99.15	51.45	+										
20	CB	9.6	95.76	53.42	+										
21	QP	27.5	102.35	47.81	+										
22	QP	12.6	104.18	54.41	+		+	+	+						+
23	QP	12.3	105.56	47.92	+										
24	QP	13.7	107.75	48.35	+										
25	QP	13.4	107.38	53.51	+		+	+	+						+
26	QP	11.8	110.12	43.39	+										
27	QP	28.3	111.44	50.29	+		+	+	+						+
28	QP	31.8	112.53	44.75	+										
29	QP	12.4	114.42	48.01	+		+		+						+
30	QP	12.6	117.33	42.34	+										
31	QP	13.9	119.19	46.32	+		+		+						+
32	QP	17.6	121.16	45.70	+		+	+	+						+
33	QP	11.0	119.68	40.77	+										
34	QP	8.3	123.16	41.27	+										
35	QP	5.6	124.10	44.61	+		+		+						+
36	RE	12.2	140.84	42.58	+										
37	RE	7.1	156.40	48.94		+									
38	RE	.6	102.22	113.71						+	+				
39	RE	.9	143.88	71.40		+									
40	RE	2.8	117.51	57.87	+										
41	RE	4.8	112.70	67.73	+										
42	QP	88.0	102.24	62.73	+		+	+	+						+
43	QP	6.5	97.05	57.84	+										
44	QP	17.7	95.20	60.09	+										
45	QP	3.1	97.90	61.80	+										
46	QP	11.0	93.71	65.49		+									
47	QP	11.0	76.83	58.80		+									
48	QP	40.8	70.31	57.60	+										
49	QP	35.3	66.34	58.34	+		+	+	+						+
50	QP	53.0	59.51	55.08	+										
51	RO	42.4	30.69	66.11	+										
52	RO	34.5	31.98	63.53	+										
53	BZ	0.0	7.00	78.20											
54	QP	28.3	75.70	73.60											
55	QP	10.3	78.04	78.90											
56	QP	47.1	81.70	75.09											
57	QP	15.7	77.84	84.43		+									
58	QP	44.2	84.73	76.88	+										
59	QP	11.0	90.96	84.96	+										
60	RE	4.7	99.59	83.36		+									

Table 1, continued.

Feature	Type	Area	Northing	Easting	Investigation Method										
					I	N	T	L	C	S	E	D	F	M	Profile
61	RE	18.9	118.47	86.49		+									
62	RE	4.7	134.57	76.22		+									
63	RE	11.0	139.30	78.57	+					+	+				
64	RE	1.7	193.24	70.87		+									
65	RE	3.1	125.91	95.24	+										
66	RE	72.3	112.99	99.13		+									
67	RE	73.9	110.34	107.13	+										
68	RE	27.1	109.71	93.42		+									
69	RE	58.5	103.42	106.63	+										
70	RE	4.0	89.49	92.13						+	+				
71	QP	35.3	80.00	100.00	+		+	+	+						+
72	QP	30.6	74.20	106.05	+		+	+	+						+
73	QP	10.6	74.94	102.47	+		+								+
74	QP	15.9	72.00	95.00	+										
75	QP	15.7	59.40	100.48		+									
76	RO	11.8	19.58	87.55		+									
78	QP	17.3	40.51	114.80	+										
79	QP	5.9	41.08	112.34	+										
80	QP	8.8	41.63	110.41	+										
81	QP	31.8	55.02	109.41	+										
82	QP	23.6	50.83	112.24	+										
83	QP	12.6	53.64	116.05	+										
84	RE	4.7	75.00	125.00	+					+	+				
85	RE	1.6	83.30	112.87	+										
86	RE	44.0	79.60	123.18	+					+	+				
87	RE	13.0	95.20	126.59						+	+				
88	RE	4.7	105.10	121.58		+									
89	RE	7.1	90.34	176.14		+									
90	RE	56.6	94.94	136.34		+									
91	RE	.1				+									
92	RE	28.3	79.86	141.07		+									
93	RE	5.9	69.93	138.64		+									
94	QP	31.4	84.38	90.84	+										
95	RE	4.1	30.56	126.70		+									
96	QP	6.4	64.88	101.94	+										
97	QP	14.5	61.00	106.00	+										
98	RE	8.8	120.89	55.19		+									
99	QP	22.4	97.13	68.14		+									
100	QP	2.4	104.23	57.78	+										
101	RE	44.0	69.85	119.71	+										
102	QP						+	+			+				+
103	QP						+	+							+
104	QP						+								+
105	HT										+				
106	HT										+				
107	HT										+				
108	HP										+				
109	HT										+				
110	HP										+				
111	QP							+							+
112	QP														+

KEY:

Feature Type
- QP = quarry pit
- RE = reduction feature (lithic scatter)
- OC = outcrop quarry
- CB = cobble quarry
- RO = reduction/outcrop quarry
- HT = hearth
- HP = possible hearth
- BZ = bulldozer cut

Investigation Method
- I = inventory collections
- N = feature inventory without collections
- T = backhoe trench
- L = lithic inventory column sample(s)
- C = cruciform collections
- S = surface scrapes
- E = excavation units
- D = discretionary (systematic random) surface scrapes
- F = extra-feature surface collections (isolates)
- M = miscellaneous (uncontrolled) collection



Figure 8. 26Ek3032, Locality 36, Feature 72, quarry pit.



Figure 9. 26Ek3032, Locality 36, Feature 55, quarry pit.

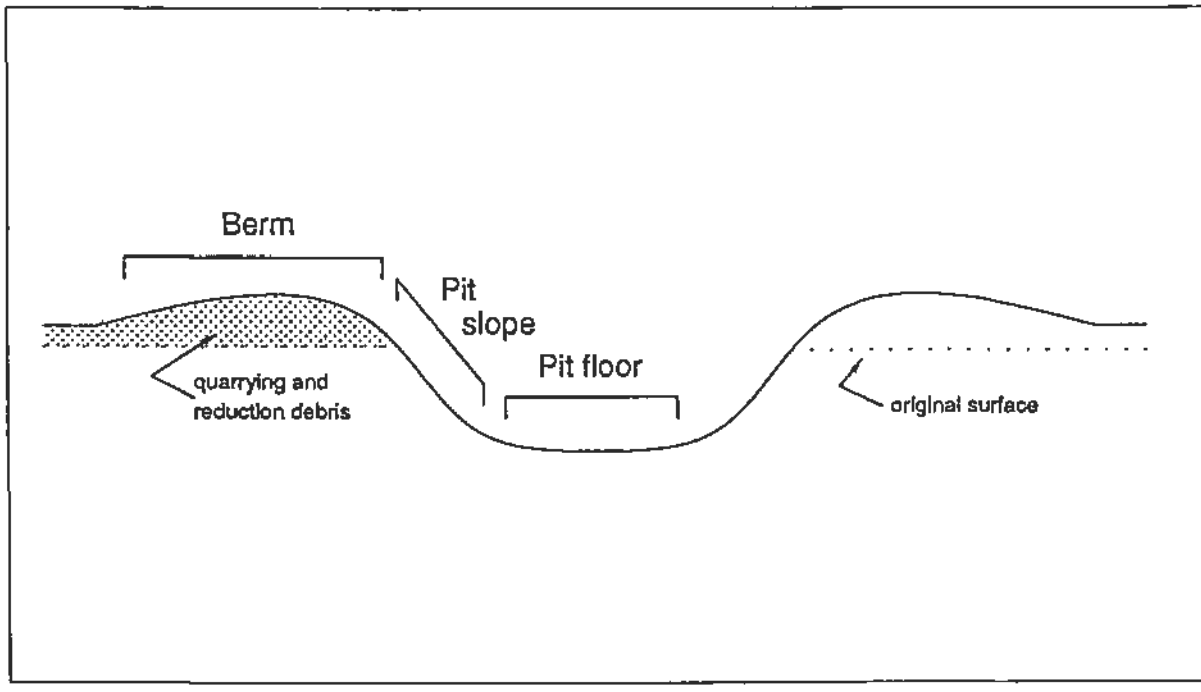


Figure 10. Schematic profile of a quarry pit.

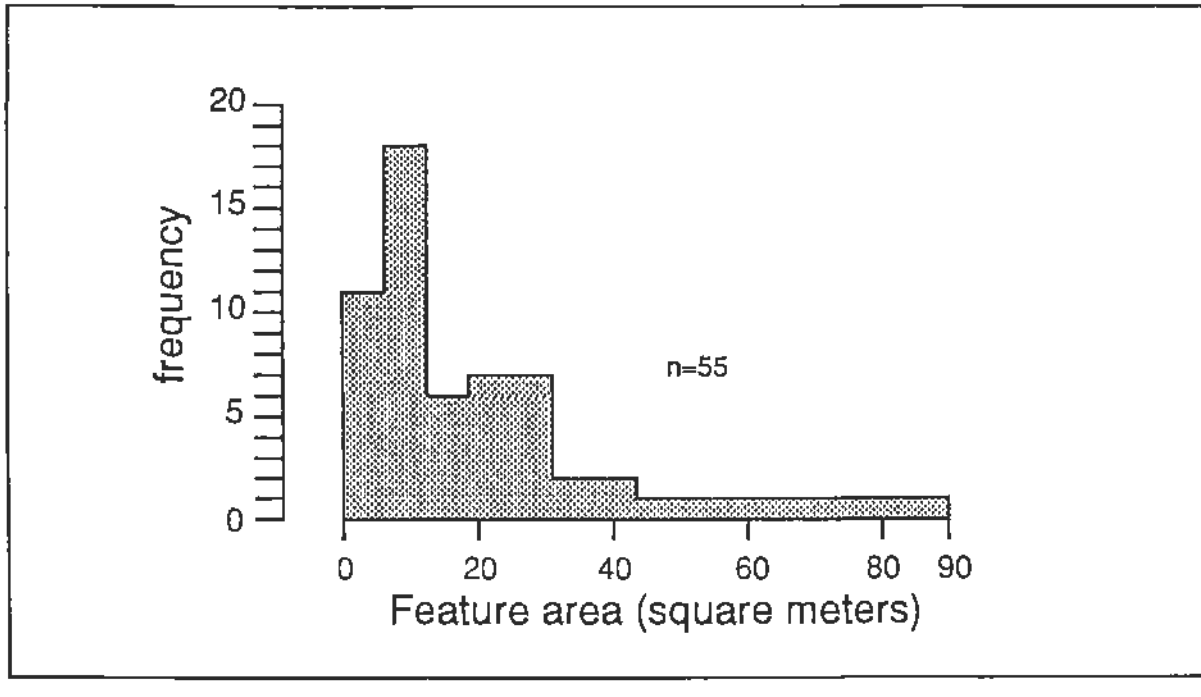


Figure 11. Histogram of quarry pit surface area.



Figure 12. 26Ek3032, Locality 36, Feature 60, reduction feature/lithic scatter.

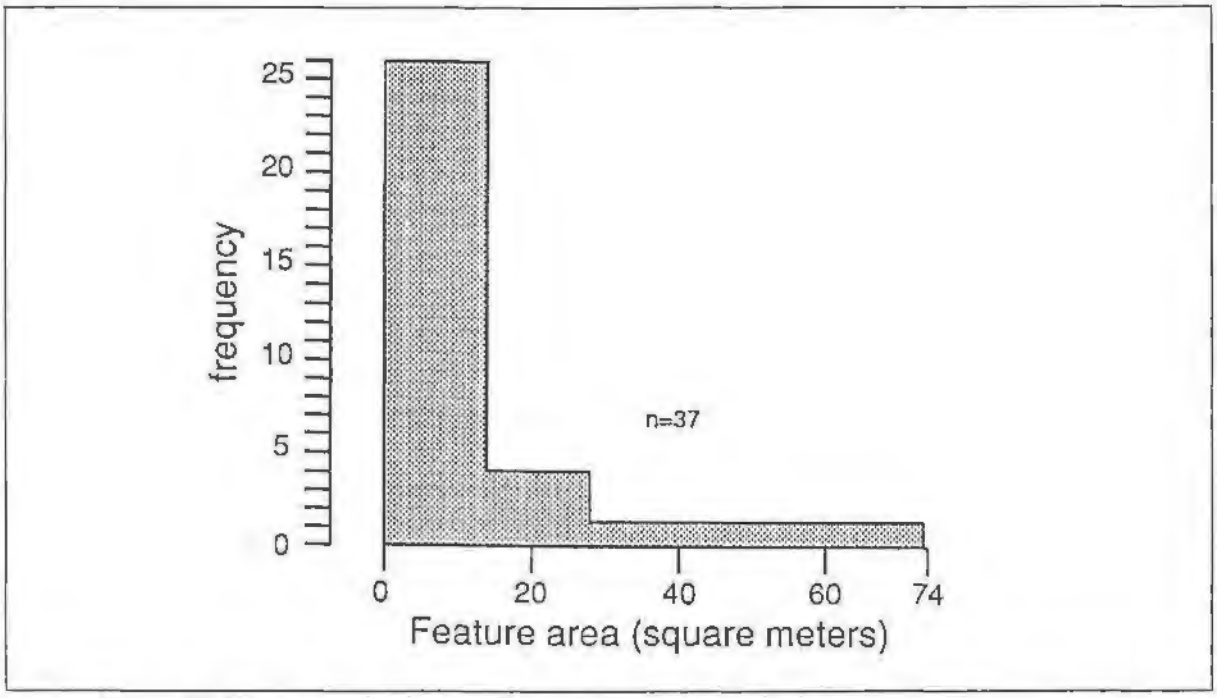


Figure 13. Histogram of reduction feature/lithic scatter surface area.

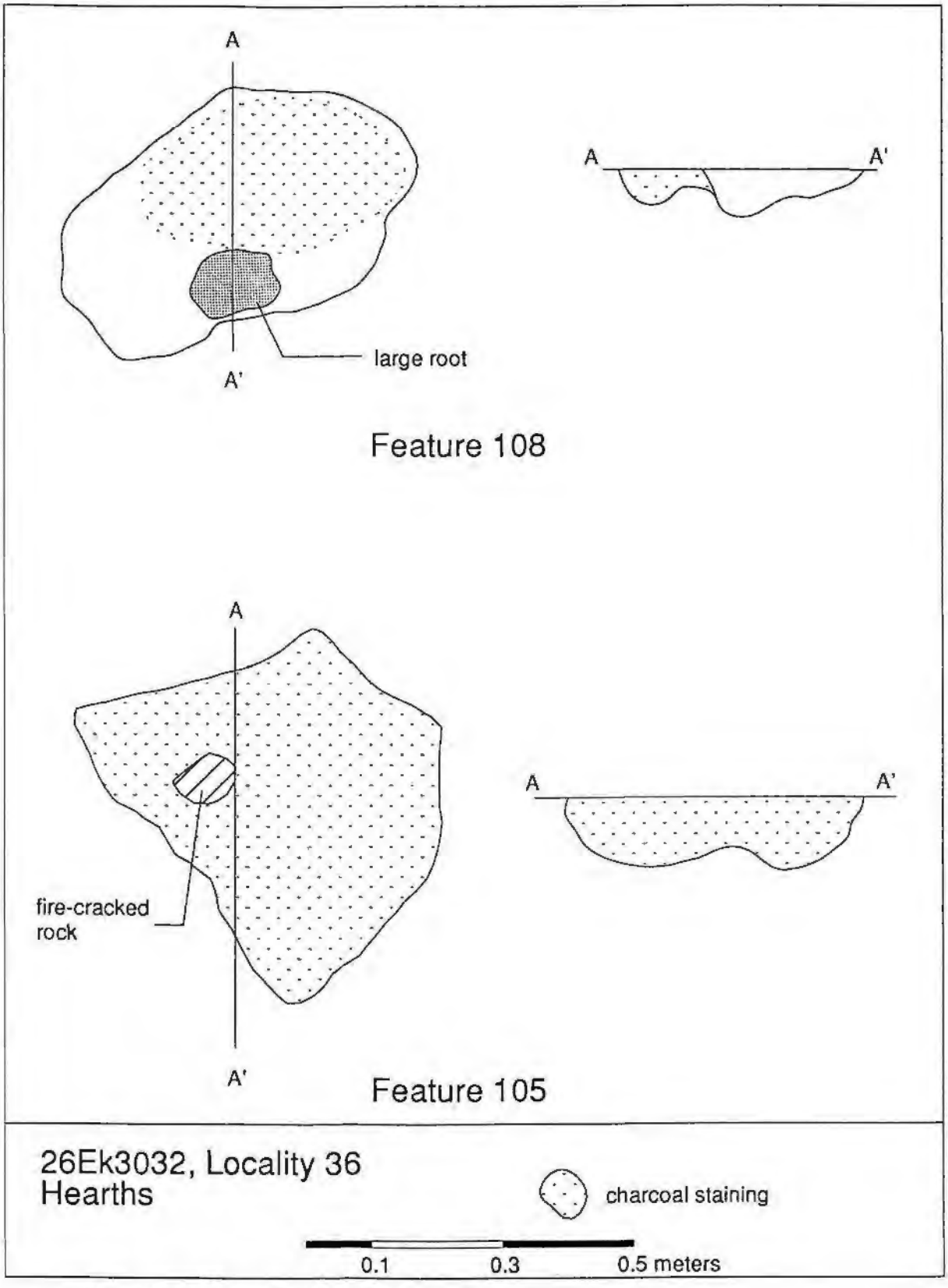


Figure 14. Plan views and profiles of hearths.



Figure 15. 26Ek3032, Locality 36, Feature 107, buried hearth.

Quarry pits dominate the surface feature assemblage (Table 2). Reduction features are less frequent, and outcrop/lithic scatter features are relatively rare.

Table 2. Frequencies of Surface Feature Types.

Feature Type	n	%
Utilized Outcrop	5	5.2
Quarry Pit	55	56.7
Reduction/Lithic scatter	37	38.1
Total	97	100.0

Surface Collection, Feature Inventory, and Random Surface Scrape Excavation

To clarify site boundaries, identify the number and nature of surface features, and investigate site formation processes, initial scrutiny of Locality 36 involved intensive surface survey (2 m transect intervals), during which all features and extra-feature artifacts were flagged for mapping and collection. We then returned to features and documented their size, form, content, and inferred function, and placed a central datum in each for subsequent mapping; mapping was performed with an electronic distance measuring device that recorded data into a computer. Sixty quarry features and 37 reduction features were mapped and inventoried (cf. Figure 7). Formed artifacts (*e.g.*, bifaces, cores, and hammerstones) were plotted on a sketch map and/or were shot in by the electronic transit, and then collected.

We established a 10 m x 10 m grid across the site assigning northing and easting coordinates to the southwest corner of each block. This enabled a surface debitage density sampling scheme, intended to measure the intensity of quarry production as well as the areal extent of quarrying activity. Two small (25 cm^2), randomly drawn units were selected within each 10 x 10 m grid square for surface scraping. Using tape measures, the southwest corner of each unit was measured in from the southwest corner of the grid block, plotted on a map, and shovel scraped to a depth of 2 cm; soils were passed through 1/4 in. mesh.

Investigations within quarry pits and quarry pit complexes employed surface scrape excavation units and backhoe trenches. Measuring 25 x 25 cm or 50 x 50 cm, surface scrapes were laid out in cruciform patterns across three groups of quarry pits. The scrape units crossed pit berms, slopes, and bottoms, and extended to the area outside, but adjacent, the pits. Investigations within the Feature 22 quarry pit complex employed 57 disjunct 25 cm x 25 cm cruciform units (one every 50 cm) through Features 22, 25, 27, 29, 31, 32, and 35 (Figure 16). The Feature 42 transect, which intersected the Feature 22 baseline (Figure 17), consisted of sixteen 50 cm x 50 cm units placed at one meter intervals; the larger collection units were used due to the wealth of large flakes and chunks on the surface. Approximately 35 m to the south, a baseline was established at Feature 49 in order to sample within and adjacent a large, deep quarry pit. Here, we employed 18 disjunct 50 cm x 50 cm units following the surface slope along an east-west axis (Figure 18). Collections in the Feature 72 quarry pit complex employed twenty 50 cm x 50 cm surface scrape units placed across Features 71, 72, and 73, and 12 additional 50 cm x 50 cm units placed perpendicular to the initial baseline (intersecting in Feature 72; Figure 19).

The distribution of types and quantities of debitage recovered from these various contexts in and around quarry pits was expected to address prehistoric task organization. These cruciform-patterned units also provided data to assess the extent of post-depositional surface movement which may have redistributed surface artifacts. The material was screened through 1/4 in. mesh, and angular debris, tuff fragments, and flakes were collected.

Subsurface Excavation

Trenching

Backhoe trenches were excavated first over or adjacent surface scrapes (Figure 20). Extensive use of backhoe trenches (265 m of trench were excavated) was essential to the project, allowing us to investigate prehistoric quarrying strategies, assess variation in toolstone quality, and detect subsurface features. Trenches also were intended to provide data on techniques and strategies of toolstone extraction used by prehistoric quarriers.

Trenching through the Feature 22 quarry pit complex (Trench 4) found the surface pits to be shallow, but revealed a subsurface quarry pit (Feature 112) buried beneath the berm of Feature 27. Backhoe excavations along the Feature 42 transect (Trench 5) found the pit to be deep and rich in charcoal. A large, deep adit and a buried quarry pit (Feature 102) were revealed in the sidewalls of Trench 3, several meters downslope from surface Feature 490. Trenching through the Feature 72 complex (Trenches 1, 2, and 7, respectively) exposed three additional quarry pits (Features 103, 104, and 111).

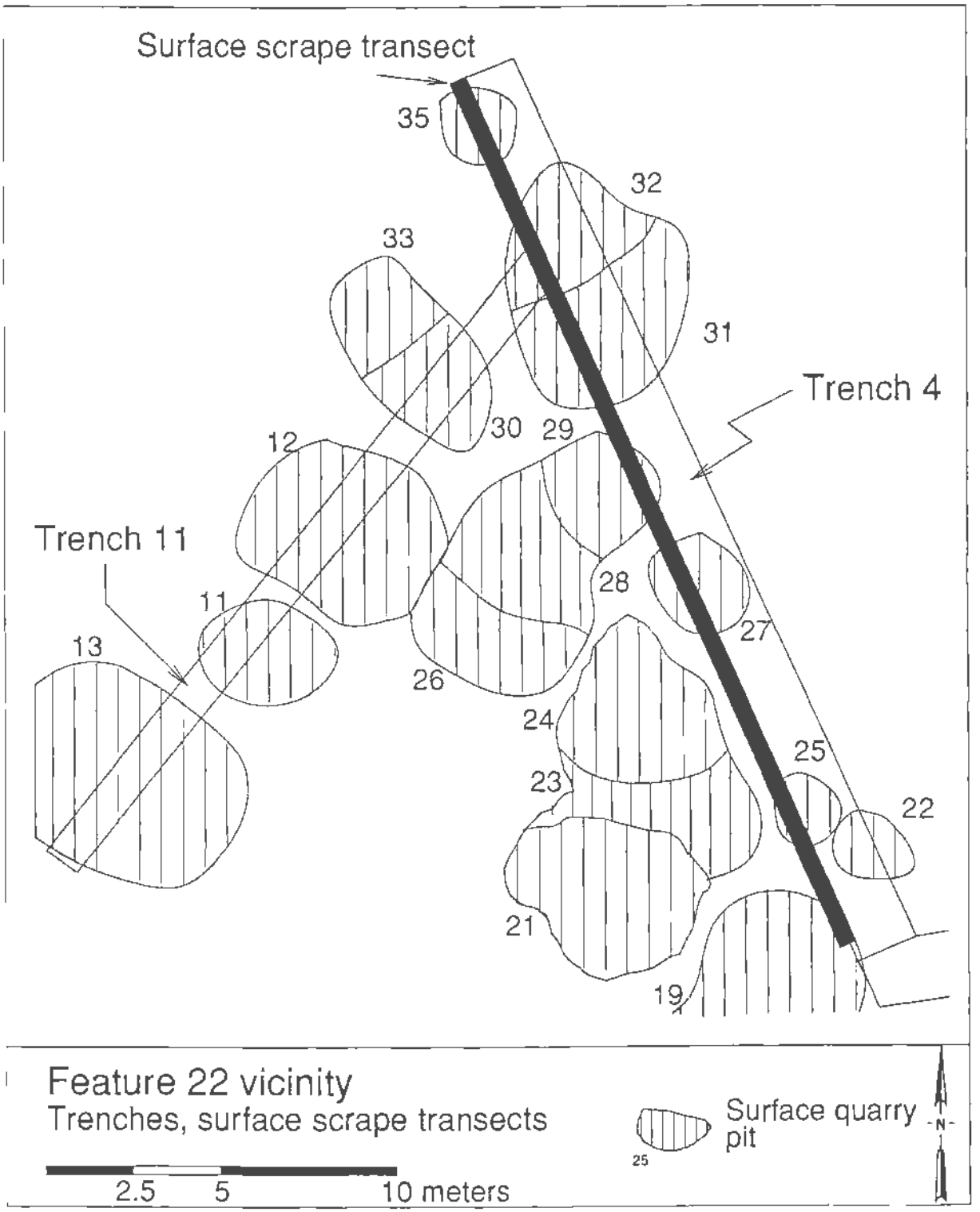


Figure 16. Backhoe trenches, excavation units, and lithic transect collections within the Feature 22 quarry pit complex.

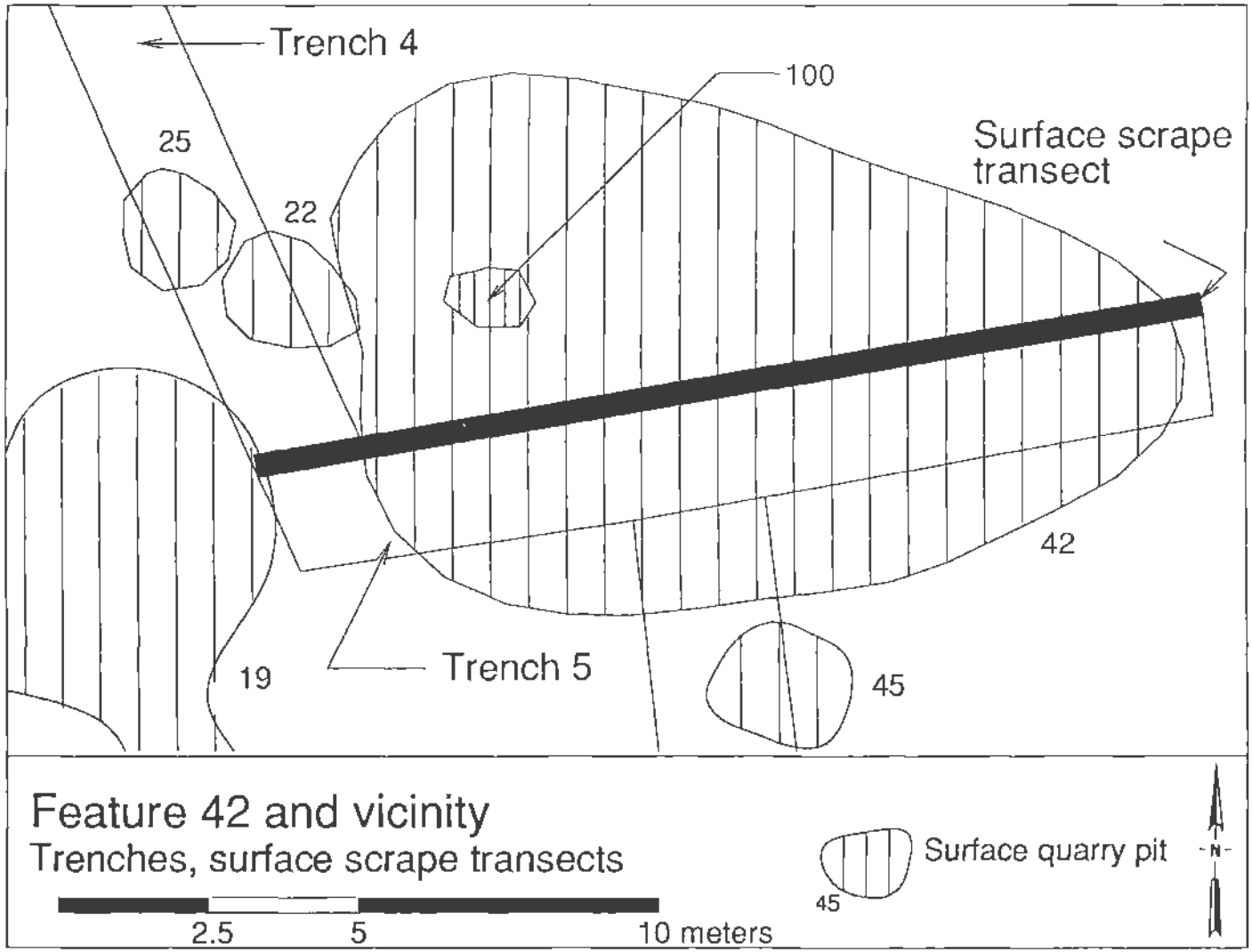


Figure 17. Backhoe trenches, excavation units, and lithic transect collections within the Feature 42 quarry pit complex.

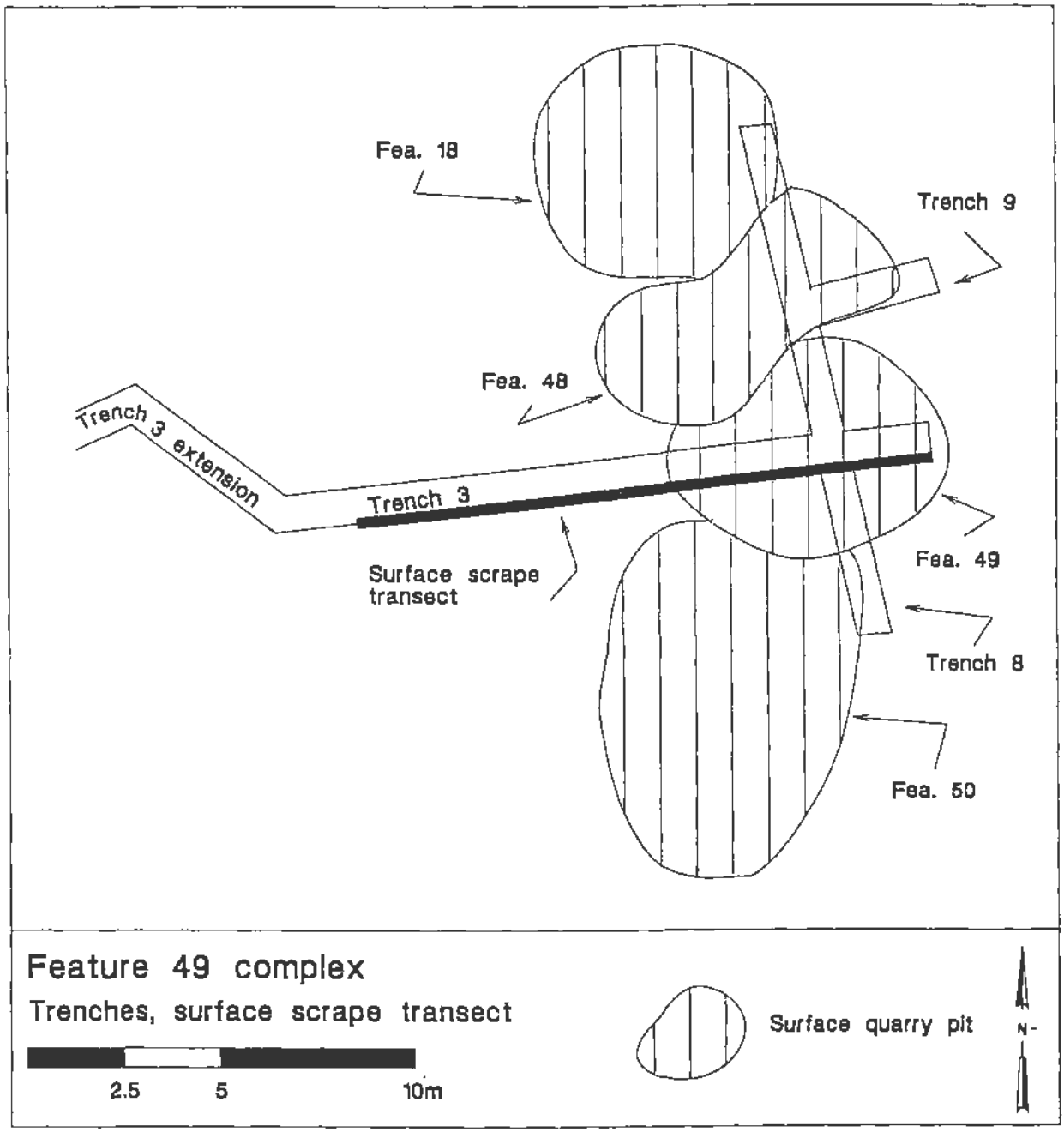


Figure 18. Backhoe trenches, excavation units, and lithic transect collections within the Feature 49 quarry pit complex.

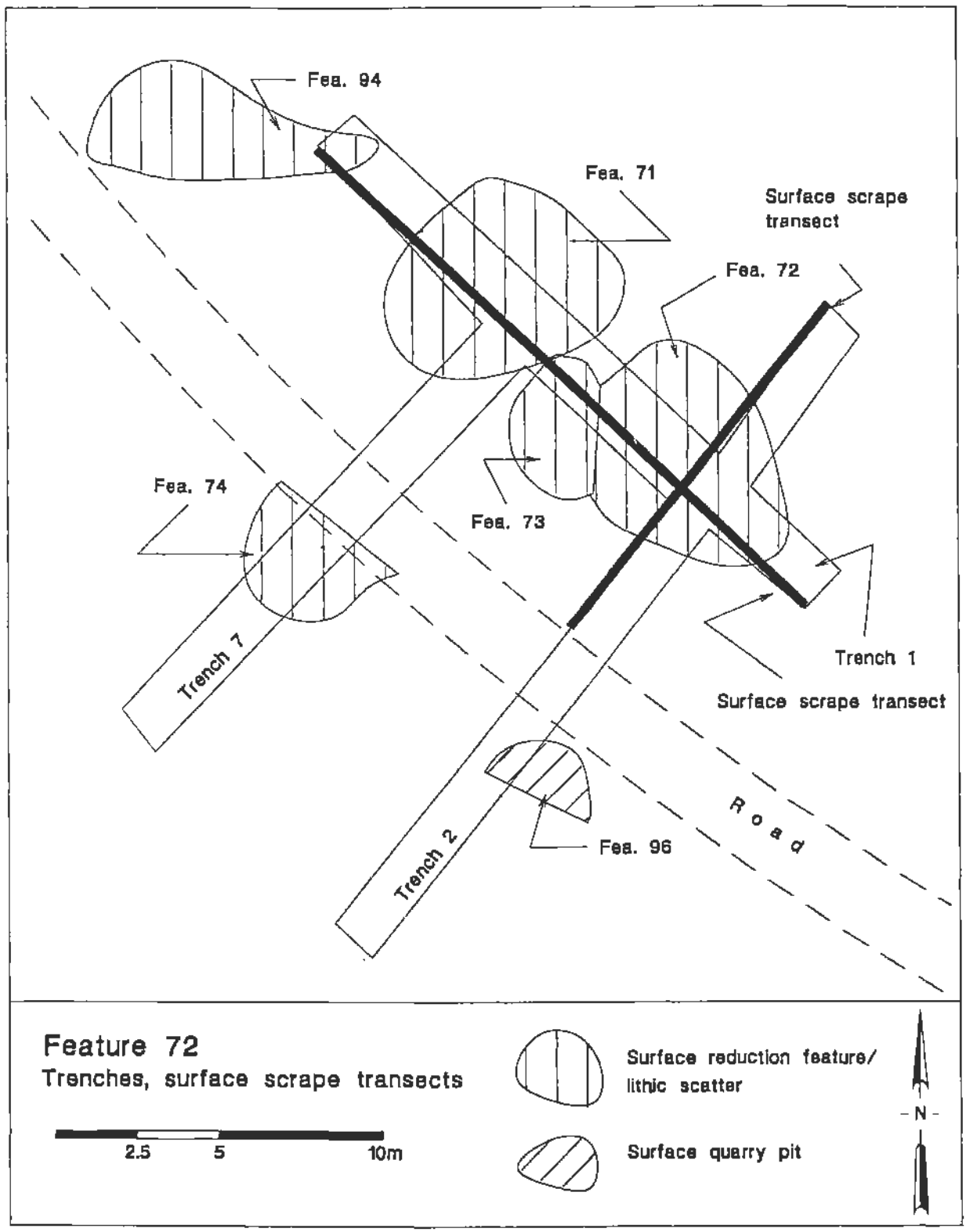


Figure 19. Backhoe trenches, excavation units, and lithic transect collections within the Feature 72 quarry pit complex.

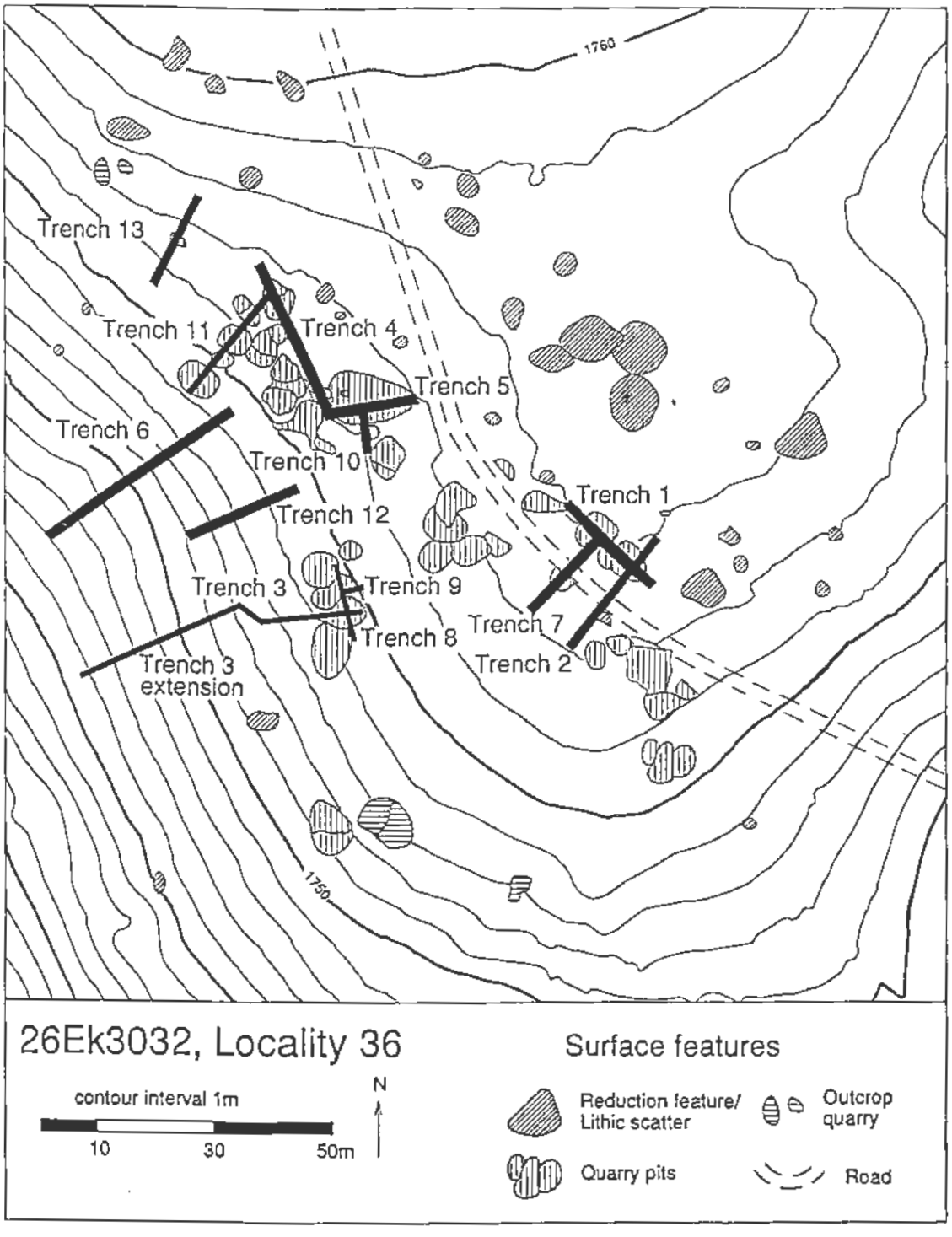


Figure 20. Trench locations.

Subsequent to our first cuts through surface quarry features, we employed additional backhoe trenches to investigate quarry pit complexes more fully and to explore non-feature portions of the site. Near Feature 22, Trench 11 was excavated through Features 11, 12, 13, 30, and 31, and Trench 10 was excavated perpendicular to Trench 5 in the vicinity of Feature 42 (cf. Figures 16, 17). Perpendicular to Trench 1, an additional trench (Trench 7) was excavated parallel to Trench 2; excavation of Trench 7 was designed to investigate the substrate for buried quarry pits.

A short extension of Trench 3 (the "dog leg"; cf. Figure 18) was dug in the vicinity of Feature 102 to reveal an additional profile of the buried pit; the trench then was extended approximately 30 m downslope to explore the area for additional buried features (which were not encountered). Finally, we employed three backhoe trenches in areas with no visible surface features; Trenches 12 and 13 were placed within inter-feature areas to check deposits for buried features and Trench 6 to expose a soil profile for geomorphological investigations (cf. Figure 20).

Both walls of each trench were cleaned, straightened, and examined closely by the project geoarchaeologist who recorded general observations regarding stratigraphy, geomorphology, and pedogenesis, and evaluated the utility of trench wall profiles for interpreting geological and cultural processes operating at Locality 36. Key profiles were selected for closer study and documentation through detailed stratigraphic description and profile drawings. Since backhoe trenches were excavated in groups of intersecting trenches in each of three areas (A, B, and C), at least one wall of each intersecting trench was profiled and described. Of isolated Trenches 6, 12, and 13, located on the steep slope below the quarry, only the north wall of Trench 6 was profiled. In Trench 3, only the north wall of the dog leg extension was profiled. Soil samples were collected for sediment analysis during the process of description.

Many strata in quarry pit deposits consisted mostly of debitage, thus informing of technology as well as cultural and geological site formation processes. Technological data were recovered by a lithic analyst who assayed the technological attributes of over 100 strata in the field (cf. Chapter 4). Each field assessment was documented with a small witness sample to provide a reference collection for future researchers.

Backhoe trenches facilitated collection of charcoal samples, not only to date the use of the quarries but to examine the possibility that fire was used as an aid to toolstone extraction. While the excavation team was still in the field, charcoal retrieved from the (buried) Feature 102 quarry pit exposed in Trench 3 was subjected to radiocarbon assay. Upon receiving a rather early date for the sample (ca. 4000 years B.P.), three excavation units (Units 588, 589, 590) were placed at the edge of Trench 3 in hope of documenting temporal technological variation.

Reduction Feature Excavations and Non-feature Area Sampling

Based on our initial inventory of the numerous reduction features occupying the northern and northeastern portions of the site, we selected eight features for surface collection and excavation (Features 6, 38, 63, 70, 84, 86, 87, and 92; Figure 21). These were chosen to reveal the range of variation expressed in surface manifestations. Although the size and number of units varied, most were explored by a series of 50 cm x 50 cm randomly placed excavation units employing 1/4 in. mesh screen. The random placement of small units in these features assisted in retrieving data relevant to the structure of isolated lithic events while reducing overall assemblage sample size.

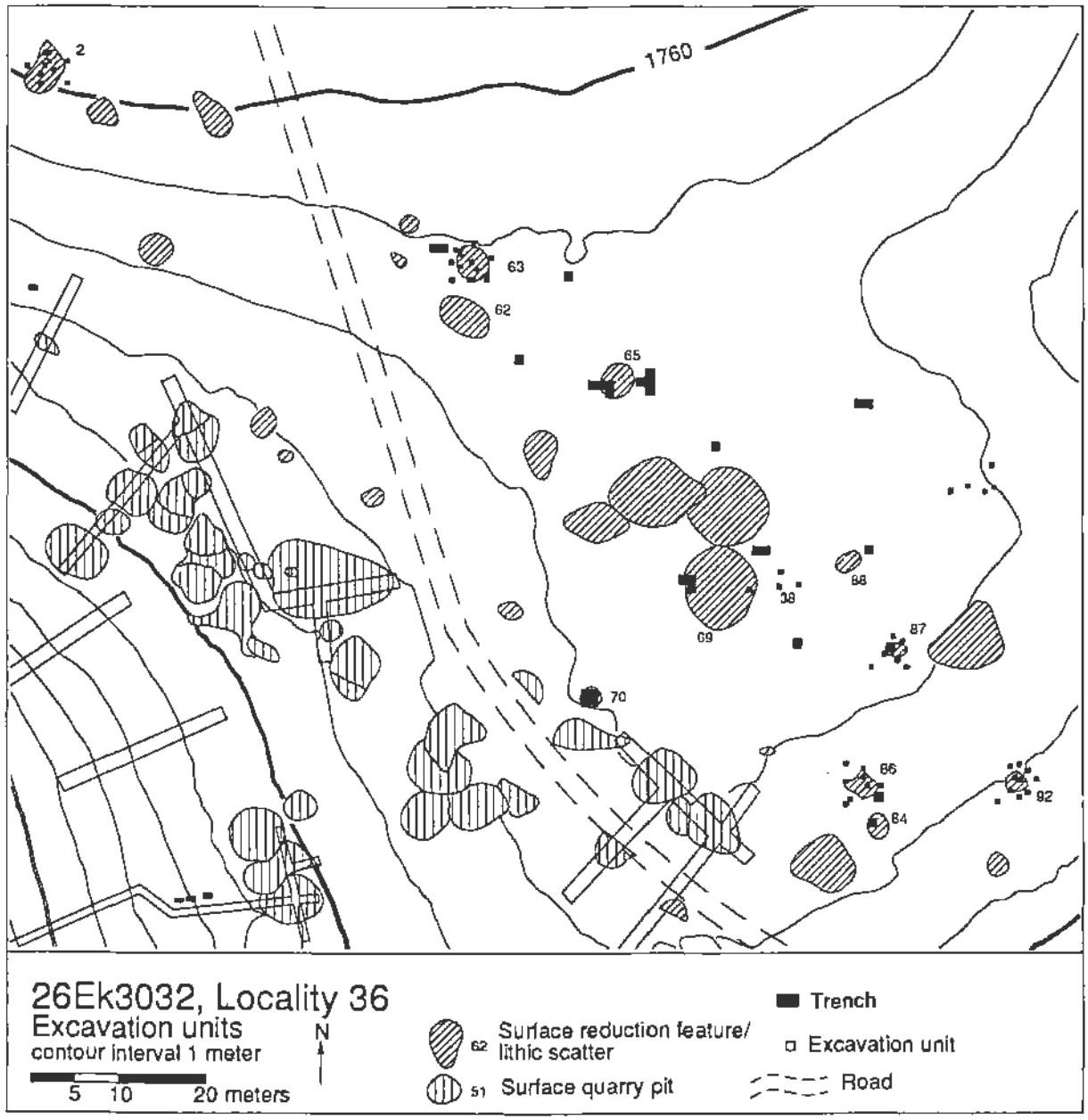


Figure 21. Reduction feature/lithic scatter features selected for surface collection and excavation.

Limited excavations also were conducted in two non-feature portions of the site. In the northeastern area, surface survey identified a delicate, bifacially pressure flaked tool and a late stage biface fragment about one meter apart; both artifact types are rare at the locality and probably represent non-quarry related activity. Their presence (and close proximity to one another) prompted placement of five 50 cm x 50 cm excavation units to explore for additional data; excavations found only a few flakes and no additional tools.

A recent bulldozer cut (Feature 8), located approximately 15 m northwest of the Feature 22 quarry pit complex, had exposed a dense concentration of opalite flakes and chunks ca. 10 cm below the existing ground surface. To explore the possibility of a buried surface, we excavated a 1 m x 50 cm unit immediately adjacent the bulldozer disturbance. Excavations (and subsequent backhoe trenching [Trench 13]) encountered bedrock immediately below surface, capped with abundant non-cultural opalite colluvial cobbles and exfoliated chunks of bedrock amid a few flakes and pieces of shatter.

Mechanical Surface Scraping

We employed a road grader to remove surface loess deposits (ca. 30 cm deep) in the northeastern part of the site in hope of discovering buried reduction features and/or hearths (total area scraped was ca. 45 m x 95 m; Figure 22). The results of the exercise disclosed a single reduction feature, five hearths, and one charcoal scatter (a possible hearth; Features 105-110); their discovery prompted our excavation of 1 m x 1 m units within and adjacent the features to collect datable charcoal and sample associated deposits (Figure 23). Further, in order to sample inter-hearth areas (in part, to secure the "cultural integrity" of the hearth features), we excavated five disjunct 1 m x 1 m units; no charcoal was encountered and artifacts were few.

Actualistic and Replicative Experiments

Investigation of prehistoric quarrying techniques was aided by actualistic quarrying and replication experiments, including reexcavation of a prehistorically worked and backfilled quarry pit. The latter was intended to provide a rough estimate of toolstone recovery rates for scavenging from previously discarded debris as well as to assess the rate of extraction of good quality, fresh toolstone. Because we used tools and techniques similar to those used in the past (including local hammerstones of various sizes and materials, bone and antler digging sticks, and wooden wedges), we were able to estimate the size range of raw material packages that may have been extracted by prehistoric quarriers. In conjunction with previous experiments at Tosawihi, these efforts investigated costs of prospecting for toolstone and evaluated the relative utility of a variety of extraction techniques and quarrying tools.

Previously established biface reduction sequences (Callahan 1979, Bloomer, Ataman, and Ingbar 1992) were followed in experimental biface replications. Toolstone processing was also examined with experimental techniques. Large pieces of opalite were weighed and broken into smaller blocks and flake blanks which then were processed into bifaces. Thus, by producing bifaces similar to those made by prehistoric knappers, we were able to estimate the size of raw material packages needed to manufacture the type of bifaces produced at Locality 36 and the quantities of waste involved in processing, and to calculate toolstone processing rates.

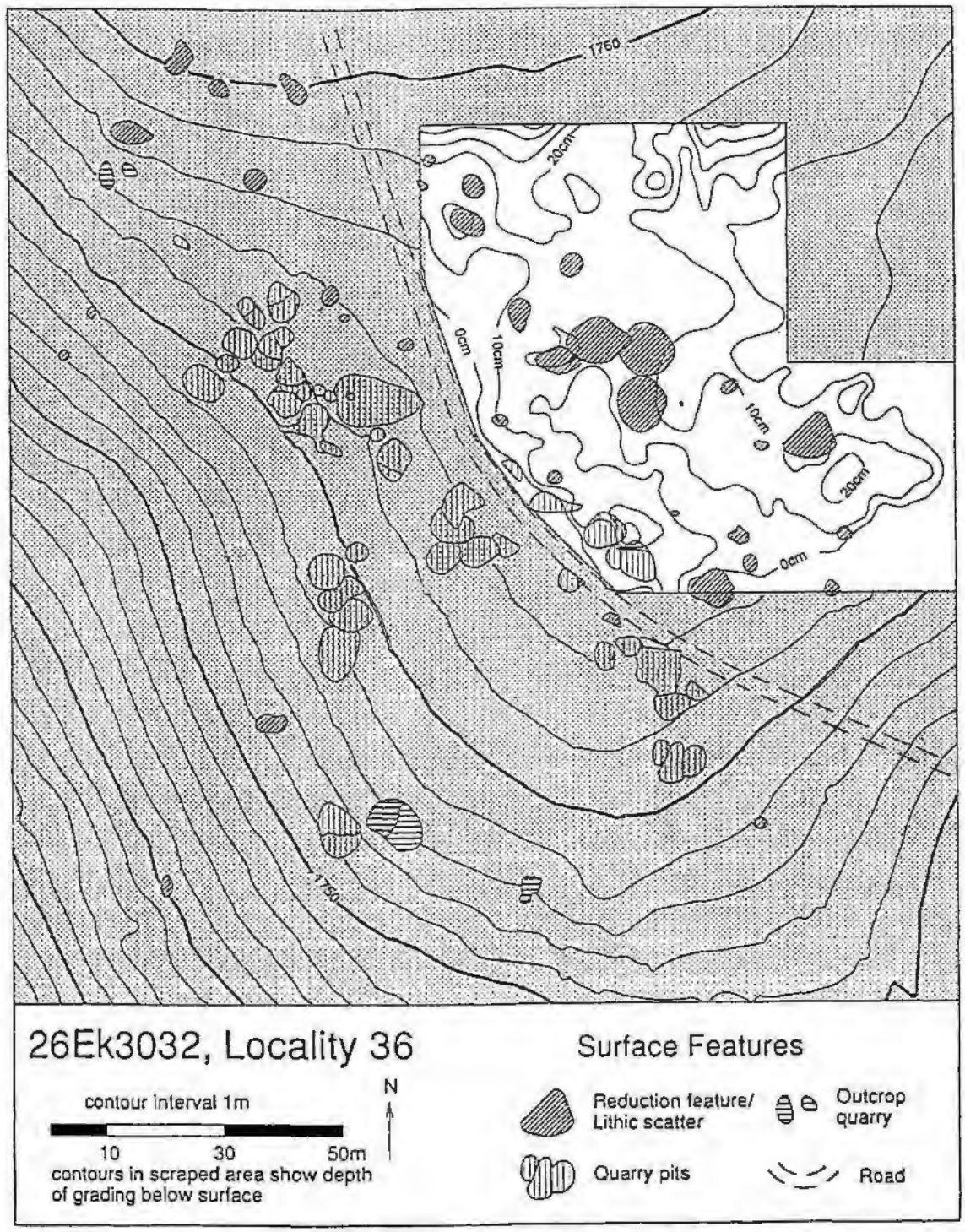


Figure 22. Area scraped with mechanical grader. Contours show depth of sediment removed.

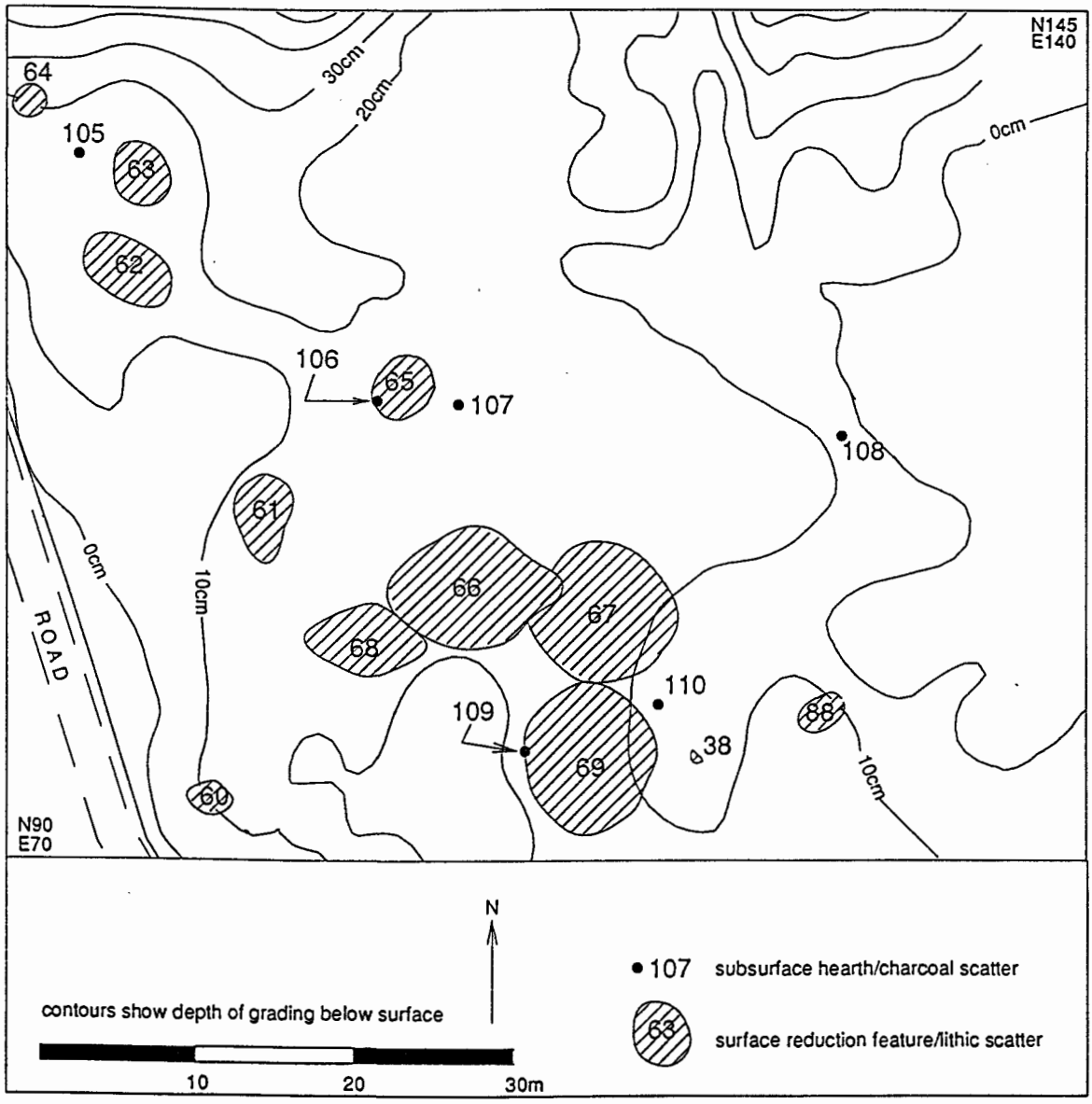


Figure 23. Surface and subsurface features, graded area.

Site Disturbance

Prior to our work at Locality 36, we considered the site to have been only minimally disturbed by recent activities. In 1987, the site was surveyed as part of ongoing work; the road passing through it (cf. Figure 7) was a two-track which had affected its integrity only minimally. By 1990, the road inadvertently had been graded through a large quarry pit complex (part of Area A), a portion of which was disturbed to a depth of approximately 20 cm. This disturbance leveled several quarry pits in Area A before we had an opportunity to map them. One of the only datable (and earliest) artifacts recovered from the site, a fragment of an obsidian stemmed point, was recovered from the disturbed portion of the road; its associations are equivocal.

An additional disturbance occurred after completion of mitigation and was monitored by IMR staff. It involved mechanical removal of the lower slope of the western edge of the site (Figure 24). No subsurface features were noted, although erosion of existing *in situ* deposits upslope may increase.

Processing and Curation

Upon transfer of field collections to the laboratory, artifactual materials (with the exception of bone, soil, and carbon samples) were water screened; cleaning of formed artifacts was supplemented by brushing with soft toothbrushes. Bone artifacts were dry-brushed only. Formed artifacts were numbered individually; debitage, faunal remains, and flotation samples were bagged and numbered as lots. Physical numbering of an item was accomplished with black or white drawing ink, sealed with a layer of clear nail polish (lacquer).

A computer generated catalog was compiled from analytical artifact databases, and provides basic information on provenience, raw material, count, weight, and storage box number.

All artifactual material was bagged by artifact class, then by reference and specimen numbers in .002 or .004 mil plastic bags. Each ziplock bag contains a paper provenience tag and an artifact lot. The bags are packed in one cubic foot cardboard boxes. The collection consists of approximately 120 boxes. Each box is boldly labeled with IMR project number, the site name: "Tosawihi", box number, site and locality number: "26Ek3032, Locality 36", and a brief list of contents.

The artifacts recovered from Locality 36 will be curated under arrangement with the Nevada State Museum, Carson City, where previous Tosawihi collections have been stored. Paper copies and computer disk copies of the catalog, paper copies of field notes and photos, projectile point keying forms and other analytical data, and the final report will be curated at the museum as part of the collection.

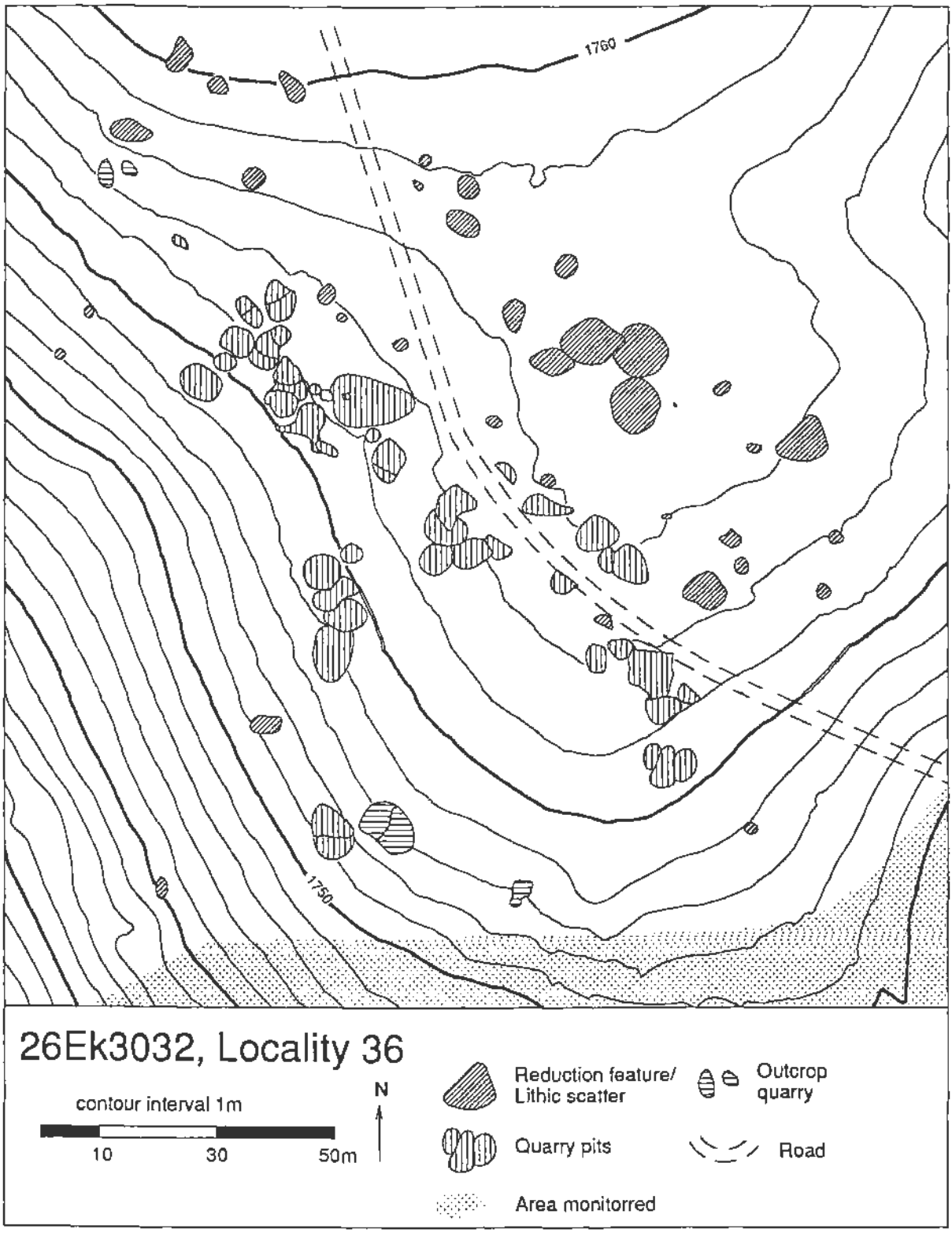


Figure 24. Area monitored during post-investigation development.

Chapter 4

DEBITAGE

Eric E. Ingbar, Kathryn Ataman, and Mark W. Moore

This chapter describes and analyzes debitage recovered from Locality 36. We introduce Tosawihi lithic technology as revealed by earlier research, present the techniques and sampling of debitage recovery from Locality 36, give the methods used to analyze it, and summarize our conclusions. We defer discussion of debitage distributions to later chapters.

Previous research (Ataman and Bloomer 1992; Bloomer, Ataman, and Ingbar 1992; Elston and Raven 1992) has shown that production of bifaces was a primary goal of prehistoric work at Tosawihi. Biface production, measured by reduction stage, changed with distance from quarry sources (Ataman and Bloomer 1992; Raven 1992a). The transport of bifaces away from quarries, and later away from the Tosawihi vicinity, followed the law of least effort: few bifaces were moved (even a few hundred meters) from quarry sites prior to removal of most unnecessary toolstone mass (Raven 1992a). The removal of mass also shapes bifaces into what we regard as "stages" of biface reduction; sites more distant from opalite sources exhibit higher proportions of later stage reduction. Exceptions to this generalization tend to prove the rule: *thin* early biface blanks have been found up to 12km from the quarries. Little evidence of local use of opalite bifaces was found in earlier research; even 12km from the nearest opalite outcrops, opalite bifaces were used rarely (Ataman and Bloomer 1992). If a "production sphere" is defined as the area in which tools were produced but not actually used, it seems that the opalite biface production sphere extended at least 12km from toolstone sources.

The research discussed above relied on data from a large number of non-quarry sites and from only a few, relatively isolated, quarries. The most intensive opalite exploitation occurred within the boundaries of site 26Ek3032, wherein Locality 36 is one of numerous quarries. Thus, study of Locality 36 constitutes our first glimpse at the center of the production sphere.

Foremost among the several research topics addressed in this chapter is the question of *what* was produced at Locality 36, and in what quantity. Obviously, opalite toolstone extraction was important and, to some degree, debitage analysis permits examination of how toolstone extraction was conducted by identifying core (including biface blank) forms created from extracted opalite.

Too, we wish to know what commonly happened to extracted opalite *at the locality*. Hypothetically, the range of options spans a continuum from transport of blocks or large flakes for reduction elsewhere to production of finished tools on the spot. Between these extremes lies a range of lithic production options including removal of unneeded toolstone mass without much shaping of tools, mass removal followed by some initial shaping, and mass removal followed by nearly complete tool production. Because we suspected successful reduction products were removed from the site, debitage provided the most direct testimony on which options were employed. Examination of debitage from quarry pits, from chipped stone reduction concentrations, and from other contexts allows determination of core form, of reduction technology, and of degree of reduction, all of which bear on the question.

An additional question asks why non-quarrying activity ever occurred at Locality 36. The query springs from our interest in how toolstone procurement meshed with general economic and mobility patterns. Prehistoric hunter-gatherers had to outfit their stone toolkits and the least costly way would have been to stage other activities in conjunction with quarry visits. Yet, the

Tosawihi landscape offers few resources to reward such "other activities" (Raven 1992b), so prehistoric strategies of toolstone procurement must have attempted to minimize support, opportunity, and associated costs (Chapter 3). One way to do this is through labor organization and mobility scheduling (Elston et al. 1992), a consequence of which *might* be spatial conjunction of toolstone procurement and other activities, i.e., use of quarries to stage non-quarrying activity. Archaeologically, this should be reflected as tool *maintenance*. For example, edge retouch flakes from tools made on non-local toolstone may reflect the maintenance of active tool edges.

The preponderance of debitage recovered from Locality 36 is opalite. Colors (beige, grey, and white), textures, and inclusions observed in the debitage do not differ from those in the bedrock; undoubtedly, most of the opalite originated at the locale. The few recognizably non-local flakes of opalite, jasper, and chalcedony, as well as rare non-Tosawihi materials (e.g., obsidian), are discussed below. All following analyses and interpretive statements concern locally available opalite unless otherwise noted.

Tosawihi Lithic Technology

Earlier research has revealed the local dominance of biface production (Elston and Raven 1992). Biface production generally proceeds from either a flake/core-based approach or from a block-based approach (Binford and Quimby 1963; Flenniken and Stanfill 1980:24-27). In the flake/core approach, the intended product of initial reduction is a flake blank struck from a core. The core may be of almost any form, so long as it can produce flakes large enough to serve as blanks. Flake blanks then are reduced to bifaces. In contrast, in a block-based strategy the intended blank is the block itself.

The two approaches are not mutually exclusive, since large flakes from block blank production themselves could be used as blanks. More often, however, block blank flakes are not useful as biface blanks, being too small, too weak, or of the wrong shape. Recycling such waste flakes into "chip blanks" (Binford and Quimby 1963) for other tools can be important, but such recycling is not the primary objective in a block-based strategy.

The production of a biface can be seen as occurring in stages (Muto 1971), even though the reduction process is continuous. Reducing a flake-core during the initial production of flake blanks involves raw material acquisition and initial core preparation; maintenance of the core as flake blanks are removed is a potential third stage. An exhausted flake blank core then may become a blank itself, following the process used in a block-based approach. Block-core blank production can be achieved in a single stage of raw material acquisition, or, if two stages are used, acquisition may be followed by initial reduction of the block to a generally appropriate size.

A blank, whatever its genesis, may be used as a tool without modification, or it may be reduced further to a unifacial or bifacial tool. If so reduced, it proceeds through an initial edging stage and then passes through early biface thinning, late biface thinning, pressure flaking, and perhaps haft preparation (e.g., notching). Heat-treatment is a separate process that can occur any time in the reduction process. Although the reduction process is continuous, an item need not have passed through all the analytical stages we impose (cf. Bloomer, Ataman, and Ingbar 1992).

We have summarized the production of Tosawihi flake blank-based bifaces elsewhere (Bloomer, Ataman, and Ingbar 1992). Most Locality 36 blanks may have been derived from block cores, so we focus on their production in the following discussion. Late stages of biface production, reiterated here for the sake of completeness, are the same for both techniques.

Production begins with acquisition of toolstone blocks (i.e., toolstone extraction) from bedrock. Natural cracks and flaws provide avenues of attack to separate pieces from bedrock, dictating the size and shape of extracted pieces. Debris produced as part of the extraction process may include fragments of tuff, the matrix around opalite or stringers within it. As well, angular debris and large irregular flakes generated by tapping and beating on bedrock are common by-products, as are rejected opalite chunks.

Once a piece has been extracted, testing for interior stress planes by removing a few flakes determines how suitable it is for further reduction. Failure along internal stress planes will split the piece without producing conchoidal fractures. Testing also may produce large flakes that terminate on fracture planes in apparent step fractures. Testing flakes also may follow along a fracture plane, yielding a flake with a flatter ventral surface than would have formed otherwise.

Testing may be combined with mass reduction. Mass reduction removes irregularities from a block and trims it to a size appropriate for initiation of blank production. At this point, the piece is in Stage 1 of biface production—blank selection (following Callahan [1979]; cf. Chapter 5). Blank production begins with edging, usually accomplished by percussion flaking. Flakes are driven from the block margins where necessary to form a biconvex cross section. Blank preparation may be necessary only on parts of the block, or the entire block may need attention. Raw opalite (i.e., not heat-treated) is tough and inelastic, requiring considerable force to detach flakes. Therefore, hammer blows must land away from the margins of the block (producing flakes with thick, wide platforms). Marginal strikes cause the margin simply to break off. The entire blank preparation process constitutes Stage 2 of biface production. The amount of blank preparation varies, depending on the initial form. For example, thick biconvex flake blanks need less edge preparation than do subrectangular or tabular blocks.

Following removals designed merely to shape the edge, subsequent flake removals begin to thin the biface (thereby increasing its width to thickness ratio). Such early thinning also may serve to edge the emerging biface, so that platform morphologies may overlap with those of edging flakes. As the facial morphology becomes increasingly regular, early biface thinning flakes become somewhat less thick, propagate more evenly, and tend to carry across the midline of the piece. Patterns of flake removal emerge through this early thinning stage and such patterning often is evident on the resulting flakes. Initial thinning comprises Stage 3 of biface production.

Late initial thinning (Stage 3), and all late thinning (Stage 4), are intended to address the thickness of the biface rather than influence its outline. At Tosawihi, late initial thinning and late thinning frequently was done with soft hammer percussion. Our own experimental knapping of raw opalite found the material too brittle to thin consistently with hard hammer blows. Heat-treatment often occurs at about Stage 3 of reduction, increasing the elasticity of the stone so that it can be thinned more reliably (Bloomer, Ataman, and Ingbar 1992).

Research Methods

Debitage analysis followed a general strategy established in earlier research (cf. Bloomer and Ingbar 1992). Technological analysis, whereby debitage attributes were observed in each sample, served as one analytical technique. Mass analysis, whereby flakes were size-graded, counted, and weighed, served as a second, equally important, technique. We also used a simple sorting of platform-bearing flake fragments from edge marginal fragments, weighing and counting each group, and weighing angular debris as an ancillary analytical technique on some sample sets.

Data recovery at Locality 36 yielded a lot of debitage, prompting our use of a random sampling plan to select samples from a variety of contexts. Comparison with samples not randomly selected then served to confirm or refute analytical outcomes based on the random sample. Random sample selection is reviewed further below.

Technological Analysis

Current debitage research involves two lines of inquiry—attribute analysis and typological analysis. Attribute analysis involves observation of specific attributes (often reflected as metric measurements) of individual flakes; typological analysis observes *flake types*. Identification of flake types depends on the subjective observation of many attributes measured and recorded in attribute analyses. Rather than giving each attribute analytical importance, the sets of flake attributes subjectively are summed (often using polythetic criteria) to comprise a single type determination.

In our previous work, and here as well, we have ignored attribute analysis in favor of typological analysis of debitage assemblages (Bloomer and Ingbar 1992), doing so for two reasons: (1) the outcome of many attribute analyses simply reaffirms the existence of flake types, which appear in such analyses as attribute clusters; (2) experienced lithic analysts can conduct typological analyses more quickly. Flake typology is best derived from prior knowledge or insight concerning the technology under study. Previous research at Tosawihi identified the major components and goals of the area's lithic industries (Ataman and Bloomer 1992). Experimental replications of opalite biface production served as controlled cases with which to train analysts and calibrate their observations. Earlier technological analyses (cf. Bloomer and Ingbar 1992) employed three major debitage types: angular debris, uninterpretable flake fragments, and interpretable flake fragments. The latter was subdivided into six flake types: primary decortication, secondary decortication, interior flakes, bipolar flakes, pot lid flakes, and biface thinning flakes. Five further subtypes of biface thinning flakes were distinguished: edge preparation, early stage thinning, late stage thinning, pressure flakes, and all other bifacial flakes. Each was given equal analytical importance whatever its level of subclassification, because each was considered diagnostic of different kinds and stages of reduction. Edge preparation flakes, early stage thinning flakes, late stage thinning flakes, pressure flakes, interior flakes, and both types of decortication flakes determined reduction techniques and reduction stages present in Tosawihi debitage assemblages.

With the benefit of hindsight, we simplified the typological analysis strategy. Rather than recording types, subtypes, etc., to be lumped later into synthetic interpretive categories (e.g., initial blank preparation), we put our observations directly into an interpretive framework. Based on previous research, five interpretive categories were used to record reduction stage and type of reduction within a sample. We isolated quarrying, mass reduction, blank preparation/initial edging, early biface thinning, and late biface thinning. Description of these categories, their flake types, and their attributes follows a brief digression on how this system was used to record a sample.

Any given sample can be characterized by five categories of debitage (in letters, Q, M, B, E, and L, respectively). If a category is absent, then its place may be left blank. If present in trace amounts, a lowercase letter encodes that fact. If a category of flakes is frequent but does not dominate a sample, a capital letter may be used. A dominant category is denoted with an underscored, asterisked, or bold-faced capital letter. There are, then, four possible attribute states for any given category (blank, lowercase, uppercase, emphasized uppercase); these can be combined as needed (in serial order) to characterize a sample. Theoretically, there are 4 to the 5th power combinations of letters. These 1024 permutations of sample characterization were adequate for our needs. We also recorded incidences of heat-treatment, burning, and soft hammer reduction.

Typological Analysis Categories and Incidental Observations

Typological analyses often depend upon a polythetic set of criteria. Thus, replication of any typological analysis by other researchers is difficult. Analytical comparisons are hindered, as well. We explicitly describe the typological categories employed at Locality 36, hoping that some of these pitfalls can be avoided. The type descriptions presume familiarity with simple lithic technology; Crabtree (1972) is our standard reference. Each type description begins with a general description of the category, followed by a description of specific constituent flake forms.

Quarrying (Q)—Quarrying debitage (Figure 25) results from the extraction of toolstone from bedrock. The piece extracted could be a large block, a large flake, or simply clasts removed to expedite access to more useful parts of bedrock. Quarrying debris consists of large (greater than 6 cm maximum dimension) pieces of angular debris, non-orientable block fragments (cf. Chapter 5 on modified chunks), and very large (greater than 20 cm maximum length) flakes with cortical platforms and dorsal cortex cover. The latter are infrequent at Locality 36. The most common evidence of quarrying in the Locality 36 assemblages consists of large angular debris, often having some cortical surfaces. Cortex is difficult to distinguish in Tosawihi opalite, since it often occurs with stringers of poorly silicified and unsilicified material. We use the term here to denote only obvious weathered tuff exteriors.

Mass Reduction (M)—Mass reduction is the initial step in processing toolstone, the removal of unnecessary material from a block or slab of stone. Removing mass shapes the stone; the basic intent is creation of a piece of stone suitable for further reduction. Large flakes produced as blanks for biface production are not likely to need much mass reduction, so they primarily indicate blank production from blocks or slabs of stone. Flakes resulting from removal of mass exhibit evidence of hard hammer blows, and platforms frequently have been shattered or are large and plain (Figure 26). Ring cracks are common in platforms. Unshattered platforms are single-faceted. Planar outline of mass reduction flakes is highly variable. Cross-section and long-section can be flat, but more often is very irregular. Complex dorsal scar morphology is rare. Dorsal scars parallel the flake axis and originating from the same platform edge are not uncommon. Ventral morphology is characteristically irregular due to propagation of the force of the blow into the stone (rather than oblique to it); compression rings and hinge terminations can be common in mass reduction flakes but are not infallibly diagnostic. Flake size is highly variable; in Locality 36 debitage, we observed mass reduction flakes ranging from 6cm to 20cm long. Core reduction flakes from cores with unprepared platforms or simple platforms are a specific subset of mass reduction flake and share the morphological attributes discussed above. Core reduction flakes show evidence of more controlled removal—more detailed platform preparation, more regular sectional and planar shapes. Because they comprise a subset of mass reduction flake discriminating core reduction, their isolation requires assessment of the proportion of well-controlled mass removal flakes to poorly-controlled mass removal flakes in an assemblage. We noted assemblages that contained high incidences of well-controlled mass reduction flakes as possible core reduction assemblages.

Blank Preparation (B)—Blank preparation flakes (Figure 27) are detached in the initial edging stage of biface reduction. The purpose of blank preparation is to create a bifacial edge from a rectangular or subrectangular edge. Typically, flakes are removed by hard hammer percussion, but they can be detached with a soft hammer as well. Three types of flakes are subsumed: edge

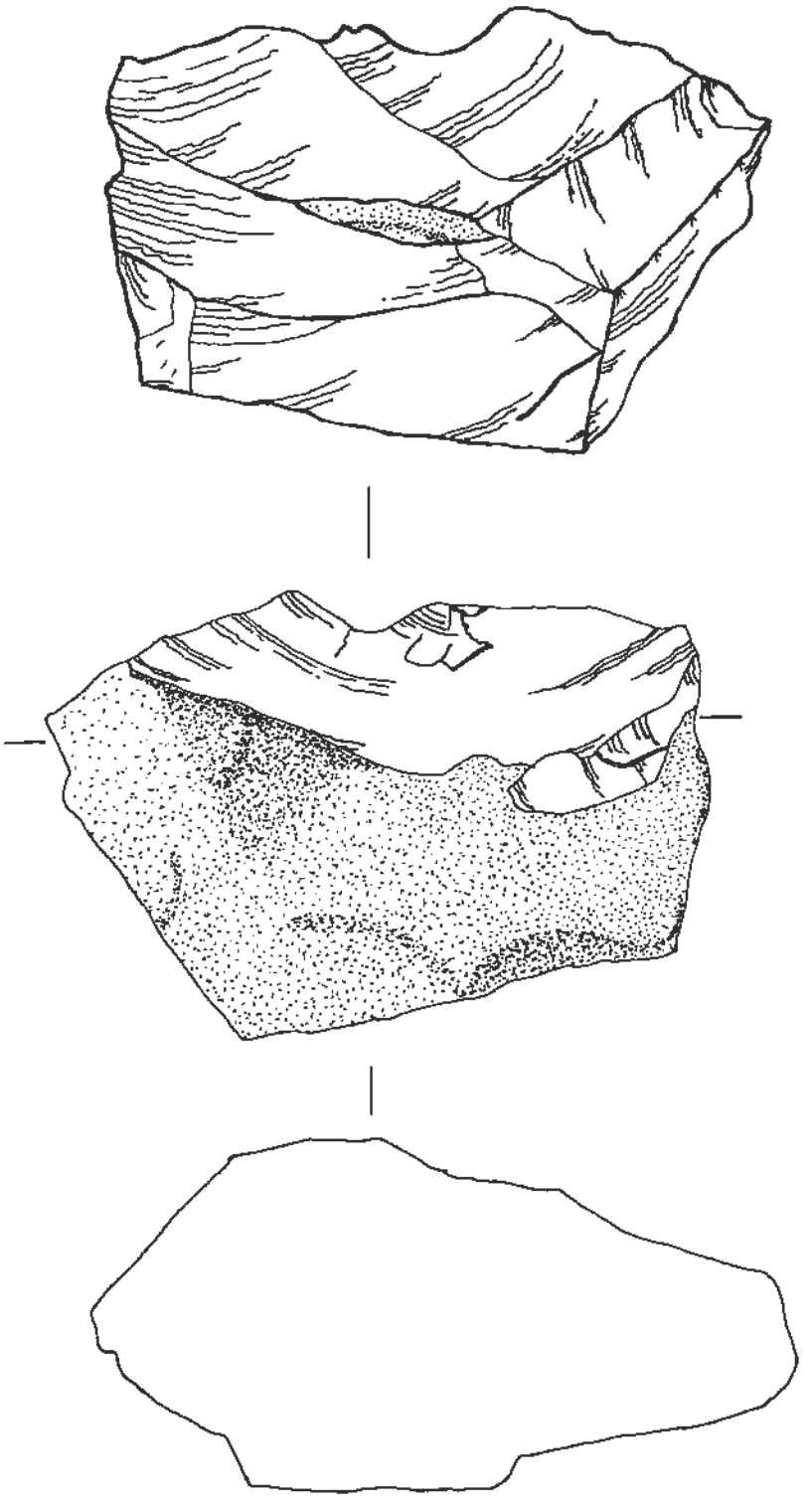


Figure 25. Typical piece of quarry debitage.

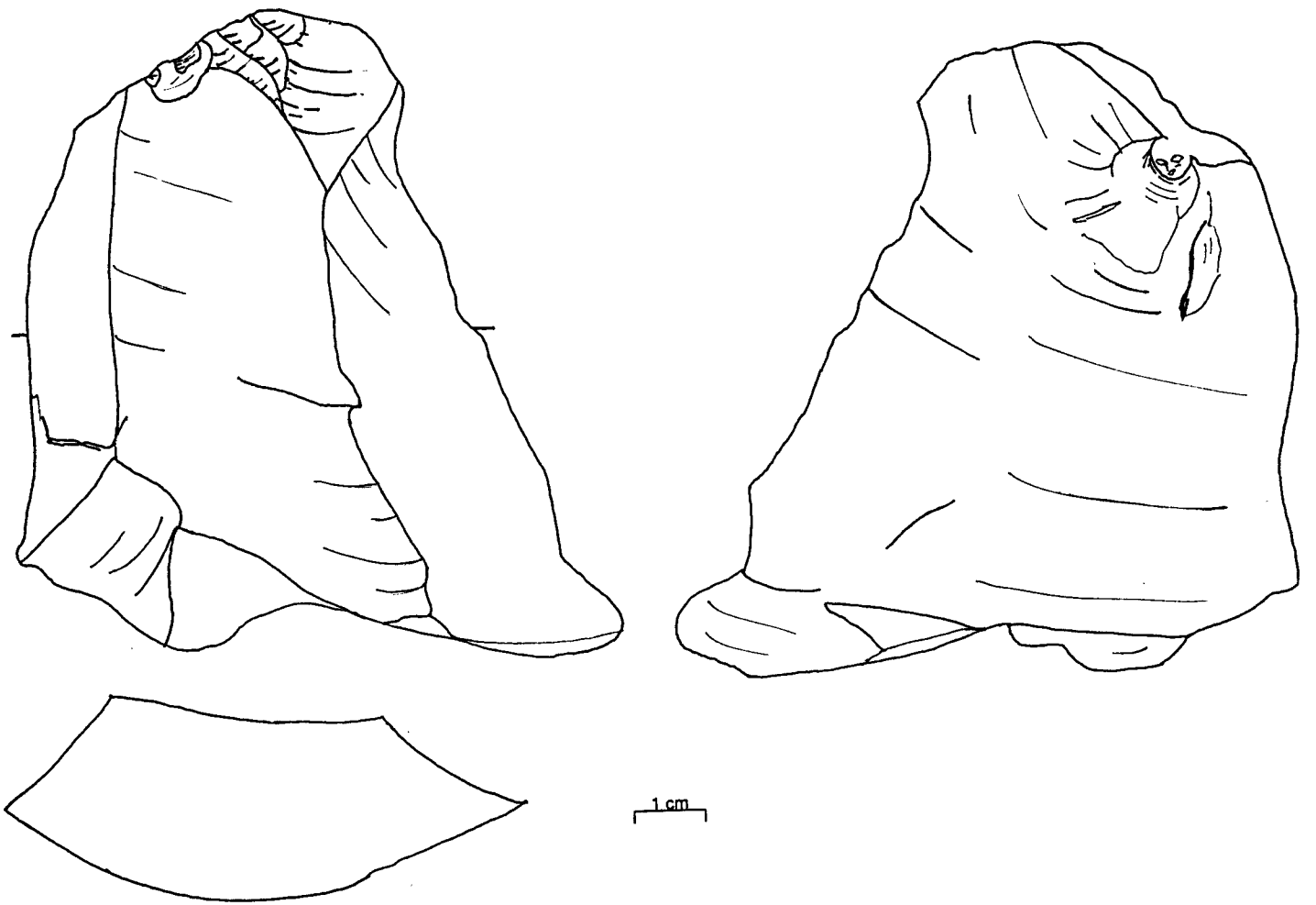


Figure 26. Typical piece of mass reduction debitage.

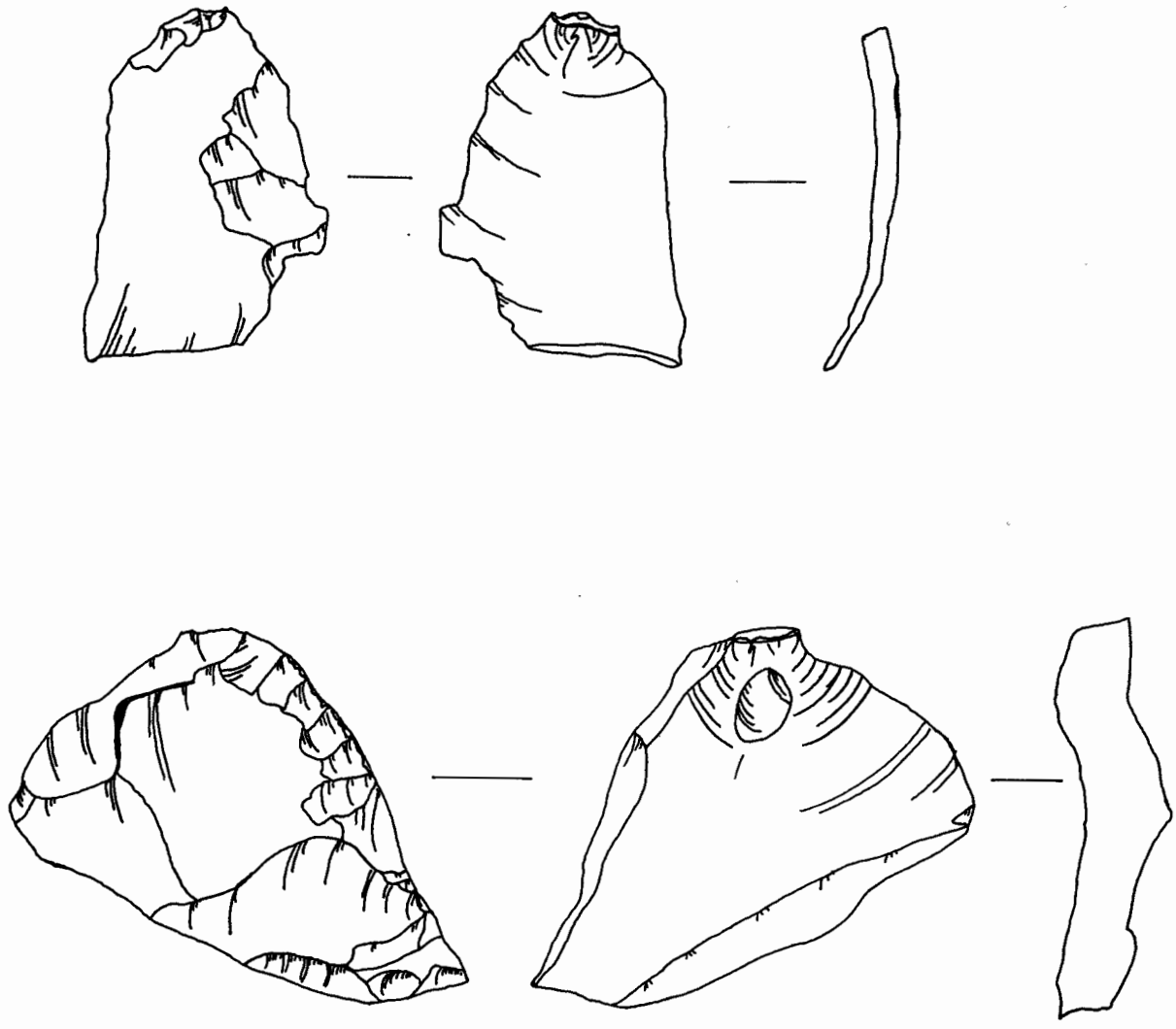


Figure 27. Blank preparation flakes. a. edge preparation flake; b. flake struck from square edge.

preparation flakes, alternate removal flakes, and bulb removal flakes. *Edge preparation flakes* are removed unifacially in sequence along an edge and generally have single facet platforms; the blow is applied slightly back from the edge of the platform. They tend to flare perpendicular to the square edge, so as to be wide but short. Cross-sections of such flakes are usually thickest at the bulb of percussion. Edge preparation flakes are highly variable in size and can be quite large (greater than 8cm maximum length). Dorsal attributes are especially distinctive, since such flakes retain edge morphology. *Alternate flakes* are similar to edge preparation flakes, but where edge preparation flakes are removed unifacially in sequence, alternate flaking proceeds by removing a flake from each face, so that the removal from one face creates a platform for the next removal from the other. Thus, the locations of platforms in relation to flake axes differs. Most attributes of alternate flakes are the same as those of edge preparation flakes with the following exceptions: one side of the platform has steep lateral edges, triangular cross-section, negative flake scars on the dorsal surface from prior alternate flake removals, and the bulb of percussion and compression rings often are oriented oblique to the platform. *Bulb removal flakes* are produced by removing the contact point and some portion of the bulb of percussion from the ventral surface of a flake blank. They represent unequivocal evidence of the edging of flake blanks. Bulb removal flakes can be struck from raw Tosawihi opalite using either hard or soft hammer percussion. Platform characteristics are highly variable. The key attributes of bulb removal flakes lie on their dorsal surfaces, which retain the exterior ventral surface of the flake blank, including the cone of percussion and/or compression rings.

Edge preparation flakes are not wholly unique to the preparation of blanks for thinning. They also are produced in early biface thinning, but generally in much lesser frequencies. Furthermore, those with relict original block surfaces (evidence of edge preparation) often can be distinguished.

Early Biface Thinning (E)—This category includes both hard hammer and soft hammer early biface thinning flakes (Figure 28). Hard hammer early biface thinning flakes are produced in small numbers in the initial edging of a biface (Stage 2 of biface reduction) and in large numbers during the initial thinning of bifaces (early to mid-Stage 3 of reduction). Removal of hard hammer flakes thin the biface and can reduce biface width by removing its edge. This advances the production of a regular edge contour begun in blank preparation. Consequently, the width to thickness ratio may not change during this process. Attributes of hard hammer early biface thinning flakes include broad multifacet or single facet platforms, the force applied slightly back from the edge; as well, the flake expands away from the platform, flakes in long section may curve and be somewhat thick with negative flake scars (of several orientations) on the dorsal surface, prominent cones of percussion may be present, specimens may exhibit relatively acute (less than approximately 60 degrees) platform to dorsal surface angles, and terminations may feather or hinge.

Soft hammer early biface thinning flakes are detached so as to thin early stage bifaces that already have regular edge contours, e.g., a thin well shaped flake blank. In contrast to hard hammer early biface thinning flakes, soft hammer thinning flakes have multifacet platforms resulting from force applied on or near the flake margin. The platforms often are abraded or ground to alleviate slippage of the percussor. They are thinner than hard hammer thinning flakes, but have more prominent dorsal ridges than soft hammer late thinning flakes. Rather than having distinct cones of force, they tend to display indistinct points of percussion, diffuse cones of force, and lipped platforms resulting from initiation by a bending fracture. The distal terminations usually are feathered. Size of both soft hammer and hard hammer early biface thinning flakes is conditioned strongly by initial biface size. Early thinning flakes rarely extend from edge to edge, usually not even crossing the midline of the biface.

Late Biface Thinning (L)—Late biface thinning flakes (Figure 29) generally are removed by soft hammer percussion to thin the facial surfaces of a biface and to make the topography of the faces more regular. Late biface thinning begins late in Stage 3 reduction and continues through Stage 4. The flakes cause little loss of width, serving primarily to reduce thickness. Platform characteristics and plan outline are similar to those for soft hammer early biface thinning flakes, from which they differ in degree but not in kind. Late thinning flakes tend to have slighter curvature in long section and to be thinner and more "ribbon-like." Dorsal ridges are more subdued than among early biface thinning flakes because the faces become much more topographically regular. Dorsal flake scars from previous removals frequently show multiple orientations in the prior flake scars. Dorsal scar patterns overall are more complex than on early biface thinning flakes, due partly to the size of late thinning flakes, which propagate much more evenly on smooth faces. Thus, in relation to biface size, late biface thinning flakes are "very substantial" in size (Young and Bonnichsen 1984:188). Flenniken (1987) estimates that late biface thinning flakes usually run slightly less than half the width of the biface, so their complete length can be used as a rough estimator of biface size.

Heat-treatment and burning—Heat-treatment was recorded whenever it was observed in a sample. Distinctive characteristics of opalite when heated include changes in luster, texture, and compliance (*cf.* Bloomer, Ataman, and Ingbar 1992). Heat-treatment of opalite increases its elasticity, permitting flakes to be removed more predictably and/or with less force. Force propagates better in heat-treated opalite, resulting in generally larger flakes. Failed heat-treatment, which sometimes cannot be distinguished from accidental burning, can create invisible flaws that lead to distinctive curvilinear or "crenated" breakage patterns (Bloomer, Ataman, and Ingbar 1992; Purdy 1975), but burned opalite usually is distinguishable from heat-treatment, as the material crazes and discolors, exhibits pot lid spalls on its surface, and often breaks into cuboid fragments. Heat-treatment was sufficiently common in a few samples that we characterized the heat-treated portion separately from the raw portion.

Soft hammer percussion—Soft hammer percussion is not specifically characteristic of the thinning stage, but we noted soft hammer flake types whenever we observed them. Such recording permitted evaluation of when soft hammer flaking began in the reduction sequence, and it allowed assessment of whether the reduction stage at which production shifted from hard hammer to soft hammer percussion correlates with materials of a particular age.

Mass Analysis

Mass analysis is a simple technique whereby debitage samples are shaken through nested sieves (Table 3). Large samples can be split into fractions prior to sieving. Counts and weights are tallied then for each size grade, and resulting data are converted to sample proportions. Sample proportions and variables then can be used for simple comparisons or in complex statistical models. Both simple and complex interpretive models depend on the (prior) analysis of controlled cases, usually drawn from experimental chipped stone reduction. The primary application of mass analysis has been in the identification of core forms (block cores, bifacial cores, finished tool edges) and biface reduction stages (Ahler 1989a, 1989b; Bloomer and Ingbar 1992).

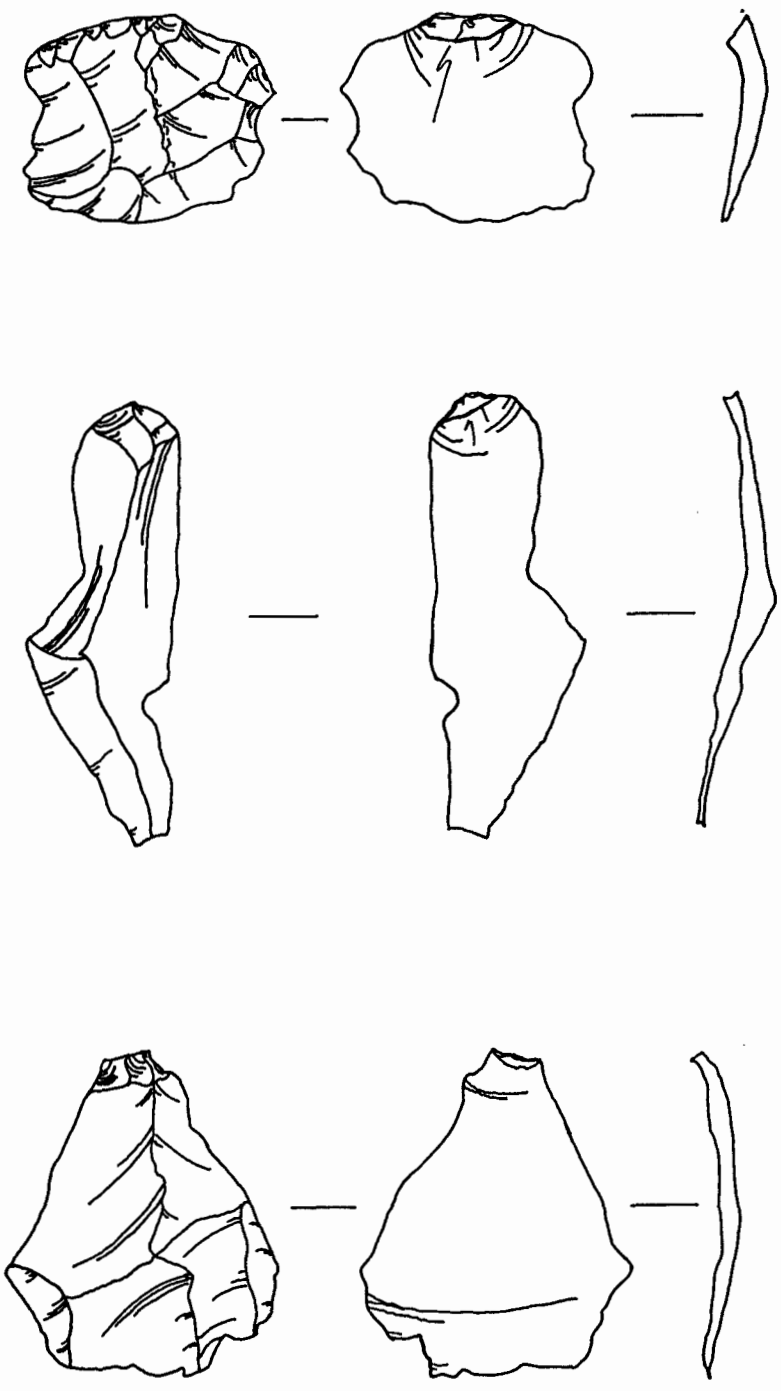


Figure 29. Late biface thinning flakes.

Table 3. Variables Recorded During Mass Analysis of Debitage.

Material type: 1. Opalite 2. Jasper 3. Obsidian
4. Basalt 5. Other

Split type: (n), split is 1/n, n=1, 2, 4, 8, 16, 32

Size Grades:

G0 (2" nominal opening)
G1 (1" nominal opening)
G2 (0.5" nominal opening)
G3 (0.25" nominal opening)

Counts and Weights within each size grade:

Count of flakes with platform remnant
Count of flakes with platform remnant and dorsal cortex
Mass (g) of flakes with platform remnant

Count of flakes without platform remnant
Count of flakes without platform remnant and having dorsal cortex
Mass (g) of flakes without platform remnant

Angular debris:

Mass (g) of angular debris caught in G0 size grade.
Mass (g) of angular debris passing through G0 size grade.

Tuff:

Mass (g) of tuff fragments

Our earlier research (cf. Bloomer and Ingbar 1992) relied on a library of data provided by Stan Ahler (1989b) and on additional data generated by our own experimental program. We developed three discriminant functions applied to each sample. The first determined statistically whether the sample was from core reduction, from tool edge retouch, or from biface reduction. Samples in the latter group then were assessed with a second discriminant function which statistically separated early biface thinning (Callahan's [1979] Stages 1 to mid-Stage 3) from late thinning and early to late thinning. A third discriminant function segregated late thinning from early/late thinning.

One outcome of the study was our suspicion that mass analysis results may vary with core form. Ahler's experimental reductions, made for the most part on thin tabular cobbles of Knife River Flint, may be inappropriate for Tosawihi opalite biface production due to constraints posed by each raw material. Opalite, for example, can occur in large blocks requiring removal of more than two-thirds of the block weight merely to initiate reduction (Elston 1992a). For the present project, we conducted additional experimental flintknapping and mass analysis of the resultant debris, contributing to a dataset that now consists of over 100 opalite reduction sequences. These data were used to generate new discriminant models for interpretation of Locality 36 debitage.

We sought a single discriminant function to segregate mass reduction (e.g., core reduction), initial bifacial edge preparation, early bifacial thinning, and late thinning. Each sample was assessed using the same descriptors employed in the technological analysis. We used only single technological class control cases, arrayed in Table 4, to generate the discriminant function. Table 5 presents the resulting discriminant function and associated statistics. Reclassification of the cases used to create the discriminant function (i.e., post-hoc classification) shows that the accuracy of the function is greatest with late thinning (80% correct classification) and least accurate with early thinning (40% correct classification). Overall, reclassification yielded approximately 65% correct classifications. Examination

of the misclassified cases shows that initial edging samples often were classified incorrectly as early thinning; conversely, misclassified early thinning samples most often were classified initial edging, an outcome suggesting considerable analytical similarity between the two groups.

Table 4. Summary of Experimental Opalite Reduction Sequences Employed in Generating the Mass Analysis Discriminant Function.

	TECHNOLOGICAL CLASSIFICATION*			
	M (n=3)	B (n=30)	E (n=5)	L (n=5)
G0 count (s.d.)	6 (9)	1 (2)	0 (0)	0 (0)
G0 mass (s.d.)	729 (1130)	63 (161)	0 (0)	0 (0)
G1 count (s.d.)	30 (28)	11 (10)	13 (8)	2 (2)
G1 mass (s.d.)	930 (1086)	180 (181)	187 (107)	21 (37)
G2 count (s.d.)	66 (68)	36 (27)	55 (40)	15 (13)
G2 mass (s.d.)	223 (243)	105 (68)	157 (119)	23 (23)
G3 count (s.d.)	217 (226)	148 (112)	213 (138)	165 (154)
G3 mass (s.d.)	78 (79)	50 (36)	75 (45)	19 (11)

*Technological characterizations: M = mass reduction; B = initial biface edging (Stage 2); E = Early bifacial thinning (to mid-Stage 3); L = late bifacial thinning (after mid-Stage 3).

Table 5. Discriminant Function.

a. Fisher's Linear Discriminant Function Coefficients.

Variable	Function 1	Function 2	Function 3	Function 4
MeanG3Wt	63.08	58.53	67.05	15.50
PerWtG3	50.59	34.73	37.82	57.75
PerCtG0	-756.17	-415.95	-528.73	-443.82
PerCtG2	117.35	77.15	80.56	93.80
WtG1G3	6.58	3.69	4.25	4.39
CtG1G3	-189.51	-114.04	-131.35	-116.97
Constant	-44.12	-23.28	-27.96	-24.41

Variables: MeanG3Wt = mean weight of G3 debitage; PerWtG3 = proportion of total mass in G3 size grade; PerCtG2 = proportion of total frequency in G0 size grade; PerCtG2 = proportion of total frequency in G2 size grade; G1G3Wt = mass in G1 size grade divided by mass in G3 size grade; CtG1G3 = frequency in G1 size grade divided by frequency in G3 size grade.

b. Post-hoc classification.

		Predicted Group Membership			
Actual Group	n	M	B	E	L
M (mass reduction)	3	2 66.7%	0 0%	1 33.3%	0 0%
B (initial edging)	30	1 3.3%	20 66.7%	8 26.7%	1 3.3%
E (early thinning)	5	0 0%	3 60.0%	2 40.0%	0 0%
L (late thinning)	5	0 0%	1 20.0%	0 0%	4 80.0%

To examine the accuracy of the discriminant function in greater detail, we tabulated all other experimental cases against their predicted classification (Table 6). These experimental cases are not individual technological stage samples, so they may fall correctly into more than one discriminant classification and still be considered "correct" in some sense. As Table 6 shows, within this loose definition of correct classification, the discriminant function worked fairly well. However, this points out a failing of the approach as a whole, whereby classification fails to take range of variation into account. We shall return to this.

Table 6. Discriminant Function Classification of Experimental Multi-stage Debitage Assemblages.

Actual Stages	Predicted Stage: Mass red.	Initial Edging	Early thinning	Late thinning	% "correct"
mass reduction and initial edging	5	1	0	0	100%
initial edging and early thinning	3	14	6	2	80%
initial edging, early thinning, slight amount of late thinning	1	12	2	0	93%
initial edging, early thinning, and late thinning	0	4	2	2	100%
early thinning, slight amount of late thinning	0	0	1	0	100%
early and late thinning	0	0	1	0	100%

Shading indicates "correct" classification.

Another approach to the interpretation of mass analysis has been proposed by Stahle and Dunn (1982, 1984). Using a nested set of ten sieves ranging from 2 in. to 1/8 in. to size-grade debitage generated by experimental small patterned biface production, they showed how the resulting cumulative density functions of mass and frequency within size grades fit a Weibull distribution function. Weibull distributions are similar to logarithmic distributions (in fact2, the latter is a special case of the former). Weibull transformation of the experimental cumulative density functions for different stages of biface production produced linear plots of the transformed variates against the natural logarithm of sieve size. Stahle and Dunn used the transformed (linear) cumulative density functions to calculate linear regressions for each biface stage. The regressions were statistically distinct for each. Because most archaeological samples are expected to be mixtures of reduction stages, Stahle and Dunn then showed how these data can be used to solve a "mixture" model by the method of constrained least squares. Although they were successful in determining the percentage contributions of different reduction stages to mixtures of their own experimental data, Stahle and Dunn (1984:34) noted

> In view of the many factors that could potentially affect prehistoric flake size data from biface reduction, a conservative approach to the interpretation of flake size analysis is recommended. Although constrained least squares analysis will assign a specific percentage to each stage present in an unknown flake assemblage, strict interpretation of these percentages could be misleading. Instead, the simple identification of initial, middle, final, or some combination of these stages would be both cautious and adequate for most archaeological purposes.

We modified the Stahle and Dunn approach in analyzing the mass debitage data from Locality 36, both to evaluate the discriminant model and to asses whether it could portray sample variation. Cumulative density functions were calculated for staged experimental reductions made on flake blanks and on block cores. Variates for each of four mesh sizes then were transformed using a Weibull transformation (cf. Stahle and Dunn 1984:11-12) and were plotted against the natural logarithm of mesh size. Figure 30 shows the resulting plots for mass and frequency for pooled replications in each of the four technological stages used in attribute analysis. Later reduction stages occur above earlier ones. We then plotted some multiple stage experimental cases against these values; these fell in intuitively sensible positions.

Encouraged by these results, we then plotted two archaeological samples, already examined by technological analysis, against the same experimental data. The archaeological cases plotted somewhat earlier than we thought they should, given our knowledge of the samples (Figure 31). The positions of archaeological sample curves show them similar to mass reduction assemblages. One likely reason is the inclusion in our control cases of replications made on flake blanks. Flake blank biface production yields less debitage than biface production on block cores. Consequently, we revised our control curves, retaining the data on late biface thinning of flake blanks, since by the time biface production reaches this stage the shape is independent of initial form. For earlier stages, we used multi-stage replications (mass reduction and initial edging; initial edging, and early biface thinning) made on block cores. Figure 32 shows one of the same archaeological specimens plotted against this set of control cases.

Sample Selection

To insure that we examined a representative sample of debitage recovered from different contexts within Locality 36, we stratified the samples on the basis of context (cf. Chapter 3), and randomly selected (at varying percentages) actual samples for analysis.

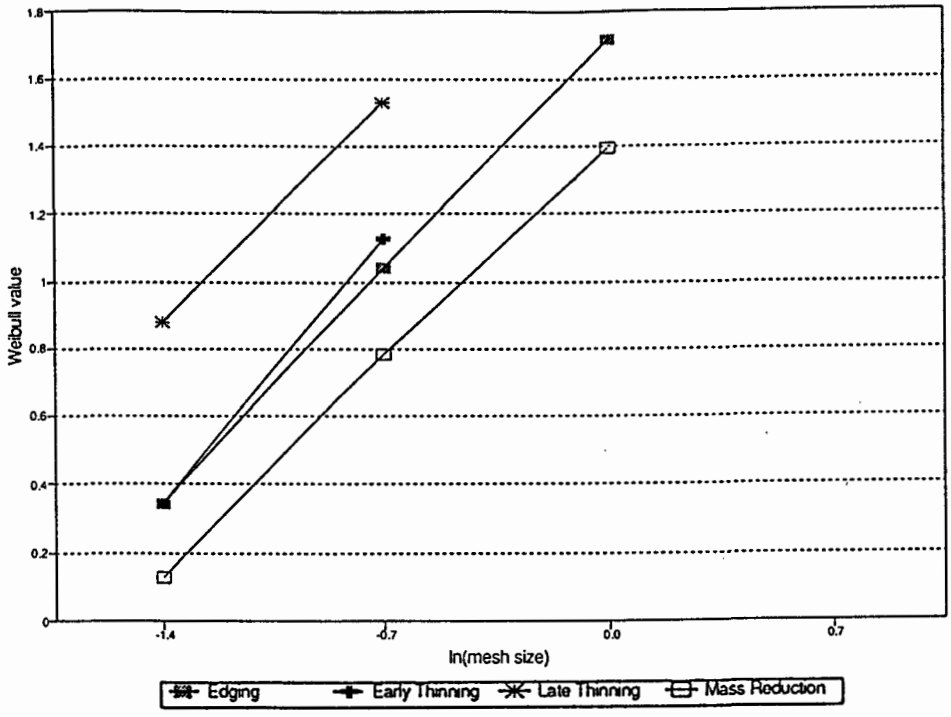
Surface Scrape Units

Five hundred sixty-two 25cm by 25cm surface scrapes (two per 10m by 10m grid square) were sorted into angular debris, platform bearing flakes, and non-platform-bearing flakes. Each category then was counted and weighed, but not size-graded. All samples then were analyzed technologically. Because some surface scrapes yielded no debitage, 486 samples resulted.

Transects Through Features

Transects through Features 42, 49, and 79, consisting of 50cm by 50cm surface scrapes at 1 m intervals, were sampled at 50% intensity. No units from Feature 22 were analyzed. Samples were subjected to the regular mass analysis sorting and size-grading protocol described above; selected samples then were analyzed technologically.

a



b

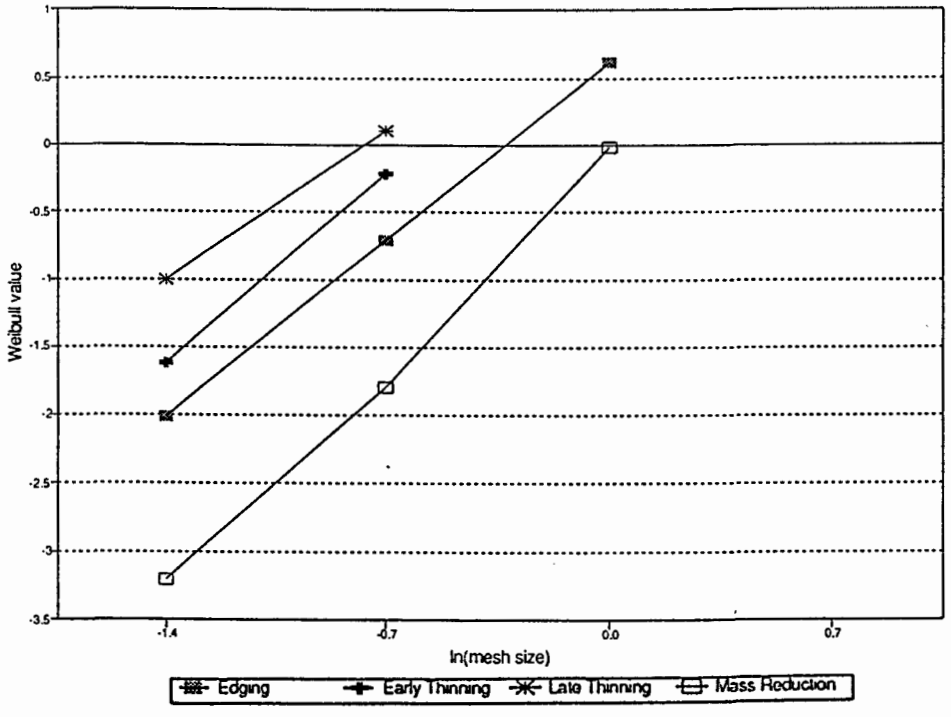
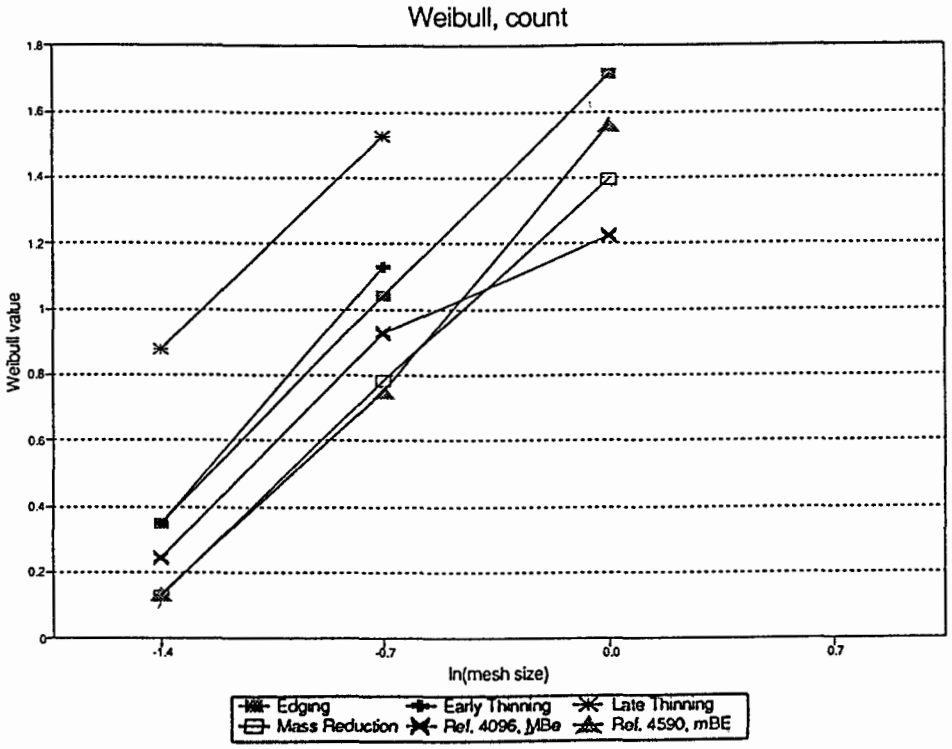


Figure 30. Plots of Weibull-transformed values of experimental debitage assemblages: a. based on counts; b. based on weights.



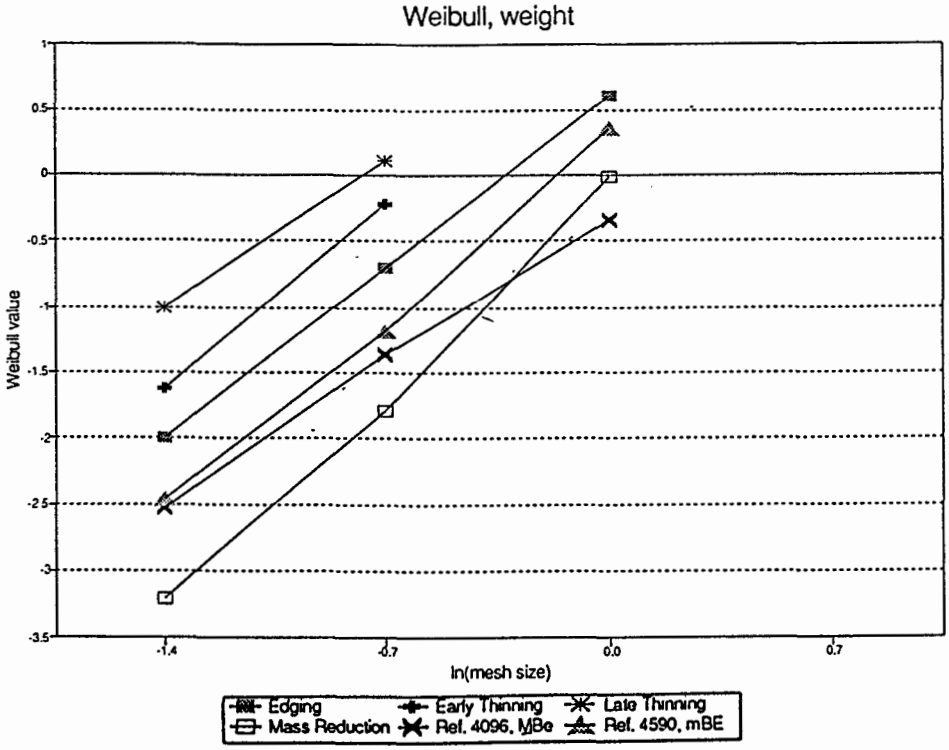


Figure 31. Plots of Weibull-transformed values of experimental debitage assemblages and two archaeological debitage assemblages.

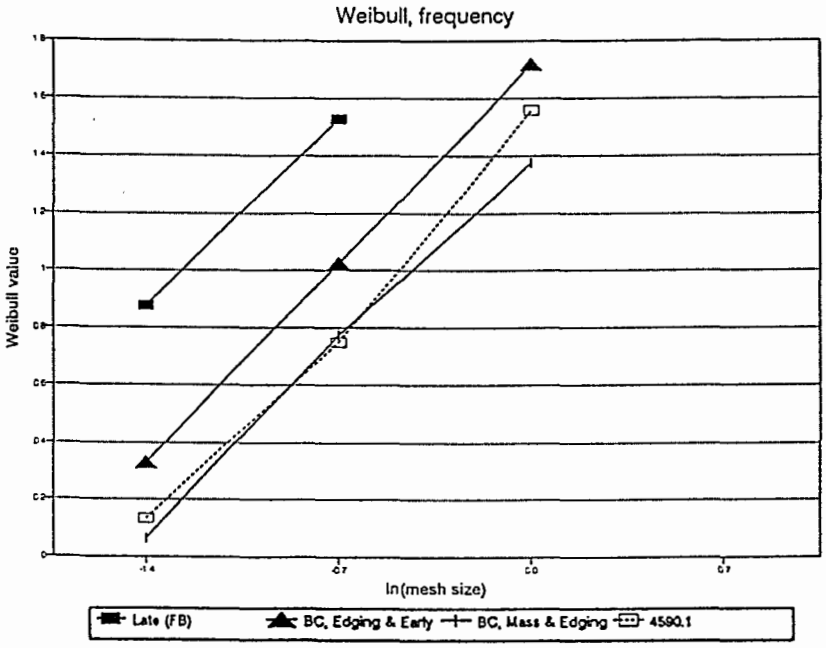
Feature	6	Address	510	Level	0	Sample	4590.1

Mass Analysis Summary (PRB + non-PRB totals)

g0 count	g0 mass (g)	g1 count	g1 mass (g)	g2 count	g2 mass (g)	g3 count	g3 mass (g)	total mass (g)	total count	angular debris mass (g)
2	210.7	26	435.0	46	159.3	158	71.2	876.2	232	44.5

Mass Analysis Statistical Result: Mass Reduction

Technological Analysis Result: mBE



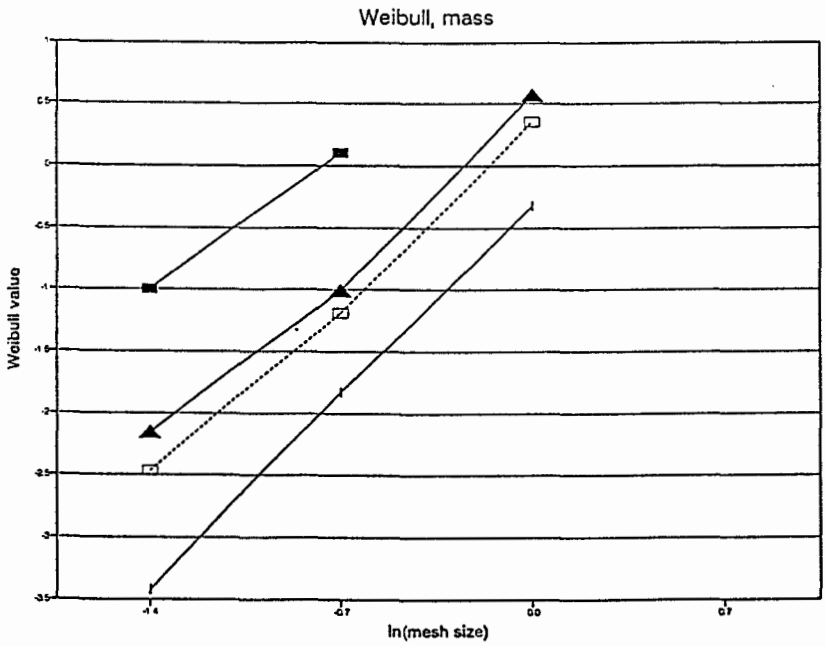


Figure 32. Example of Weibull analysis worksheet for archaeological debitage assemblages.

Reduction Feature Excavation Units

Excavation units in lithic reduction features yielded two sample portions for each unit: a surface sample (0-2 cm depth) and everything lying below. For every feature chosen for analysis half the excavation units within it were analyzed. So, for each selected unit, both the 0-2 cm and deeper levels were examined through mass analysis. The selected samples were analyzed using the usual mass analysis sorting and size-grading protocol. Selected feature samples then were examined by technological (typological) analysis.

Feature 102 Excavation Units

Three excavation units were placed along Trench 3 to sample older deposits. We selected two of these for analysis. All debitage from each level was analyzed using both the usual mass analysis sorting and size-grading, and technological (typological) analysis.

Excavation Units Associated with Buried Features

In addition to units in Feature 102, scraping by a road grader uncovered several other features (Features 105 to 110) central to the site (cf. Chapter 3). All debitage from excavation units on or adjacent these features was sorted, counted, and weighed, but not size-graded.

Inter-feature Excavation Units

Five excavation units were placed haphazardly between areas of surface features (Units 583 to 587). Samples from these were not analyzed.

Lithic Inventories of Trench Strata

We performed a technological analysis in the field, during the recording of quarry pit trenches. Notes on the exercise were converted easily into our system of notation for technological analyses performed in the laboratory; witness samples were not subjected to mass analysis.

Analytical Results

The general results of analyses are discussed in the following order: technological analysis, mass analysis using a discriminant model, and mass analysis using Weibull models. After presenting these results, we compare them. There follows a general summary of debitage evidence.

The debitage analysis data from specific contexts or specific areas of Locality 36 are used to examine other research issues elsewhere in this report. Consequently, not *all* the data are presented in this section; for example, counts and weights of debitage from the 562 random cluster sample surface scrapes are not discussed. Appendix A gives the analytical data discussed here.

Technological Analysis

Three hundred nineteen debitage samples were examined through technological observation. Sample selection was non-random; 65 samples consist of debitage from the random cluster sample surface scrapes, selected in approximately equal proportions from three groups: those with high total flake weights and low flake frequencies, those with low total flake weights and high flake frequencies, and those with relatively high weights and frequencies. A fourth potential group (low weight, low frequency) is too small for meaningful characterization. In addition, 176 debitage samples were selected from various feature contexts including reduction features, hearths, quarry pits (both surface scrapes and trench strata), and non-feature excavation units. Of these, 10 were too small to be characterized reliably. Finally, 88 additional samples were characterized in the field during examination of trench strata. Thus, among 319 samples studied, 221 were examined in their entirety.

The frequency of technologically analyzed samples from various site contexts is shown in Table 7. Samples from quarry pits or units immediately adjacent them are most frequent, followed closely by those from reduction features. Samples without feature association comprise the third most frequent class, and hearth or possible hearth settings, the least. Frequencies are presented in Table 8.

Table 7. Archaeological Contexts of Technologically Analyzed Samples (n=319).

Context	n	%
No feature association	65	20.4
Flake scatter/reduction feature	114	35.7
Hearth/possible hearth	18	5.6
Quarry pit/adjacent quarry pit	122	38.2
Total	319	100.0

Because sample selection was not random, frequencies are not directly interpretable in probabilistic terms. Nonetheless, they illustrate the overall range of variation in Locality 36 debitage, and they *roughly* reflect how frequently different reduction categories occur. The six most frequent characterizations (B*EL, MBE, QM, QMB, QMBE, and mBE) occur in approximately equal frequencies, and jointly comprise 39% of the total. These indicate the major reduction activities at Locality 36. Quarrying of opalite blocks and reduction of their mass clearly were important, as were blank preparation and early thinning. Late thinning of opalite bifaces was infrequent.

Table 8. Technological Analysis, Frequencies of Categorizations (n=319).

Technological Characterization	n	% of total
B	4	1.3
B*	1	0.3
B*E	3	0.9
B*EL	1	0.3
BE	16	5.0
BE*	3	0.9
BE*l	2	0.6
BEL	1	0.3
BEL*	2	0.6
BEl	3	0.9
C* E	1	0.3
C*mel	1	0.3
E	3	0.9
EL	2	0.6
El	1	0.3
L	1	0.3
M	7	2.2
M E	2	0.6
M*B*El	1	0.3
M*B*e	1	0.3
M*BE	4	1.3
M*BEl	1	0.3
M*Be	3	0.9
M*bE	3	0.9
M*bEl	1	0.3
M*be	1	0.3
MB	3	0.9
MB*E	3	0.9
MB*E*l	2	0.6
MB*El	1	0.3
MB*e	1	0.3
MBE	14	4.4
MBE*	3	0.9
MBEL*	1	0.3
MBEl	2	0.6
MBe	9	2.8
ME	1	0.3
Mb	2	0.6
Mbe	1	0.3
Q*	2	0.6
Q* E	1	0.3
Q* El	1	0.3
Q* e	1	0.3
Q* BE	1	0.3
Q*M	12	3.8
Q*M E	4	1.3
Q*M e	7	2.2
Q*M*be	2	0.6
Q*MB	2	0.6
Q*MBE	10	3.1
Q*MBEl	1	0.3
Q*MBe	6	1.9
Q*MBel	1	0.3
Q*ME	3	0.9
Q*MEl	1	0.3
Q*Mb	3	0.9
Q*MbE	2	0.6
Q*Mbe	3	0.9
Q*Me	2	0.6
Q*mBE	1	0.3
Q*mbE	1	0.3
QEl	1	0.3
QM	23	7.2
QM	L	0.3
QM E	5	1.6
QM EL	1	0.3
QM e	3	0.9
QM*B*E	1	0.3
QM*BE	1	0.3
QM*BEl	2	0.6
QM*Be	1	0.3
QM*b	1	0.3
QM*bE	1	0.3
QMB	15	4.7
QMB L	2	0.6
QMBE	19	6.0
QMBE*	1	0.3
QMBE*L	2	0.6
QMBE*l	1	0.3
QMBEL	3	0.9
QMBEl	1	0.3
QMBe	2	0.6
QMb	1	0.3
QMbe	3	0.9
QmB*E*l	1	0.3
b	2	0.6
b L	1	0.3
bE 109	1	0.3
bEL	2	0.6
be	1	0.3
e	1	0.3
m E	1	0.3
mB	1	0.3
mB L	1	0.3
mB*	1	0.3
mB*E	1	0.3
mB*e	2	0.6
mBE	11	3.4
mBE*	2	0.6
mBE*l	2	0.6
mBEL	1	0.3
mBEl	1	0.3
mbE	1	0.3
mbE*	1	0.3
q BE	1	0.3
qM*B*e	1	0.3
qM*BE	2	0.6
qM*Be	1	0.3
qMB*E	1	0.3
qMBE	1	0.3
qMBE*l	1	0.3
qMBe	2	0.6
qMbE*	2	0.6
qmB*E*	1	0.3
qmBE	1	0.3
TOTAL	319	100.0

KEY: Q =Quarrying Debris
M = Mass Reduction Debitage
B = Blank Reduction Debitage
E = Early Biface Thinning Debitage
L = Late Biface Thinning Debitage

Lowercase = Trace Quantity
Capitalized = Frequent
Capitalized with asterisk following = Dominant

When the frequency of each category of reduction is tabulated, a pattern of initial processing emerges (Table 9). Mass reduction, blank preparation, and early biface thinning are the most frequent kinds of reduction, occurring in at least trace amounts in 70% to 80% of the samples examined. Furthermore, they are important or dominant technological characterizations in 50% to 60% of all samples. Late bifacial thinning occurs in only 16% of the examined samples; quarry debris appears in only 38%, and is important or dominant only in 30% of the samples.

Table 9. Frequency of Single Technological Characterizations (n=319).

Category	n	% of total
Q*	67	21.0
Q	92	28.8
q	14	4.4
Subtotal	173	54.2
M*	28	8.8
M		12.4
m	33	10.3
Subtotal	260	81.5
B*		23.2
B	171	53.6
b	36	11.3
Subtotal		72.1
E*		24.5
E	153	48.0
e	56	17.6
Subtotal	233	73.0
L*		2.9
L	19	6.0
l	29	9.1
Subtotal	51	16.0

KEY: Q = Quarrying Debris; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; M = Mass Reduction Debitage; Capitalized = Frequent; Capitalized with following asterisk = Dominant

The moderate frequency of quarry debris and the low frequency of late bifacial thinning characterizations probably have separate causes. Late bifacial thinning is genuinely rare at Locality 36. On the other hand, the moderate incidence of quarrying debris is a result of our sample set; approximately 40% of our samples are from quarry pits or immediately adjacent them. Quarry debris is rare in other contexts; only two samples with quarry debris are from reduction features. So, quarry debris appears in the sample set proportionate to the number of samples from or near quarry features.

When samples from quarry pits are tabulated separately (Table 10), the robustness of this pattern is apparent. Not surprisingly, over 90% of the samples from quarry pit contexts reflect quarrying and mass reduction. The high frequency of blank preparation and early biface thinning is somewhat surprising, since one might expect these to occur away from quarry features. Other Tosawihi quarries

exhibit much lower incidences of blank preparation and early biface thinning than Locality 36 (Table 11), which is distinguished by its high incidence of early biface thinning in quarry pit contexts.

Table 10. Frequency of Single Technological Characterizations, Samples in or Adjacent Quarry Pits Only (n=122).

Category	n	% of total
Q*	67	54.9
Q	36	29.5
q	8	6.6
Subtotal	111	91.0
M*	15	12.3
M		92.4
m	9	7.4
Subtotal	116	95.1
B*		5.7
B	52	42.6
b	21	17.2
Subtotal	80	65.6
E*		18.2
E	51	41.8
e	37	30.3
Subtotal	98	80.3
L*		0.0
L	3	2.5
l	12	9.8
Subtotal	15	12.3

KEY: Q = Quarrying Debris; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; M = Mass Reduction Debitage; Capitalized = Frequent; Capitalized with following asterisk = Dominant

Table 11. Comparison of Debitage Characterizations from Quarry Sites in the Tosawihi Vicinity.

Debitage Characterization	Loc. 36 n=122	Loc. 26 n=32	Loc. 23 n=34	26Ek3200 n=12	26Ek3208 n=66	26Ek3084 n=18
Mass Reduction	116	25	23	9	64	12
% of n	95.1	78.1	67.6	75.0	97.0	66.7
Blank preparation	80	15	32	10	46	8
% of n	65.6	46.9	94.1	83.3	69.7	44.4
Early thinning	98	10	9	2	4	0
% of n	80.3	31.3	26.5	16.7	6.1	0.0

Only samples from quarry pits or adjacent to them are tabulated. Locality 26 data from Leach and Botkin (1991). Data on additional sites taken from Bloomer and Ingbar (1992).

Technological categorizations also can be used to examine how often reduction was continuous, as well as to identify the articulations of interrupted sequences. For example, if extraction and mass reduction are performed in one setting and the resulting block taken elsewhere for blank preparation and thinning, the reduction sequence at the first location will be "QM" and at the second, "BE." To examine this in the archaeological samples, the frequency of each (continuous) sequence was tallied (Table 12). The resulting tallies demonstrate that among assemblages beginning with either mass reduction or blank preparation, the most frequent terminus was early stage thinning (i.e., the biface itself was initially thinned). The sequence frequencies for samples with quarrying debris are more complicated, exhibiting this same trend (reduction through early thinning), but also a second mode consisting only of quarry and mass reduction debris. In summary, the continuity of reduction sequences indicates that early thinning of bifaces was a common endpoint of reduction regardless of starting point. A second, shorter sequence consisting of toolstone extraction and mass reduction also is common.

Table 12. Frequency of Starting and Ending Points of Continuous Sequences.

Sequence	n	
Q	8	Quarry only
QM	62	Quarry and mass reduction
QMB	24	Quarrying through blank preparation
QMBE	66	Quarrying through early thinning
QMBEL	13	Quarrying through late thinning
M	13	Mass reduction only
MB	8	Mass reduction and blank preparation
MBE	61	Mass reduction through early thinning
MBEL	13	Mass reduction through late thinning
B	8	Blank preparation only
BE	24	Blank preparation and early thinning
BEL	11	Blank preparation through late thinning
E	5	Early thinning only
EL	3	Early and late thinning
L	1	Late thinning only

KEY: Q = Quarrying Debris; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; M = Mass Reduction Debitage; Capitalized = Frequent; Capitalized with following asterisk = Dominant

Mass Analysis

One hundred fifty-six samples were sorted, size-graded, weighed, and counted using the protocol described earlier for "full" mass analysis. Seventy samples contained fewer than fifty pieces of debitage; these were excluded from further consideration, since in such small samples a miscounted item makes at least a 2% difference in proportions (cf. Bloomer and Ingbar 1992). The remaining 86 samples were analyzed using both a discriminant function classification and the Weibull comparison techniques already described. We first discuss the sample contexts, then present the results of the two techniques.

The sample set was drawn randomly from two contexts: quarry pit areas and flake scatters. Samples were selected in equal numbers from each context, but valid samples (n greater than or equal to 50) are only in approximate parity (Table 13).

Table 13. Contexts of Mass Analyzed Samples.

Context	Total n	Total %	Valid n	Valid %
Flake Scatter/ Reduction Feature	78	50.0	38	44.2
Quarry Pit/ Adjacent Quarry Pit	78	50.0	48	55.8
Total	156		86	

The discriminant model procedure already presented (cf. Table 5) was used to classify the samples; Table 14 summarizes the results. Mass reduction and early biface thinning dominate. Only three samples were classified as blank preparation. These results clearly are at odds with those from technological analysis (Table 9). We shall return to this soon.

Table 14. Summary of Mass Analysis Results, Discriminant Classifications.

Discriminant Model Mass Analysis Characterization	n	% of Valid Sample (n=86)
Mass Reduction	44	51.2
Blank Preparation	3	3.5
Early Biface Thinning	39	45.3
Late Biface Thinning	0	0.0
Not Analyzed, n50	70	81.4

The same 86 samples also were classified by plotting them against the Weibull distributions of our replications (cf. Figure 32). We next examined plots of individual replications to calibrate our interpretations. Then we characterized each sample by contrasting the plots of mass and frequency distributions. Each sample was summarized using a notation similar to that employed in the technological analysis, differing only in the lack of a "dominant" notation for each category (e.g., "M*" in Table 9). This technique lacks the numeracy of the least-squares regression employed by Stahle and Dunn (1982, 1984), but we think it appropriate for these data. Table 15 presents the frequencies of the resulting characterizations. The three most frequent characterizations (BE, BEl, MBe) together account for more than half the sample. Overall, results are similar to those from technological analysis. Differences lie partly in the more frequent characterization of trace amounts of late bifacial thinning in the Weibull results, where quarrying by-products were not an analytic category.

Table 15. Frequency of Technological Categories, Weibull Analyses (n=86).

Characterization of Weibull Plot	n	% of total
BE	18	22.2
BEL	1	1.2
BEl	13	16.0
El	2	2.5
MB	8	9.9
MBE	8	9.9
MBe	14	17.3
Q	1	1.2
QMb	2	2.5
mBE	8	9.9
qMB	5	6.2
qMBE	1	1.2
Total	81	100.0

KEY: Q = Quarrying Debris; M = Mass Reduction Debitage; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; Capitalized = Frequent

When the sample results are considered in terms of the frequency of individual characterizations (Table 16), as presented above for the technological analysis, blank preparation and early biface thinning are clearly the dominant reduction stages; mass reduction is a distant third, and late bifacial thinning is relatively infrequent.

Table 16. Frequency of Individual Characterizations, Weibull Analyzed Samples (n=86).

Category	n	% of total
Q	3	3.5
q	6	7.0
Subtotal	9	10.5
M		38.2
m	8	9.3
Subtotal	46	53.5
B	76	88.4
b	2	2.3
Subtotal	78	90.7
E	70	81.4
e	14	16.3
Subtotal	84	97.7
L	1	1.2
l	15	17.4
Subtotal	16	18.6

KEY: Q = Quarrying Debris; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; M = Mass Reduction Debitage; Capitalized = Frequent; Capitalized with following asterisk = Dominant

Comparison of Techniques and General Synopsis

Some mass analysis results, particularly those from discriminant classification, are at odds with the characterizations made in technological analysis. For example, Tables 9 and 14 reflect very dissimilar characterizations of the same debitage. On the other hand, the Weibull results and technological analysis results are *relatively* similar. Characterizations of the Weibull plots suggest less mass reduction, more blank preparation, and more early biface thinning than the technological analysis. They do not detect quarry reduction at all, since it was not included in the control cases. Which analysis is correct? Why do they differ? Reasons for differences in the analytical techniques are discussed here, contrasting the results for each sample set and technique.

Two issues merit consideration. First, Locality 36 provides an opportunity to evaluate archaeological methods themselves. The technical challenge presented by the sheer volume of material in quarries can be met only by active development of efficient analytical techniques. Comparison of the three analyses used in this project is a step in this direction. Second, to determine what was produced at and transported from Locality 36 requires evaluation of the accuracy of the different debitage analysis techniques.

Mass Analysis Discriminant Modeling

The discriminant function classification of mass-analyzed debitage assemblages does not fit well with either the Weibull characterizations or the technological analysis results (compare Tables 8, 9, 14, 15, and 16). The discriminant results (cf. Table 14) suggest a much later debitage assemblage at Locality 36 than either of the other techniques. Furthermore, blank preparation is hardly visible in the discriminant classifications, but as a single technological category it was found in 72% of the technologically analyzed samples and in over 90% of the Weibull characterized samples.

Accepting, for the moment, that the results of technological analysis are more likely correct than the discriminant classification of mass analysis data, no consistent pattern of misclassification can be discerned (Table 17). Samples characterized by technological analysis as dominated by one reduction type (e.g., "M*") do not fall consistently within their correct—or nearly correct—categories. Several explanations are possible: (1) poor control cases may have been used to build the discriminant function, (2) the resulting functions themselves have poor discriminatory power, or (3) the archaeological samples "violate" assumptions inherent in the discriminant approach, contradicting the logic of discriminant modelling.

The use of inappropriate control cases certainly would affect the accuracy of the resulting discriminant functions. Inappropriate cases are those that differ so greatly in start point, end point, or technological process from prehistoric production that they constitute feeble analogs. We believe the dataset used in creating discriminant functions to be innocent of this failure. Rather, we attempted to reproduce the technological strategies observed in Tosawihi archaeology. Another inappropriate control case derives from inaccurate recording owing either to imprecise work or to unrecognized bias. This also seems improbable, since we analyzed experimental debitage assemblages precisely as we did the archaeological ones. In fact, during analysis, we recorded many experimental assemblages employing all three techniques without reference to the start and end points of the experimental samples.

Table 17. Cross-Tabulation of Mass Analysis Discriminant Classification with Technological Analysis Characterizations.

Technological Characterization	Discriminant Classification: Mass Reduction	Blank Preparation	Early Thinning	Total
B*E	-	-	1	1
B*EL	-	-	1	1
BE	-	1	4	5
BEl	-	-	1	1
M	1	-	-	1
M*B*e	1	-	-	1
M*BE	2	-	-	2
M*BEl	-	-	1	1
M*Be	-	1	-	1
M*bE	2	-	1	3
M*bEl	1	-	-	1
M*be	-	-	1	1
MB	1	-	-	1
MBE	4	-	-	4
MBE*	1	-	-	1
MBEL*	1	-	-	1
MBEl	-	-	1	1
MBe	1	-	-	1
Q*M*be	1	-	-	1
Q*MBE	2	-	1	3
Q*Mbe	-	-	1	1
Q*mBE	-	-	1	1
Q*mbE	-	-	1	1
QM*Be	1	-	-	1
QM*b	1	-	-	1
QM*bE	1	-	-	1
QMB	-	-	1	1
QMBE	1	-	1	2
QMBE*	1	-	-	1
QMBE*l	1	-	-	1
QMBe	-	-	1	1
QMbe	1	-	2	3
b L	1	-	-	1
bEL	-	-	1	1
m E	-	-	1	1
mB*e	1	-	-	1
mBE	5	-	1	6
mBE*	-	-	1	1
mBE*l	-	-	2	2
qM*B*e	1	-	-	1
qM*BE	-	-	1	1
qM*Be	1	-	-	1
qMBE*l	1	-	-	1
qMBe	1	-	1	2
qMbE*	1	-	1	2
qmBE	-	-	1	1
Total	37	2	30	69

KEY: Q = Quarrying Debris; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; M = Mass Reduction Debitage; Capitalized = Frequent; Capitalized with following asterisk = Dominant

Poor discriminatory power may have led to the mismatch of results found here. A discriminant solution's power lies in the robustness of the resulting functions. The most distinctive functions should describe axes orthogonal to each other in n-1 dimensional space, where n is the number of categories one wishes to discriminate. Alternatively, a single powerful function may segregate categories along a single axis, so that each category forms a clump of cases not overlapping others. This property commonly is measured by the eigenvalues and percent of variance explained by each discriminant function. The discriminant functions determined in this research are more of the latter type: 80% of the control case variance was explained by the first discriminant function. The orthogonality of the functions was not examined mathematically, but bivariate function plots produced during the discriminant analysis indicate they are only partially orthogonal. We already have commented on the relative accuracy of the discriminant functions in reclassification of the control cases (Table 6): clearly, the categories do not "clump" as one might hope. Thus, poor discriminating power may be an important component of the results achieved here. This may be inherent to debitage data, since Ahler (1986:Table 4.15) also found that the first function accounted for a high proportion of his control case variance.

The logic of discriminant analysis is problematic as well. It is used most successfully when there is good reason to believe that the control cases used to determine discriminant functions are structurally similar to the unknowns to be classified.

The problem is simple. If one were to build a discriminant function to segregate three species of iris using measurements of 100 plants from each species, discriminant functions would apply properly to measurements from individual plants, since for each of the three hundred control cases the measurements used are from single specimens. It would violate the logic of the procedure, however, to reach then into a bag of unknown irises, take one measurement from the first, a different from the second, etc., and classify this composite case with the discriminant functions. Thus, discriminant analysis assumes that the domains of cases are similar. Inclusion of irises from still a fourth, unknown, species would create spurious results. The discriminant functions still would classify members of the fourth species as one of the three "known" species. Hence, effective use of discriminant analysis assumes (and requires) prior knowledge about unknown cases (allowing proper control cases to be chosen).

Regarding the latter assumption, our control cases (the experimental reductions) emulate the Tosawihi biface production trajectories as we understand them from prior research. The former assumption is more problematic, as it is, perhaps, in all archaeological studies. In essence, we must assume that the archaeological samples pertain to the same domain as experimental assemblages. But archaeological samples rarely are expected to be single events of reduction. Even if they are multiple events of the same *stage* of reduction, we lack sufficient knowledge of the effects of combining cases to be sure of the resulting outcome. In sum, archaeological applications of discriminant analysis *must* violate an important assumption of the discriminant process. No matter how well the analysis may reclassify unknown control cases, accuracy is unassured when the domains of unknown cases are likely to differ from the domain of control cases. We could, of course, have attempted to synthesize mixed assemblages from the experimental data, developing categories for these control cases. Yet, how would we have known what mixtures were appropriate? Any answer is circular.

Table 17 illustrates another problem. Technological analysis indicates that almost all the archaeological cases have several different stages of reduction. Even if the discriminant results more closely matched the technological characterizations, the resulting classifications would mask variation in each sample. The results would be accurate, but less informative than the technological characterizations.

In short, we are reluctant to recommend discriminant modelling in situations where a wide variety of debitage may have resulted from technologically different processes or reduction stages.

Mass Analysis Models of Weibull Distributions

To examine the efficacy of the Weibull transformation and characterization of the resulting curves, we compared the 64 samples analyzed by technological characterization and Weibull modelling (Table 18). These yielded generally similar results, except for detection of quarrying debris. Because no debitage assemblages resulting from quarrying were present in our experimental assemblages, we did not have a control curve for it. Hence it was interpreted from the Weibull plots for only two samples, both with curves that plotted lower than the Mass Reduction-Blank Preparation curve (cf. Figure 32).

Table 18. Cross-Tabulation of Weibull Analysis Characterizations and Technological Analysis Characterizations.

Technological Characterization	Weibull Characterization										
	QMb	QMB	QMBE	MB	MBE	MBe	BE	BEL	BEl	El	Total
B*E	-	-	-	-	-	-	-	-	1	-	1
B*EL	-	-	-	-	-	-	-	-	1	-	1
BE	-	-	-	-	-	-	1	-	-	-	1
M	-	-	-	-	1	-	-	-	-	-	1
M*B*e	-	1	-	-	-	-	-	-	-	-	1
M*BE	-	1	-	-	1	-	-	-	-	-	2
M*BEl	-	-	-	-	1	-	-	-	-	-	1
M*Be	-	-	-	-	-	1	-	-	-	-	1
M*bE	1	-	-	1	-	-	1	-	-	-	3
M*bEl	-	-	-	1	-	-	-	-	-	-	1
M*be	-	-	-	-	-	-	-	-	1	-	1
MB	-	1	-	-	-	-	-	-	-	-	1
MBE	-	-	-	-	1	1	2	-	-	-	4
MBE*	-	-	-	1	-	-	-	-	-	-	1
MBEL*	-	-	-	-	1	-	-	-	-	-	1
MBEl	-	-	-	-	-	-	-	-	1	-	1
MBe	1	-	-	-	-	-	-	-	-	-	1
Q*M*be	-	-	-	1	-	-	-	-	-	-	1
Q*MBE	-	-	-	-	-	1	1	-	1	-	3
Q*Mbe	-	-	-	-	-	-	1	-	-	-	1
Q*mBE	-	-	-	-	-	-	-	-	-	1	1
Q*mbE	-	-	-	-	-	-	-	-	1	-	1
QM*Be	-	-	-	-	-	1	-	-	-	-	1
QM*b	-	-	-	-	-	1	-	-	-	-	1
QM*bE	-	-	-	-	1	-	-	-	-	-	1
QMB	-	-	-	-	-	-	1	-	-	-	1
QMBE	-	-	-	-	1	-	1	-	-	-	2
QMBE*	-	-	-	-	1	-	-	-	-	-	1
QMBE*l	-	-	-	-	-	1	-	-	-	-	1
QMBe	-	-	-	-	-	-	1	-	-	-	1
QMbe	-	-	-	1	2	-	-	-	-	-	3
b L	-	-	-	-	-	1	-	-	-	-	1
bEL	-	-	-	-	-	-	1	-	-	-	1
m E	-	-	-	-	-	-	-	-	-	1	1
mB*e	-	-	-	-	1	-	-	-	-	-	1
mBE	-	1	-	-	2	2	-	-	1	-	6
mBE*	-	-	-	-	-	-	-	-	1	-	1
mBE*l	-	-	-	-	-	-	-	1	1	-	2
qM*B*e	-	-	-	-	-	1	-	-	-	-	1
qM*BE	-	-	-	-	-	-	-	-	1	-	1
qM*Be	-	-	-	-	-	1	-	-	-	-	1
qMBE*l	-	-	-	-	1	-	-	-	-	-	1
qMBe	-	-	1	-	-	-	1	-	-	-	2
qMbE*	-	-	-	-	-	-	1	-	1	-	2
qmBE	-	-	-	-	1	-	-	-	-	-	1
Total	2	4	1	5	15	11	12	1	11	2	64

KEY: Q = Quarrying Debris; M = Mass Reduction Debitage; B = Blank Reduction Debitage; E = Early Biface Thinning Debitage; L = Late Biface Thinning Debitage; Lowercase = Trace Quantity; Capitalized = Frequent; Capitalized with Following Asterisk = Dominant

Close attention to Table 18 also reveals that the characterizations of the Weibull transformations tend to encompass a lesser range of reduction stages than do technological characterizations. Presuming, again, that the technological characterizations are correct, the Weibull process itself is less sensitive to mixtures of different stages of reduction, at least when applied as here. The cause of this is the process itself. Characterization of the Weibull curves afforded us considerable leeway in interpretation, but they still plot only in one position, just as in discriminant analysis a classification is of either one type or another. When samples from different reduction stages are combined, the resulting curve is elevated or depressed. Thus, there is no indication of range. Adding additional control cases to the Weibull plots may alleviate the problem to some extent, but it still leaves the question of sample domain, discussed above, unresolved.

Technological Analysis and Characterization

Our results suggest that of the three methods of analyzing reduction stage, technological analysis seems to be most effective, for several reasons. First, the analyst quickly can assess for himself whether samples are of similar domains. For example, it is relatively easy to distinguish mass reduction and early stage thinning debris. Second, the time commitment probably differs little from that of mass analysis, especially when large samples are analyzed. We were able to analyze technologically about ten samples per hour. Finding samples, removing them from bags, and rebagging them was the major time consumer in the analytical process. Third, during the process of scanning the analyst has an opportunity to see new facets of the reduction technology. This can be important in understanding a reduction technology. For example, during the course of this analysis we noticed that the incidence of bulb removal flakes is not uniform in samples having blank preparation; some of the older quarry pit strata contained these flakes more often than other settings. This prompted further examination of the bifaces from the site. In any case, the analytical process itself is open-ended, permitting the researcher to follow new lines of inquiry as they present themselves.

The unconstrained nature of the characterization has drawbacks too. It can be difficult to compare samples to each other, and to the work of other analysts. Technological analysis presumes some prior knowledge of the technology under investigation (as do the two other techniques used in our analysis). Lastly, scan-based technological analysis lacks the perceptible precision of strictly quantitative techniques. None of these problems is insurmountable. Comparison of samples still can be accomplished, as we have shown above in presenting our results. Comparison to the work of other analysts simply requires more communication among researchers and avoiding idiosyncratic levels of characterization. The presumption of prior knowledge does not differ in kind from formal analysis, and is unavoidable in any chipped stone analysis. Lastly, quantitative approaches are not necessarily more precise, as we have taken some pains to demonstrate. Yet, if quantification of technological analysis is a desired goal, it is relatively easy to tabulate flake types for quantitative models of lithic reduction (cf. Bloomer and Ingbar 1992). These will be subject to the same problems of sample domain discussed above.

We found that size-graded samples (i.e., those already recorded by mass analysis) were somewhat easier to sort during technological analysis. In fact, there was a tendency for certain kinds of flakes to appear in particular size-grades. Quarrying debris almost invariably was trapped

by the 2 inch sieve. Mass reduction flakes were caught mostly in the 1 inch and the 2 inch sieves. Blank preparation flakes often remained in the 1/2 inch sieve. Eliminating certain size-grades from technological analysis, as has been suggested (Moore 1991a), seems dangerous given these observations. Since recording the data necessary for the Weibull analysis is simple (consisting only of counting and weighing the flakes in each size-grade), we think studies of debitage assemblages probably should combine technological analysis with this simplified recording of mass analysis data.

Synopsis

The analysis of debitage can be used to address several questions. Although our answers to these sometimes are tentative, we address each of them in turn.

What was produced at Locality 36? Locality 36, like every other quarry locality at Tosawihi, appears to have been a source for material worked into bifaces. Almost all the debitage samples show evidence of biface production. Exceptions are the few samples containing only mass reduction or quarry debris. Some indications of biface size were noted during technological analysis. In the main, the bifaces produced at Locality 36 were of "average" Tosawihi size (approximately 8 cm to 12 cm in length), but flakes struck from larger bifaces also were found, particularly in Features 6 and 86. We estimate that some of the bifaces reduced in these features were at least 25 cm long.

What commonly was done with extracted opalite *at the locality*? Following extraction, opalite reduction at Locality 36 commonly included a stage of mass removal, followed by either flake blank production or initial preparation of block edges.

We found distinct evidence of the reduction of flake blanks into bifaces (i.e., the presence of bulb removal flakes) in many samples. The absence of bulb removal flakes in some samples neither confirms that block reduction occurred nor that flake blank reduction did *not* occur; rather, it is equivocal, since these are produced in low frequencies during flake blank reduction. However, the frequent occurrence of mass reduction debris suggests that bifaces also were commonly reduced directly from blocks of opalite.

Later phases of blank preparation—edge regularization—occurred commonly. Early bifacial thinning also was performed frequently. Evidence of heat-treatment is not abundant, but was present consistently in reduction features. When conducted, it usually was done sometime prior to (or during) the removal of early biface thinning flakes; many heat-treated flakes are early thinning flakes. Judging from the debitage, flake blank-based bifaces were heat-treated as well (though infrequently), but apparently at an earlier stage. In some samples we found evidence of heat-treatment before completion of blank preparation, associated with evidence of flake blank reduction. Overall, the incidence of heat-treatment observed at Locality 36 is much lower than at non-quarry sites in the Tosawihi vicinity (Elston and Raven 1992). This suggests spatial differentiation in the location of technological processes.

Bifaces were reduced infrequently, but not rarely, beyond early Stage 3. No evidence of the final finishing of biface edges was found. Based on the debitage alone, we estimate that bifaces were transported away from Locality 36 at the completion of or during Stage 3 early thinning.

Were activities other than opalite reduction performed at Locality 36? Very few pieces of debitage were recovered of materials other than locally available opalite. The few flakes of non-local raw material almost always were small flakes from facial reduction of stone tools or edge

margin maintenance. This scant evidence suggests that *perhaps* a few activities other than opalite reduction occurred at Locality 36, but they were so infrequent and/or made so little use of stone tools that they left no concentrated areas of lithic debris.

Chapter 5

FLAKED STONE ARTIFACTS

Kathryn Ataman

This chapter describes the biface, flake tool, and projectile point assemblages recovered from Locality 36. The significant activities represented at the Locality focused on toolstone extraction and early stage biface production, and yielded many bifaces. Despite extensive excavations, the number of flake tools and projectile points recovered is limited, however, and reflects a narrow range of activities.

Failure and Rejection at Locality 36 : The Biface Assemblage

Most formed artifacts in the Locality 36 assemblage are bifaces; 635 complete and fragmentary bifaces were recovered. Most were abandoned early in reduction in or around quarry pits; only a few were finished sufficiently to serve as tools. The most striking aspect of these bifaces is that they represent an assemblage of manufacturing failures, many of them unbroken rejects, discarded for various reasons. This strongly influenced our analysis and interpretation.

Research Aims

Our analytical methods are those described by Ataman (1992). They are recapitulated briefly as the data are described and attributes of raw material, size, reduction stage, thermal alteration, breakage characteristics, and manufacturing techniques are examined.

Extrapolation from the unsuccessful to the successful product is central to our understanding of the Tosawihi biface production system. To extrapolate, we must consider other Tosawihi bifaces and make connections between them and those from Locality 36. Evidence for residential occupation of Locality 36 is scant, as it is at other (less intensively) examined quarry loci in 26Ek3032. Yet, extensive reduction of toolstone has been observed at campsites within a 12 km radius of the quarry center, suggesting that many of the bifaces produced at Locality 36 were transported to other sites in the vicinity, where they were reduced further before export from Tosawihi. This question will be examined through comparison of export products from Locality 36 and from previously investigated Tosawihi sites.

Bifaces broken in manufacture provide important information; when only finished objects are present, the manufacturing process is difficult or impossible to reconstruct. Observation of bifaces broken in various stages of manufacture, along with data from debitage studies, allows us to reconstruct production methods (Callahan 1979) and to identify reduction techniques that may be peculiar to specific features, sites, regions, or timeframes.

Throughout this chapter, comparisons will be made with assemblages analyzed during earlier research conducted in the Tosawihi vicinity (Elston and Raven 1992) from 1987 to 1989. A summary of these comparisons and more detailed comparison with specific quarry locations is

presented later in the chapter. Like material from Locality 36, the earlier assemblage is composed primarily of rejects, but of ones discarded at a point much later into the reduction sequence and for different reasons.

Assemblage Description

Raw Material

Most bifaces recovered from Locality 36 are made of opalite; a very few are made of chalcedony and opal, varieties of opalite defined by degree of silicification. Tosawihi opalite can be recognized by its distinctive appearance under ultraviolet light (Elston 1992a) where it emits green light. While the ultraviolet scan technique is useful for identifying Tosawihi material recovered from non-Tosawihi contexts, presently it allows us to identify the presence of exotic materials. None were noted.

A small number of bifaces (n=4) are made of jasper, which does not outcrop at Locality 36. This material probably derives from either Locality 225 of 26Ek3032 or 26Ek3084, both nearby jasper quarries. In addition, there is a small number of opalite bifaces, the raw material of which clearly is of Tosawihi origin but from outside Locality 36. One, an early Stage 4 biface of green translucent opalite, probably is from the greater Tosawihi vicinity, considering that it glows green under ultraviolet light, but the material has not been noted in our previous studies. Another, made of distinctive salmon pink opalite (late Stage 3), probably derived from one or another of Localities 38, 39, and 48, all of which are within 300 m of Locality 36.

While the raw material outcropping at Locality 36 varies in texture, type, and number of inclusions, the color is quite uniform, ranging among grey, white, and beige. Approximately 97% percent of the assemblage exhibits these colors. Finely swirled and/or banded patterns appear in some of the material, much of which was recovered from contexts with early (ca. 4000 B.P.) ^{14}C dates. The presence of this distinctive opalite provides us a way to identify reduction activity relating to the earliest use of the quarry. The high proportion of bifaces made of the colors observed in the Locality 36 outcrops, and the swirled and banded patterning on some pieces in the assemblage, reinforce an impression that almost all the bifaces were derived from the raw material sources of Locality 36.

Size

Nearly 48% of the bifaces are complete and complete individual dimensions occasionally are preserved on broken pieces. For example, a piece missing only a tip still will retain its maximum width and thickness, although not its complete length or weight. In the interest of obtaining samples as large as possible, complete dimensions were recorded for each size variable (Table 19).

Table 19. Dimension Frequencies and Mean Dimensions of Bifaces.

	n with complete dimension	Mean	Standard Deviation
Complete Length	324	115.4 mm	26.1
Complete Width	429	74.1 mm	17.7
Complete Thickness	447	35.3 mm	12.1
Complete Weight	303	318.8 g	179.0

Most of the bifaces are failed, rejected specimens, and their proportions are likely to differ from successful products transported away from the quarry. Since there are so few Stage 1, Stage 4, or Stage 5 bifaces in the assemblage, only the sizes of Stage 2 and 3 bifaces are discussed here (the staging scheme is described in the following section). Recovered from an area closer to a material source than most bifaces in the earlier assemblage, Locality 36 bifaces are larger (Table 20). While only slightly longer (ca. 1 cm), width and thickness are substantially greater. Larger size and a high proportion of complete pieces indicates that these bifaces often were discarded because they could not be thinned successfully (Figures 33, 34). Thus, there is a significant difference between Locality 36 and the earlier assemblage, where only about 10% of the bifaces were complete and breakage was the main reason for biface discard.

Table 20. Comparison of Biface Sizes: 1987-1989 and Locality 36 Assemblages by Stage.

		Length (mm)			Width (mm)			Thickness (mm)			Weight (g)			
Stage		Mean	s.d.	CV	Mean	s.d.	CV	Mean	s.d.	CV	Mean	s.d.	CV	W/Th Ratio
Early 2	1987-1989	107	26.8	0.25	73.3	13.4	0.18	29.9	11.5	0.38	236.3	148.9	0.63	2.45
	Loc. 36	123.3	29.3	0.24	83.7	21.6	0.26	42.6	13.8	0.32	361	167	0.46	1.96
Late 2	1987-1989	110.6	28.7	0.26	69.2	17.8	0.26	38.2	12	0.31	258	218.5	0.85	2.45
	Loc. 36	115.7	16.1	0.14	78.7	16.8	0.21	39.1	11.5	0.29	351.5	180.3	0.51	2.01
Early 3	1987-1989	107	25.1	0.23	67.7	16.6	0.25	29.5	10.6	0.36	231.9	165.1	0.71	2.29
	Loc. 36	115.3	24.6	0.21	74.8	16.8	0.22	36.3	11.2	0.31	328.9	185.8	0.56	2.06
Middle 3	1987-1989	106.8	29.8	0.28	60	18	0.30	21.9	9	0.41	182.6	137.1	0.75	2.74
	Loc. 36	115.1	26.9	0.23	66.3	16.2	0.24	30.2	10.8	0.36	244.7	129.9	0.53	2.19
Late 3	1987-1989	108	36	0.33	50.7	17.8	0.35	14	5.7	0.41	128.2	88.4	0.69	3.6
	Loc. 36	107	27.7	0.26	61.9	14.6	0.24	20.7	6.3	0.30	246.7	-	-	2.99

There is little length difference between late Stage 2, early Stage 3, and middle Stage 3 bifaces, but width, thickness, and weight decrease through the reduction sequence while width/thickness ratios increase. Differences in width/thickness ratios, coupled with differences in the number of complete discarded specimens in both assemblages, again suggests that thinning failure at Locality 36 was one of the main reasons for discard. This point raises the issue of biface function to the extent that, if bifaces were intended primarily as cores, successful thinning would not be a primary factor in retention or discard decisions. Rather, bifaces with platforms and surfaces suitable for the detachment of flakes would be selected for retention.

Although the assemblage consists primarily of products rejected before their completion, consideration of size homogeneity allows us to evaluate whether biface production was oriented toward a standardized product(s) or toward variable ones. Standard deviation is the statistical

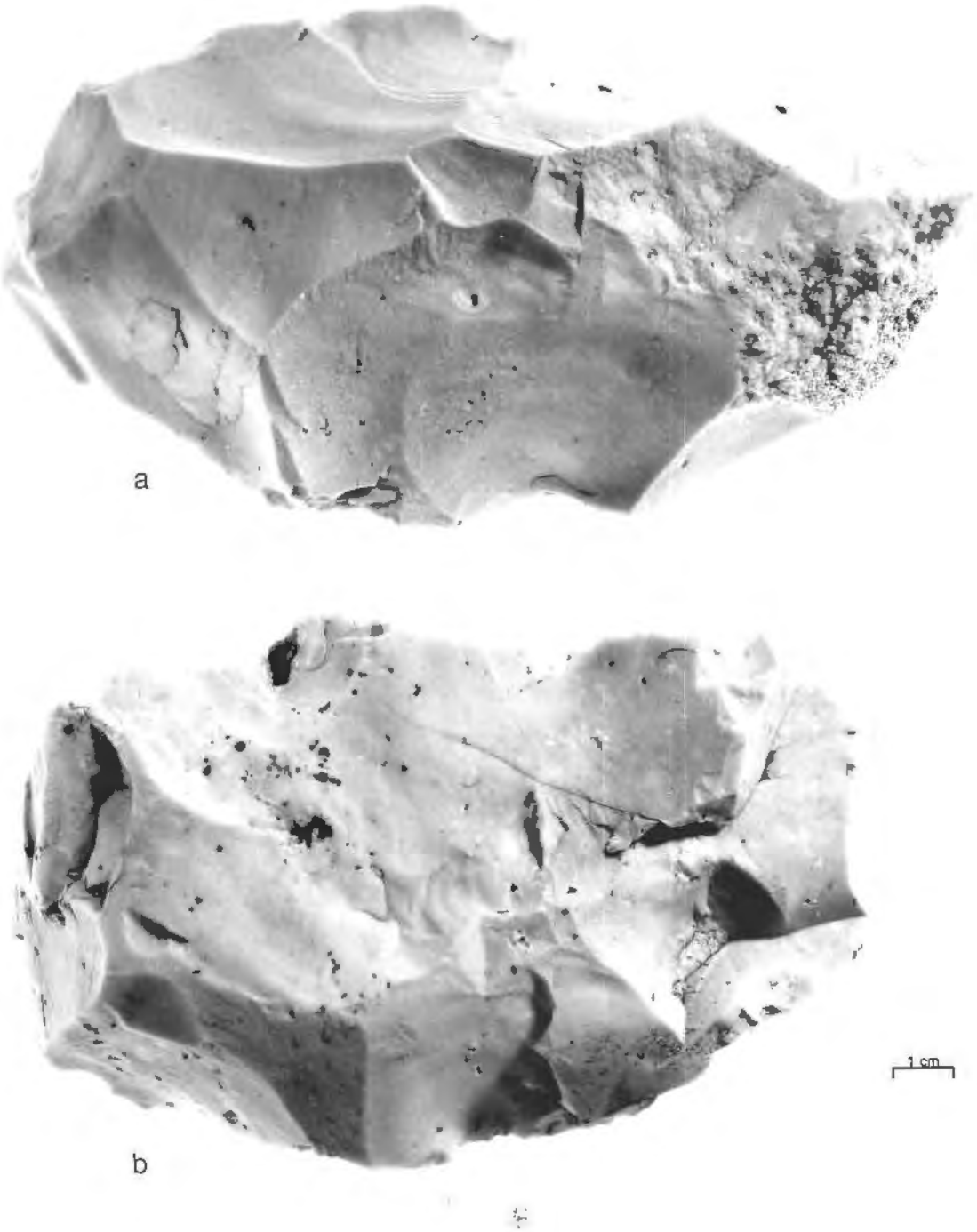


Figure 33. Complete bifaces discarded due to unsuccessful thinning.

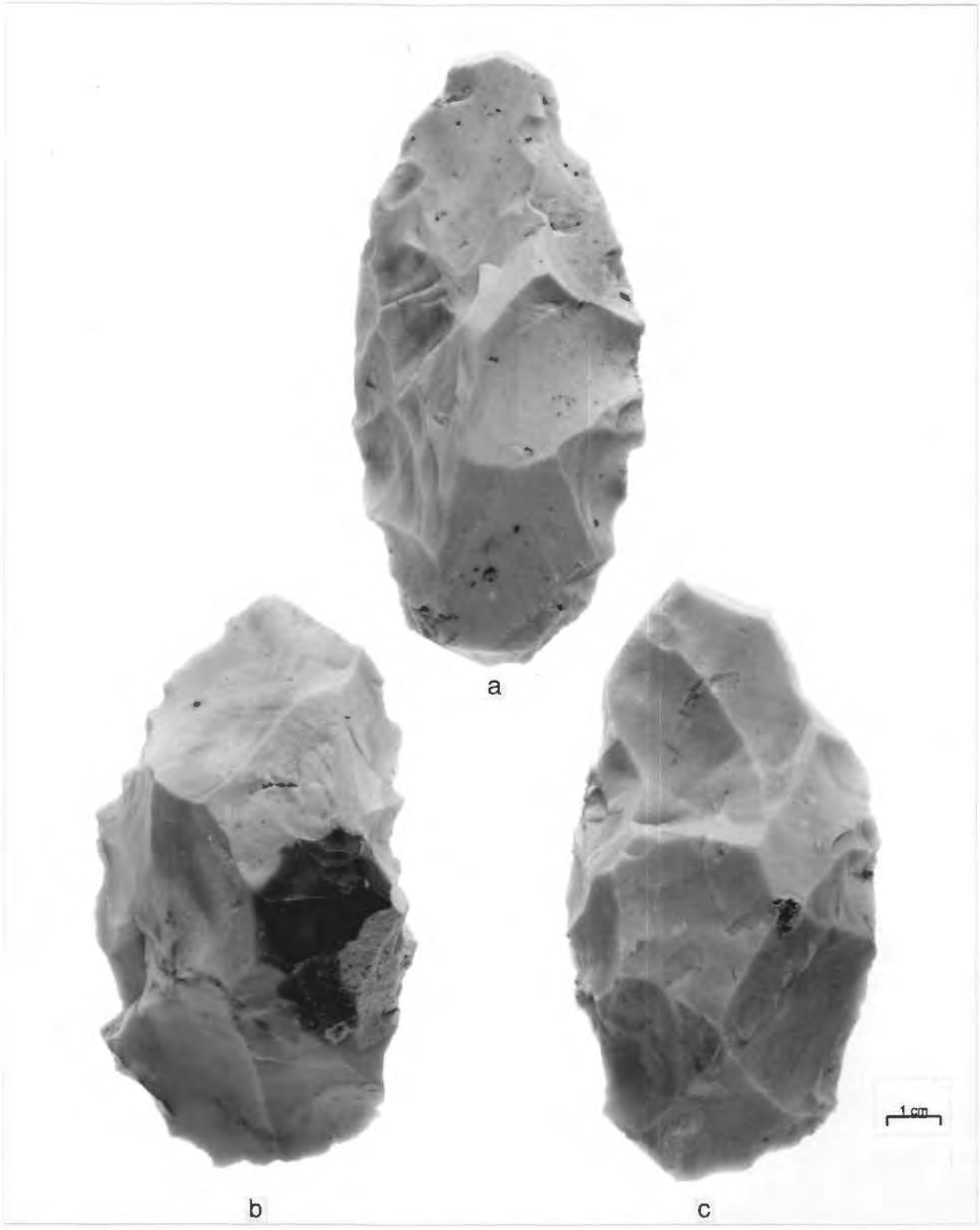


Figure 34. Bifaces discarded due to unsuccessful thinning.

measure of dispersion used most frequently, but comparison of standard deviations alone is misleading when, as in the present case, compared samples differ considerably. The coefficient of variation (CV) facilitates comparison of biface size using the standard deviation relative to the mean. A high value indicates greater variation. Table 20 presents means, standard deviations, and coefficients of variation for dimensions of complete bifaces at various reduction stages. Length and width exhibit fairly low variation (CV=0.21–0.26 and 0.14–0.26, respectively); thickness (CV=0.29–0.36) and weight (CV=0.46–0.56) are more variable.

When the assemblages are compared, in each dimension and in each stage, Locality 36 almost without exception has a lower coefficient of variation. This suggests that the product or products reduced at Locality 36 quarries are less variable in size (and, as we have noted above, are somewhat larger in most dimensions) than those reduced at previously investigated sites. This pattern, and the lower width/thickness ratios of Locality 36 bifaces, suggest that a single product was manufactured at the locality and that failure in thinning was the main reason for discard.

Reduction Stage

The reduction stages described here are based on Callahan's (1979) scheme for biface manufacturing. Variation in extent of reduction (flake scar patterning), cross-section, and width/thickness ratio all contribute to the determination of stage. The first stage consists of the unworked blank, the second of blank preparation and edge preparation, the third of primary thinning, the fourth of secondary thinning, and the final (Stage 5) of shaping and finishing. In our previous work at Tosawihi (Bloomer, Ataman, and Ingbar 1992), we subdivided Stages 2 and 4 into early and late, and Stage 3 into early, middle, and late in order to gain more detail about the organization of biface production. We use the same scheme here, but without subdivision of Stage 4.

The number of Stage 1 bifaces is very small, because, a Stage 1 biface, as defined, must have been selected for use in order to distinguish it from a rejected flake or block. At a source area it is impossible to recognize selected but unworked blanks, unless they are found in unusual contexts (e.g., caches). At Locality 36, bifaces were classified as Stage 1 only when they were observed outside direct quarry contexts. Only three such pieces were recovered (Table 21). Stage 4 and Stage 5 bifaces also are rare, reflecting the early nature of biface reduction at the quarry. Most of the assemblage consists of Stage 2 and Stage 3 bifaces.

Table 21. Biface Stages Represented in the Assemblage.

Stage	No.	%	% excluding indeterminate stage n=616
Stage 1	3	0.47	0.49
Early 2	31	4.90	5.00
Late 2	99	15.60	16.10
Early 3	343	54.00	55.70
Mid 3	107	16.80	17.40
Late 3	25	3.90	4.10
Stage 4	6	0.94	0.97
Stage 5	2	0.30	0.32
Indeterminate	19	3.00	-
Total	**635**	**100.00**	**100.00**

One complete, heat-treated Stage 5 specimen (two refitted pieces) appears to have been a finished tool (Figure 35e). Several sections of both edges appear to have been straightened with retouch and resharpening is evident in at least one area along the distal end of one lateral margin. At 100x magnification (using a light-incident metallurgical microscope), heavy rounding, probably indicative of use, is visible along 3 cm of one edge. This biface probably functioned as a cutting tool, but the material worked could not be determined nor is it known if the item once was hafted. Two other pieces, both distal ends of late stage bifaces (Figure 35a, b), were examined for use wear traces. Both exhibit some edge rounding and straightening, but use could not be established definitively.

Manufacturing Technology

Biface manufacturing attributes can indicate spatial or temporal differences in technology. Four technological features of bifaces are considered here: blank form, evidence of specialized reduction techniques, thermal alteration, and manufacturing failure. Each is discussed below, and the information is used in subsequent analyses to examine contextual differences.

Blank Form

Biface blanks may consist of flake blanks produced from a core or detached directly from bedrock, alluvial or colluvial cobbles, or blocks extracted from surface or subsurface bedrock. Flake blanks produced from cores and directly from bedrock can be morphologically similar, as is the debitage produced in their reduction, although bedrock-detached flake blanks more frequently exhibit straight profiles, wide platforms, and hinged terminations. The only positive evidence for flake blanks detached from bedrock is the negative flake scar on the bedrock (Figure 36).

In early stages of reduction, flake blanks can be recognized by characteristic features on the unworked portions of the ventral surface (Figure 37), such as point and cone of percussion, compression rings, and curved profile. Indirect evidence for the use of flakes as biface blanks includes the presence or absence of large cores in the assemblage. Because large cores can be worked into small ones, however, and cores can be worked directly into bifaces, a lack of cores is inconclusive evidence for the absence of flake-based biface reduction.

Use of quarried blocks for blanks is even more difficult to recognize. Unless a considerable portion of the original blank remains unworked (Figure 38), use of block blanks can be presumed only by reference to absence of cores, absence of flake blank produced bifaces, *and* absence of characteristic flake blank indicators in the debitage (i.e., presence of bulb removal flakes and alternate flakes or edge preparation flakes with original flake blank surfaces). Since recognition of block-based bifaces is problematic, flake blank bifaces here are contrasted with block and indeterminate bifaces combined.

At Locality 36, 13.7% of the bifaces exhibit characteristics suggesting their production on flake blanks (Table 22; cf. Figure 37). It is impossible however, to establish the precise frequency of the use of flake blanks because the evidence (visible on the ventral surface only) becomes obscured as reduction continues. In order to compare the sizes of flake blanks and block blanks in the assemblage, we first must eliminate the possibility that reduction stage influences that relationship. A chi-square test of this relationship (excluding Stage 4, Stage 5, and indeterminate stage bifaces) produces a value of 2.92 (df=5, prob. ca. 0.70), indicating no statistical association. Nevertheless, as seen in Table 22, flake blanks were noted more often among early stage bifaces. This allows us to compare directly the dimensions of flake and block based bifaces as a group.

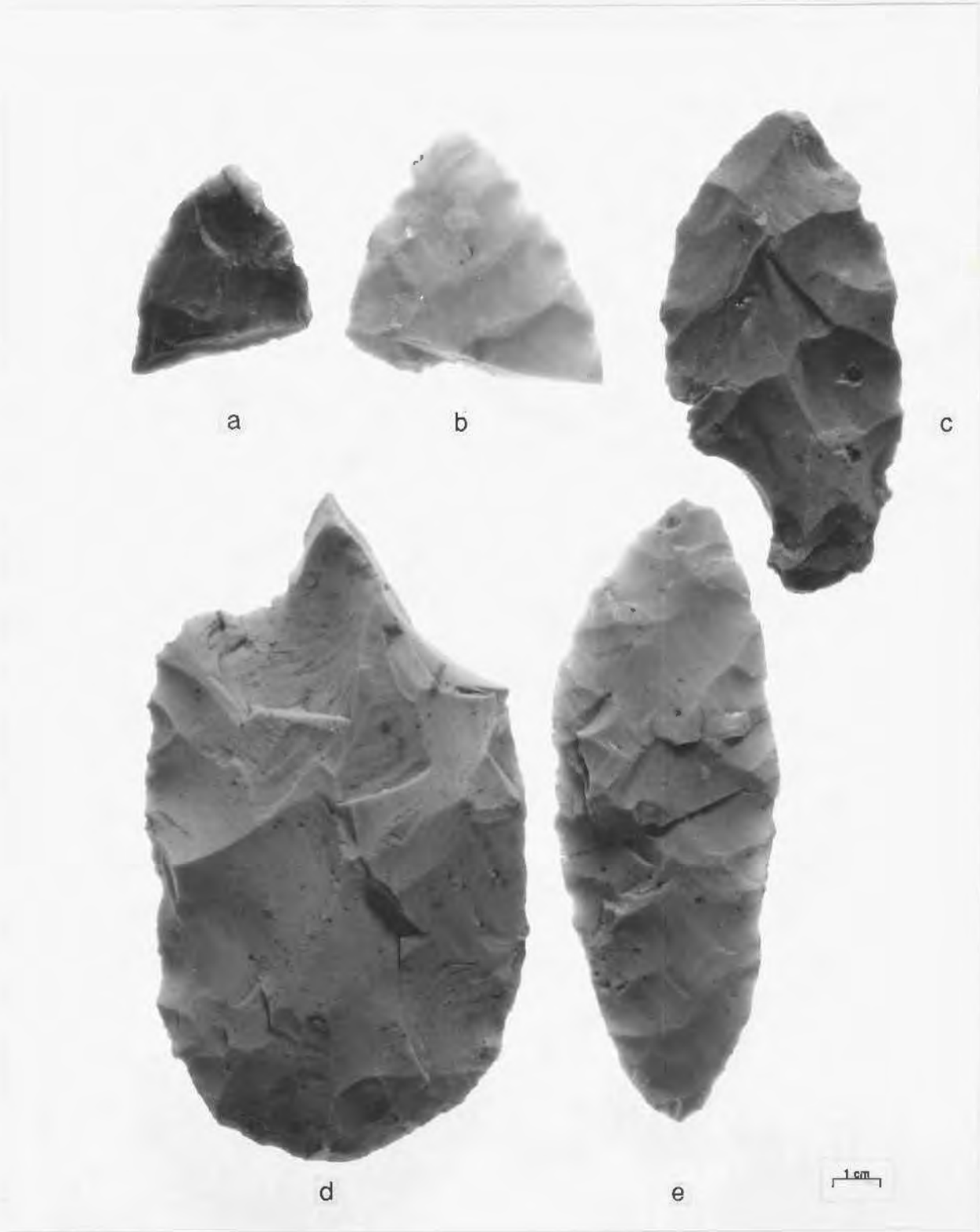


Figure 35. Successfully thinned bifaces.



Figure 36. Flake scar on bedrock outcrop.

Table 22. Bifaces from Flake Blanks by Reduction Stage.

Stage	no. made on flake blanks	% on flake blanks	no. on blocks or indet. blanks	% on blocks or indet. blanks	Total
1	1	33.3	2	66.3	3
Early 2	5	16.1	26	83.8	31
Late 2	21	21.2	78	78.8	99
Early 3	47	7.4	296	86.3	343
Mid 3	10	9.3	97	90.6	107
Late 3	1	4.0	24	96.0	25
4	1	16.7	5	83.3	6
5	1	50.0	1	50.0	2
Indeterminate	0	0.0	19	100.0	19
Total	87		548		635

The length, width, thickness, and weight of complete flake-produced bifaces and block and indeterminate bifaces were compared with t-tests. Differences in length were significant to p=.002, width to p=.014, and thickness and weight to p<.000. In each case, flake blank bifaces were smaller than the other two groups. Irregular blocks often require shaping before edging is feasible and the flakes produced in the course of shaping can be quite large. It is possible that flake blank bifaces were produced from early stage debitage produced in Stage 2 reduction, which would explain the presence of flake blank bifaces and absence of cores (cf. Chapter 4).

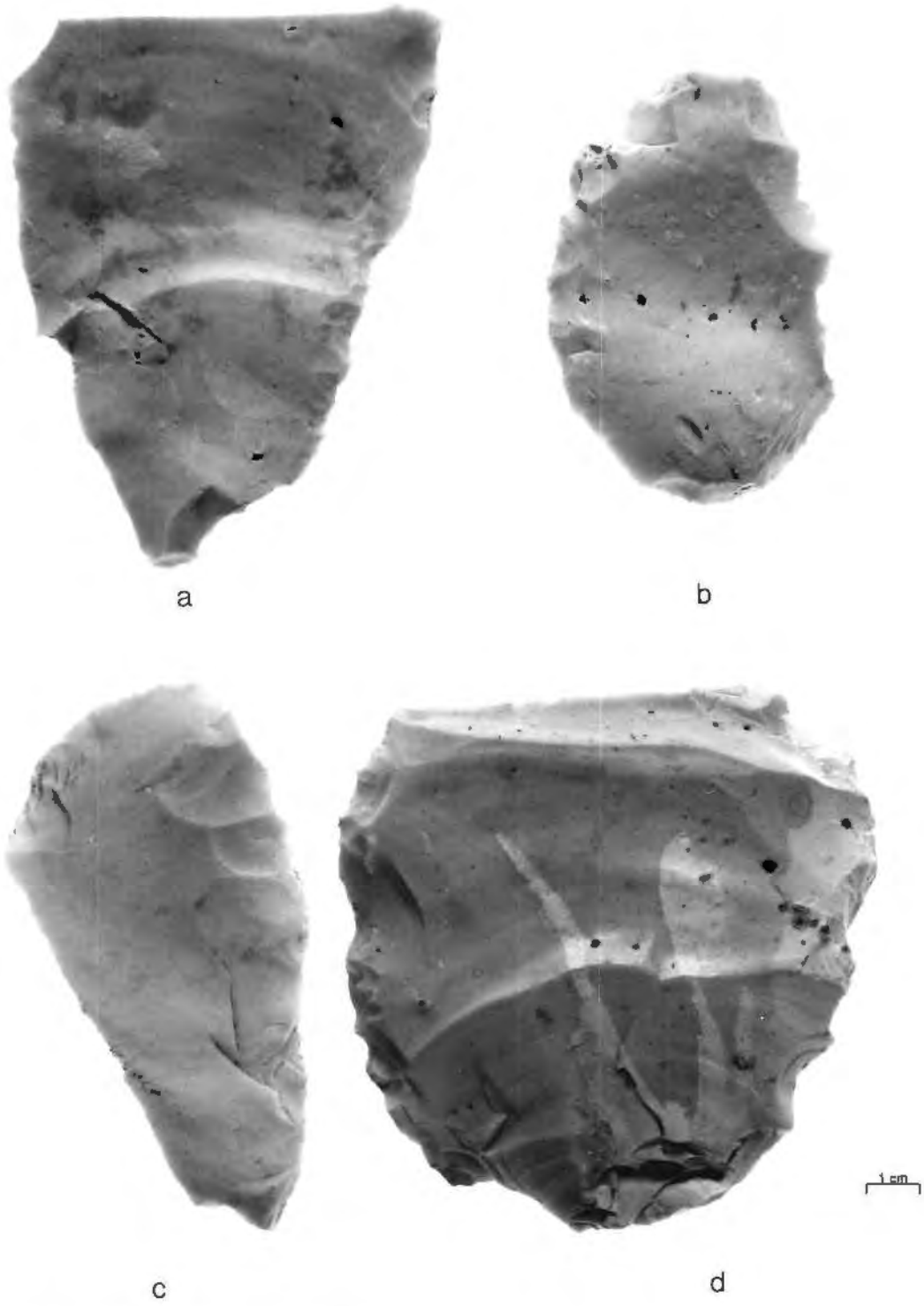


Figure 37. Selected flake blank-based bifaces.

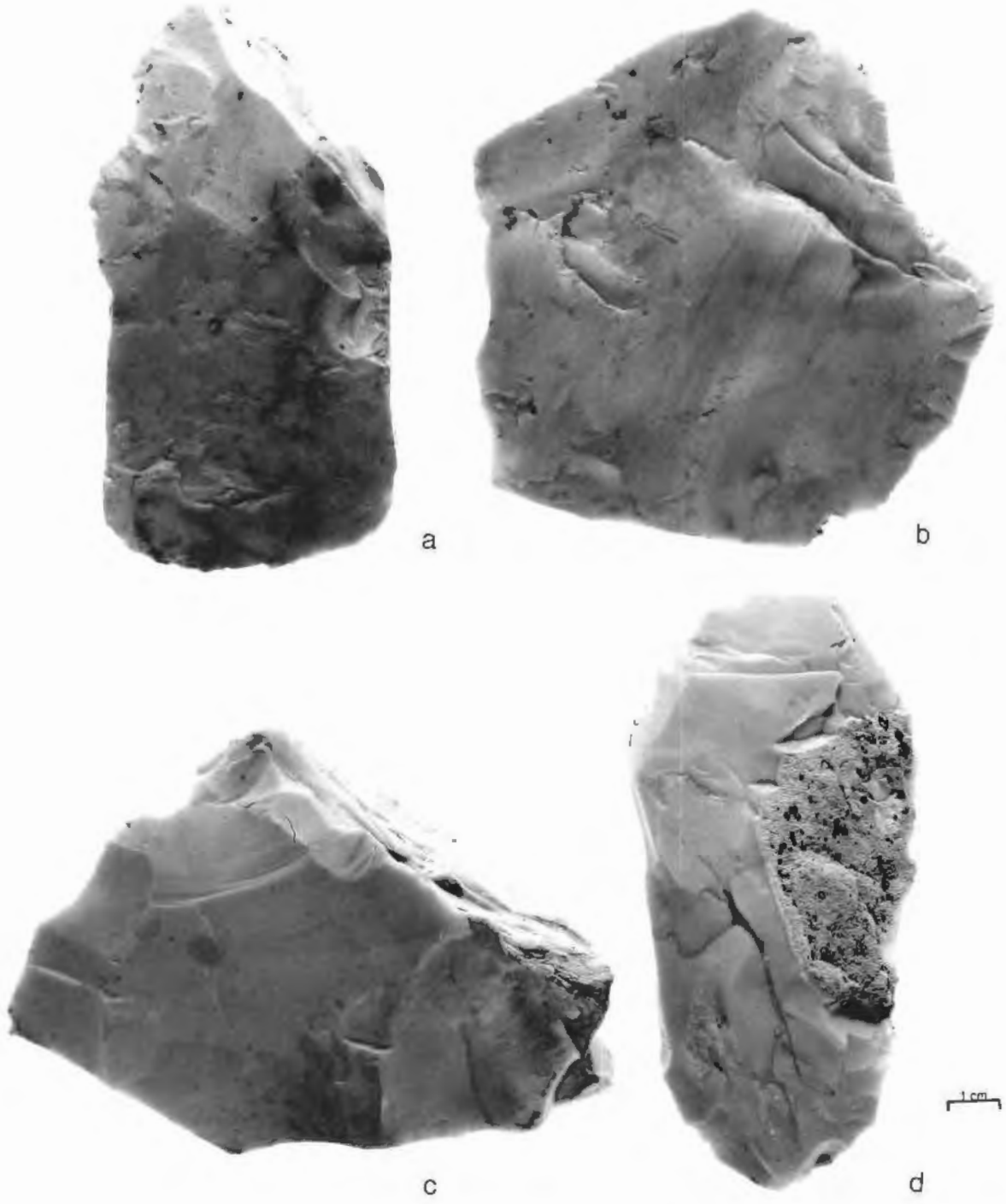


Figure 38. Selected block-based bifaces.

Specialized Reduction Techniques

Bifaces are among the most common formed artifacts in North American lithic assemblages, and they usually are produced in similar ways following a rather standard reduction sequence, even in different time periods or geographical areas. In this sequence, flakes are removed from an irregularly shaped blank to produce a lenticular form, and further reduction flattens the lenticular cross-section. Even within this generalized framework, however, reduction techniques specific to lithic industries may be employed that reflect temporal changes in technology or manufacture by groups that did *not* share a common technological tradition. In order examine the possibility that such patterns exist in the technology of biface production at Locality 36, we examined presence/absence, frequency, and distribution of several specialized techniques.

The use of four specific thinning techniques was examined in the course of analysis; two were selected because their presence had been noted in previous studies of Tosawihi bifaces (Bloomer, Ataman, and Ingbar 1992), while the others have been noted in other industries. Unifacial thinning of a square edge may have been developed to deal efficiently with the block blanks common at Tosawihi and at Locality 36 in particular, a form dictated primarily by the nature of the raw material deposits. End-thinning, outrepassé thinning, and the unifacial biface technique are less common at Locality 36, but, if their presence is restricted in time or space, changes in manufacturing strategies could be indicated.

Most often, thinning from a square edge is undertaken in Stage 2 reduction (blank preparation), although it has been noted when alternate flaking (edge preparation) and primary thinning (Stage 3) already had been initiated on another edge. Using this technique, mass is removed by means of a series of overlapping flake removals from the frequently right-angled edge of the blank prior to preparing an edge for bifacial thinning (Figure 39). Thinning from a square edge sometimes can be recognized on middle and late Stage 3 discards, but at Locality 36 most distinctive flake scars produced by use of this technique have been obscured by middle Stage 3.

Use of this technique was noted in a study of bifaces recovered from five caches in the Tosawihi vicinity (Moore 1992), suggesting it probably is relatively common in the assemblages from other Tosawihi sites. Fifteen percent of the total assemblage from Locality 36 exhibited evidence of thinning off square edges; the proportion was slightly higher among Stage 2 and early Stage 3 bifaces than among middle Stage 3 and later examples. No biface exhibiting this thinning technique had been heat-treated. Block-based bifaces often (41.9%) exhibit this technique, while flake blank produced bifaces were only rarely (5.7%) thinned in this way.

End-thinning is the second thinning technique examined in this analysis. It most often involves removal of a ridge running along the axis of the biface (Figure 40). Such ridges are set up by primary thinning in Stage 3, the distal ends of the negative scars forming the ridge. This technique is similar to "the Coso technique," whereby obsidian bifaces were thinned and biface blanks detached after setting up a central ridge. At Coso, however, the use of this technique was more frequent and the negative thinning scars covered much larger areas of the biface surface (Elston and Zeier 1984:Figure 21).

At Tosawihi, this technique may have been practiced as a last resort, when laterally oriented thinning was unsuccessful. Most end-thinning was practiced after initiation of primary thinning but before secondary thinning. Aside from being more risky to attempt in later reduction (hitting a biface on the end when it is relatively thin invites failure), the lenticular cross-section of a biface usually has been flattened by the end of primary thinning and there is little need for end-thinning. Six percent of bifaces at Locality 36 exhibit the use of this technique; two were heat-treated, and only five items exhibited both square edge and end-thinning.



Figure 39. Bifaces exhibiting unifacial square edge thinning technique.



Figure 40. Bifaces exhibiting end-thinning technique.

Another specialized technique, deliberate use of lateral outrepassé flaking or overstriking to achieve biface thinning, has been noted by Bradley (1982) in a Folsom assemblage. Outrepassé flakes are produced by striking back from the edge of the platform at a right angle. Controlled use of this technique produces a wide, almost flat, negative scar, drastically thinning the face, but significantly narrowing the biface as well. Failure in end thinning often can result in a similar but longitudinally oriented outrepassé. The frequency of lateral outrepassé flaking at Locality 36 is very low (n=5); it seems unlikely that its appearance in the assemblage is intentional. Only one biface exhibiting lateral outrepassé flaking showed use of one of the two thinning techniques mentioned above (thinning from a square edge). None was heat-treated.

Presence/absence of a recently described biface reduction technique, "the unifacial biface technique" (Skinner 1991), reported at several sites in Mono County, California, was examined in this analysis. It is said to be a distinctive biface reduction technique common in the Central Valley of California and the Sierras, extending to Northern California and Idaho (Skinner 1991, Skinner and Ainsworth 1991). The technique is said to consist of the use of side-struck, biconvex flakes requiring neither edging stage nor advanced dorsal reduction (early/middle Stage 4) prior to ventral thinning. This means that both primary and secondary thinning are performed on the dorsal face before thinning is initiated on the ventral face. In contrast, the Coso technique uses flakes detached from extensively reduced bifaces as biface blanks, resulting in flakes with worked dorsal surfaces (ca. mid Stage 3) and unworked ventral surfaces (Elston and Zeier 1984). A unifacial biface technique has been said to influence relative dimensions of bifaces and proportions of debitage types, and thus to invalidate most staging schemes (Skinner 1991:247).

Extensive use of a unifacial biface technique should be recognized easily in quarry contexts, where bifaces frequently are broken in various stages of reduction. To investigate this at Locality 36, both as a distinctive cultural trait and to judge its effect on our staging scheme, the extent of reduction on each face of the Locality 36 bifaces was recorded separately (Table 23); other variables involved in Callahan's staging scheme (cross-section and width/thickness ratio) cannot be addressed when only one face is examined.

Table 23. Unifacial Biface Technology at Locality 36.

	Dorsal Face						
	Stage 1	Early 2	Late 2	Early 3	Late 3	Early 4	Late 4
Ventral Face							
Stage 1	3	2	2	4	1		
Early 2	2	30	10	3			
Late 2			60	17	3		
Early 3	1	2	10	228	8		
Late 3				1	56		
Early 4						3	
Late 4							1

n=475 of a total of 635 (this includes 103 bifaces on which the dorsal and ventral faces are distinguishable and 372 on which both faces are reduced equally.

Proportions of bifaces made using the unifacial biface technique are not presented for the Mono County sites, precluding comparison of their frequencies to other assemblages. Nevertheless, the large numbers of early stage bifaces at Locality 36 provide a good test of the presence of the technique. There are very few bifaces conforming to the pattern described for unifacial biface technique (Table 23). Only four specimens in the Locality 36 biface assemblage were reduced

extensively on the dorsal surface before primary thinning on the ventral surface, while 24 exhibit primary thinning on the dorsal face before primary thinning was initiated on the ventral face. Thirteen examples exhibited primary thinning on the ventral face before primary thinning was started on the dorsal face. Most bifaces in the assemblage were reduced equally on each face. It seems unlikely that the unifacial biface technique is significant as a cultural or chronological marker at Tosawihi; biconvex flake blanks occasionally were used for the production of bifaces, but they were edged in the same way as others in the assemblage (Moore 1992:Figure 37). Although a small number of bifaces in many biface industries contain examples on which dorsal reduction preceded ventral reduction, unless large proportions of the bifaces in the assemblage exhibit such patterning, a specialized reduction technique is unsupported. The contextual associations of square edge and end-thinning, the two specialized reduction techniques appearing in the Locality 36 assemblage, are examined in Chapter 8.

Thermal Alteration

Thermal alteration affects the appearance and flaking quality of opalite, making it more vitreous, lustrous, and brittle, as well facilitating controlled flaking. Heat-treatment commonly was used prehistorically in much of North America, both in biface and projectile point manufacture. The process usually involves building a fire over a pit in which silicious raw material or unfinished tools are buried, and it can be performed at various points in the manufacturing process. The stage at which bifaces are heat-treated often can be determined by comparing lustrous and non-lustrous negative flake scars. When a partially finished biface is heat-treated, the existing negative flake scars will retain the dull surface of the non-heat-treated piece, but if worked subsequently, any new removals will have a glassy, lustrous appearance. Thus, if a piece is worked only minimally after heat-treatment and then discarded, the stage can be determined; if it is worked extensively however, all traces of the dull surface will be removed and only lustrous scars will remain, rendering stage of heat-treatment impossible to determine.

At Tosawihi, heat-treatment was important in the biface manufacturing process (Bloomer, Ataman, and Ingbar 1992). In previously investigated assemblages, 40% of the bifaces were heat-treated; of these, most were heat-treated roughly midway though the reduction sequence. In contrast, only 6.8% of the bifaces from Locality 36 are heat-treated (Table 24). Although this proportion is much lower than those among earlier assemblages, it is comparable to proportions reported for non-Tosawihi quarry sites. These additional data confirm our impression that only rarely was heat-treatment carried out at quarries where no adjacent residential sites occurred (cf. Elston 1992b).

Table 24. Heat-Treatment in the Biface Reduction Sequence.

	n	%
Heat-treated as a Stage 2 Biface	6	0.9
Heat-treated as a Stage 3 Biface	13	2.0
Heat-treated during Reduction but Stage Indeterminate	3	0.5
Heat-treated but Stage Indeterminate	11	1.7
Possibly Heat-treated	9	1.4
Thermally Altered Post-deposition	1	0.2
Not Heat-treated	592	93.2
Total	**635**	**100.0**

Only 33 bifaces recovered from Locality 36 were heat-treated. An additional 9 may have been heat-treated. The proportion of heat-treated bifaces within each manufacturing stage increases through the reduction sequence (Table 25). There is minimal heat-treatment in the early stages of reduction, but 12% of the middle Stage 3 bifaces and 20% of the late Stage 3 bifaces were heat-treated.

Table 25. Heat-treatment of Bifaces by Stage.

Bifaces	Heat-treated	Possibly Heat-treated	Not Heat-treated	Total	% Heat-treated
Stage 1	0	0	3	3	**0**
Early Stage 2	0	0	31	31	**1.0**
Late Stage 2	1	0	98	99	**1.0**
Early Stage 3	8	3	332	43	**2.3**
Mid Stage 3	13	1	93	107	**12.1**
Late Stage 3	5	2	18	25	**20.0**
Stage 4	2	2	2	6	**33.3**
Stage 5	2	0	0	2	**100.0**
Indeter. Stage	2	1	16	19	**10.5**
Total	**33**	**9**	**593**	**635**	**100.0**

Manufacturing Failure

Bifaces fail for a variety of reasons: raw material flaws, knapping mistakes, unworkable edges or unacceptable proportions, thermal failure during heat-treatment. Reasons for discard are linked to these failures; some are functional *(i.e.*, they no longer can be made into the intended form), some to cultural preference regarding size, proportion, or shape.

In general, bifaces tend to break more frequently during later stages of reduction. Fatal breaks are less likely to occur during Stage 2 because 1) pieces are larger then and it is easier for the knapper to recover from mistakes, and 2) when only edges are being prepared, less force is necessary for flake detachment, and mistakes are less likely to be uncorrectable. The risk of breakage increases when primary thinning is initiated (Stage 3) and is even greater during secondary thinning (Stage 4), when the biface is thinner and more susceptible to misplaced or misangled hammer blows.

Of the 50% of bifaces which broke during manufacture, approximately half broke due to flaws in the raw material (Table 26). The other half broke probably owing to knapper error. Most broke due to misplaced blows resulting in hinge or outrepassé terminations, edge collapse (which may reduce the width of the biface significantly), or from perverse or bending breaks resulting in fragmentation.

Many more bifaces were discarded unbroken at Locality 36 than at other Tosawihi sites studied so far. Unbroken bifaces probably were discarded due to their unacceptable proportions. When width/thickness ratios of complete pieces by stage are compared between Locality 36 and the earlier assemblage, those from Locality 36 are consistently lower, indicating that thinning of these pieces was less successful. Stacked fractures, low width/thickness ratios, and edge collapses all can lead to discard. Many of these problems are a function of knapper error.

Table 26. Biface Breakage Type.

Stage	Unbroken		Material Flaw or Fracture Plane		Hinge/Outrep.		Edge Collapse		Perverse/Bend.		Thermal		Other/Indet.		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Stage 1	2	0.67	0	0.00	0	0.00	0	0.00	1	1.02	0	0.00	0	0.00	3	0.47
Early 2	21	7.07	5	3.16	0	0.00	0	0.00	4	4.08	0	0.00	1	4.76	31	4.88
Late 2	56	18.85	25	15.82	8	22.22	1	5.88	5	5.10	0	0.00	4	19.05	99	15.59
Early 3	171	57.57	81	51.27	22	61.11	5	29.41	53	54.08	1	12.50	10	47.62	343	54.02
Mid 3	43	14.48	33	20.89	3	8.33	3	17.65	16	16.33	4	50.00	2	9.52	107	16.85
Late 3	2	0.67	7	4.43	2	5.55	1	5.88	9	9.18	2	25.00	1	4.76	25	3.94
Stage 4	1	0.34	0	0.00	0	0.00	0	0.00	4	4.08	1	12.50	0	0.00	6	0.94
Stage 5	0	0.00	2	1.27	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	0.31
Indeterm.	1	0.34	5	3.16	1	0.28	7	41.12	2	2.04	0	0.00	3	14.29	19	2.99
Total	297	46.77	158	24.88	36	5.67	17	2.68	98	15.40	8	1.26	21	3.31	635	100.00

Discussion

Biface Production Techniques

While biface reduction technology may have changed through time, in every period the decision to use one blank type or another probably considered toolstone utility maximization strategies (toolstone being difficult as well as expensive to extract [*cf.* Chapter 9]). When small blocks of toolstone were extracted it probably was more advantageous to reduce them directly into bifaces without an intervening flake blank stage. On the other hand, when a large block of good quality material was extracted, it would have been more advantageous to produce a number of flakes from it to use as biface blanks. It is likely that at least some flake blanks were selected from early stage block reduction debitage, which often includes suitable small biface flake blanks (this is another method of maximizing the utility of extracted toolstone). However, the nature of biface blanks cannot be addressed solely with reference to bifaces. Core, modified chunk, and debitage studies, as well as flake blank and block-based biface contexts, all provide data to address the issue, and are considered in later discussions.

Specialized reduction techniques also may have been developed to maximize utility in response to the nature of the toolstone. While unifacial thinning on square edges (the most common specialized technique noted in the assemblage) may be used occasionally in flake-based biface reduction, it clearly is most useful for thinning blanks with several squared edges such as are found on block blanks. Whether this technique was part of the technology employed in the earliest visits to Locality 36 or was adopted later is discussed in later chapters.

Export Stage and Form

In our previous work at Tosawihi we concluded that most prehistoric occupation of the area was of short duration and was related primarily to the procurement and processing of toolstone intended for use elsewhere (Elston 1992b). Thus the bifaces produced at Tosawihi were exported out of the area of production.

One of the questions we are interested in addressing with the present analysis asks the form and stage of bifaces leaving Locality 36. We assume that many of the bifaces recovered at Tosawihi sites peripheral to the quarry proper (26Ek3032) were reduced initially near the areas where the toolstone was extracted. This pattern fits models of return maximization and transport cost minimization previously proposed for predicting artifact distributions at Tosawihi (Elston 1992c); *i.e.*, it is not cost-effective to transport raw material mass that later will be discarded as waste. Empirical evidence from sites in the Western Periphery and the Northern Corridor (Leach, Dugas, and Elston 1992; Schmitt and Dugas 1992), the areas farthest from the quarry proper, supports this contention. Although there is evidence for a limited amount of reduction of previously unworked flake blanks, most biface reduction undertaken in these areas was of already partially reduced bifaces (Bloomer and Ingbar 1992). Thus, it is likely that many bifaces produced at Locality 36 were transported to other sites in the Tosawihi vicinity and further reduced before leaving the area, especially if we find that bifaces exported from Locality 36 were earlier in stage than those from the quarry peripheries. Other replication and archaeological studies of breakage (Amick 1985; Sassaman, Hanson, and Charles 1988) have noted that successive stages of reduction, heat-treatment, and soft hammer use tend to increase breakage rates. If the incidence of broken pieces serves as proxy for breakage rates, various scenarios of export can be modeled.

We examine the question of export stage with several classes of data. We use incidence of breakage in each stage of the reduction sequence in the archaeological assemblage and observation of biface breakage in experimental replications to set up expectations about breakage. Then, from the proportion of the total represented by each stage in the archaeological assemblage (using only broken examples), breakage rates and export stages are modeled.

The proportion of broken bifaces in each stage of the reduction sequence at Locality 36 is shown in Table 27. The proportion of broken bifaces steadily increases from early Stage 2 to mid Stage 3; the greatest increase occurs between middle Stage 3 and late Stage 3, after which, the proportion of broken pieces decreases. The number of specimens in Stages 1, 4, and 5 is very low, but the pattern of slowly increasing breakage through the first three stages, with the greatest increase between mid and late 3, is clear.

Table 27. Proportions of Broken Bifaces by Reduction Stage.

	Complete	Broken	Total	% Broken
Stage 1	2	1	3	33.3
Early Stage 2	21	10	31	32.2
Late Stage 2	56	43	99	43.4
Early Stage 3	174	169	343	49.3
Mid Stage 3	46	61	107	57.0
Late Stage 3	1	24	25	96.0
Stage 4	1	5	6	83.3
Stage 5	1	1	2	50.0
Indeterminate	1	18	19	94.7
Total	**303**	**332**	**635**	**47.5**

A simple mathematical simulation model of biface production can be made using insights gleaned from experimental flintknapping and the available archaeological data. We start with a pool of 100 Stage 1 bifaces. The overall success rate (*i.e.*, proportion of bifaces successfully reduced for transport) is fixed at 70% (a figure derived from experimental success rates). Thus, sometime prior to transport, 30 bifaces must break. Their distribution across stages must match the observed archaeological distribution of biface stages. Two terms are allowed to vary in the simulation: breakage rate from each stage to the next and number of bifaces leaving the assemblage at each

stage. Breakage rates are determined, in part by number of bifaces transported, since these are removed from the pool of bifaces available to break. As well, based upon experimental research, breakage rate must increase initially and then decline. "Transporting" differing numbers of bifaces at each stage following Stage 2 (since there is no archaeological evidence for transport of Stage 1 or Stage 2 bifaces) causes the breakage rates to change. With the entire model in a spreadsheet, one simply changes the number of bifaces "transported" at each stage and examines the resulting breakage rates to see if they (1) fit the pattern of the archaeologically observed breakage rates and (2) also fit the pattern of initial increase followed by decrease in later stages of reduction.

Different export scenarios can be explored easily using this simulation. If 70 out of 100 initial bifaces are successful (*i.e.*, transported off-site), we can build a model in which half of these 70 bifaces (*i.e.*, 35% of the initial 100 bifaces) are transported in a given stage. The other 35 successful bifaces (*i.e.*, 35% of the initial assemblage) can be modelled as having been removed in the very next stage, or successive reduction stages, following the first transport pulse. Using this technique while examining bifaces recovered elsewhere at Tosawihi, we concluded that 50% of the bifaces leaving the quarries were middle Stage 3, 50% were late Stage 3 or later, and most were heat-treated (Ataman and Bloomer 1992). Examination of several museum collections from sites in the greater Tosawihi region supported the conclusion that few, if any, Stage 1 or Stage 2 bifaces left Tosawihi for destinations outside the production area, most were mid Stage 3 or later, and almost all were heat-treated (Ataman and Bloomer 1992).

At Locality 36, as might be expected, exported bifaces left in an earlier, non-heat-treated state. If we assume, as above, that breakage increases steadily through the reduction sequence to early Stage 3, then increases more steeply between middle and late Stage 3, and that probably only a small number of Stage 1 and Stage 2 bifaces left the quarry, we conclude that early Stage 3 bifaces were the primary (approximately 75%) export. The remaining exports (25%) probably left Tosawihi in middle and late Stage 3 form.

The question of intended form and proportion is even more difficult. No biface caches, where successful products were stored, were recovered at Locality 36, as they have been on the quarry, and we have few examples of finished tools. Most artifacts in our collection represent rejected and discarded items. Complete artifacts suggest unacceptable forms, and pieces broken later in reduction suggest intended forms. But this is negative evidence that cannot identify intended products unequivocally. It seems clear, however, that discarded bifaces in our assemblages are there because they could not be thinned. This bolsters our impression, which must remain unsupported until work farther afield at Tosawihi can be undertaken, that these thinned bifaces were unsuitable as flake cores (except perhaps incidentally), and that the successful products served primarily as knife preforms (Ataman and Bloomer 1990, 1992).

Comparison to Other Quarry Assemblages

Comparison of the biface assemblages from Locality 36 and other Tosawihi quarry sites is informative, providing a measure of the uniqueness of Locality 36 and perhaps indicating the most important factors shaping strategies of extraction and processing in particular circumstances. We compare biface assemblages from two other Tosawihi quarry sites with the Locality 36 material. These two sites, which have almost equal biface assemblage sizes, are Locality 26 of 26Ek3032, a quarry pit site along the lower reaches of Little Antelope Creek (Leach and Botkin 1992), and 26Ek3208, an outcrop quarry in the Western Periphery (Leach, Dugas, and Elston 1992). Locality 26 is a small site where moderately good raw material occurs in relatively shallow deposits, while 26Ek3208 exhibited thick deposits of high quality material that was exploited extensively. In terms of biface stages and proportions of unbroken bifaces, 26Ek3208 and Locality 36 are somewhat similar, but no clear patterns emerge from comparison of other attributes (Table 28).

Table 28. Comparison of Quarry Biface Assemblages

	Locality 26	26Ek3208	Locality 36
Total n	59	55	635
Reduction Stage (%)			
Stage 1	0.0	0.0	0.5
Early 2	23.6	3.3	4.9
Late 2	14.5	13.5	15.6
Early 3	41.8	62.7	54.0
Mid 3	20.0	16.9	16.8
Late 3	0.0	3.4	3.9
Stage 4	0.0	0.0	0.9
Stage 5	0.0	0.0	0.3
Blank type (%)			
Flake	15.2	21.8	13.7
Block	10.2	10.9	6.9
Complete Bifaces %	28.8	47.3	46.8
Heat-treatment %	3.4	3.6	5.2
Sq. Edge Thinning %	11.9	23.6	15.0
End Thinning %	10.2	20.0	6.0
Mean Weight (complete)	198.4	174.3	318.8

Toolstone quality at Locality 26 is lower than at Locality 36 and 26Ek3208 (Dugas, personal communication 1991). Flawed toolstone could result in a high breakage rate contributing more than thinning attempt failure to biface discard. The greater use of both flake and block reduction at 26Ek3208 is more difficult to explain. On the one hand, high toolstone quality could lead to greater reliance on a flake-based approach; on the other, a high frequency of block reduction leads to higher use of the square edge thinning technique. The stages of reduction at 26Ek3208 and Locality 36 are quite similar, and may be related to both the quality and size of material extracted. The frequency of heat-treatment at all three sites is low, indicating that only rarely was the technique performed at quarry sites. Thus, the nature of biface assemblages at quarry sites (that is, proportions of reduction stages present, blank type, thinning techniques, incidence of breakage, and amount and patterning of heat-treatment) is highly idiosyncratic. Differences among these assemblages probably owe primarily to the nature of the raw material in each deposit rather than to other factors.

The Flake Tool Assemblage

Flake tools are defined here by the presence of retouch that appears deliberate rather than a consequence of use or of post-depositional processes. This is a conservative approach to flake tool categorization adopted because, in quarry contexts, it is nearly impossible to distinguish use-induced retouch from post-depositional damage. Our conservatism probably has resulted in an at

least slight under-representation of lightly used tools. Examination of unretouched debitage from previous work at Tosawihi indicated that unretouched flakes were used occasionally for tasks requiring a sharp edge with a straight profile (*i.e.*, cutting), but that many tasks required tools with shaped and strengthened edges (Ataman 1992). It is likely that unretouched debitage was used to a limited extent at Locality 36.

The morphological typology devised previously for Tosawihi was used to classify flake tools at Locality 36; technological characteristics were noted, and functional analysis was conducted on each piece. Observations of twenty-four flake tools were recorded.

Raw Material

All flake tools are of opalite. Opalite in the Tosawihi area is highly variable in color and texture and some sources are very distinctive. At Tosawihi, color variation in any artifact assemblage provides a rough indication of opalite source diversity, but, as noted earlier, most tool material at Locality 36 is white, grey, or beige, and we can assume that the vast majority of bifaces collected there are rejected manufacturing stage bifaces derived from that source. Over 97% percent of the biface assemblage is grey, white, or beige opalite while 83% of the flake tool assemblage is of the same color range.

Type

Flake tools were classified on the basis of a morphological typology previously established for Tosawihi assemblages (Ataman 1992); the results are presented in Table 29.

Table 29. Flake Tool Types at Locality 36.

Type	n	%
Side Scraper	1	4
End Scraper	1	4
Misc. Scraper	4	17
Subtotal	**6**	**25**
Bifacial Tool	2	8
Pointed Tool	1	4
Notch/Denticulate	4	17
Subtotal	**7**	**29**
Flake w/cont. retouch-single edge	3	13
Flake w/cont. retouch-multiple edges	2	8
Flake w/localized retouch	1	4
Subtotal	**6**	**25**
Pressure flaked fragment	3	13
Other fragment	2	8
Subtotal	**5**	**21**
TOTAL	**24**	**100**

Size

Seven of the 24 flake tools are complete: average length of complete tools is 79.8 mm, average weight 65.6 g. Size varies. Scrapers and notches tend to be large, and fragments of tools usually are small (Figures 41, 42).

Technology

A paucity of cores in the assemblage indicates that flakes used for flake tool blanks probably were by-products of other reduction activities such as biface manufacture. However, blank types on which Locality 36 flake tools were made often are not distinguishable, and only a few can be identified definitely as biface thinning flakes. Blank shapes are quite variable, as are the shapes of retouched edges. Sixty-six percent were retouched on a single edge and 33% on more than one edge. The retouch on 50% of the pieces is direct (dorsal retouch), 25% inverse (ventral retouch), and 25% bifacial. The edge angles of the retouched edges also are variable; 50% are medium, 25% acute, and 25% obtuse angles.

A small number of tools (n=5) exhibits pressure flaking, which at Tosawihi usually is associated with heat-treated tools. Heat-treatment generally is not found on non-pressure flaked specimens, suggesting that heat-treated debitage rarely was used for flake tool production at Locality 36 and that heat-treated flake tools probably were less useful for the tasks undertaken there. Heat-treated opalite is brittle and does not hold a sharp edge, and thus is unsuitable for heavy-duty tasks.

Function

All flake tools were examined for use-wear traces using a binocular metallurgical microscope at magnifications of 50x, 100x and 200x, following procedures outlined for previous Tosawihi work (Ataman 1992). No attempt was made to identify precise function; we looked instead at motion of use, hardness of worked material, and intensity of use of each tool.

Eleven of the 24 tools exhibit clear evidence of use. Two pieces exhibit light use intensity, four medium intensity and five heavy intensity (Table 30).

Table 30. Motion of Use and Hardness of Worked Materials.

	Hardness				
Motion	Soft/Med.	Med.	Med./Hard	Indet.	Total
Scraping	2	2	4	0	8
Boring or Drilling	0	0	1	0	1
Chopping	0	0	1	0	1
Indeterminate	0	1	0	13	14
Total	**2**	**3**	**6**	**13**	**24**

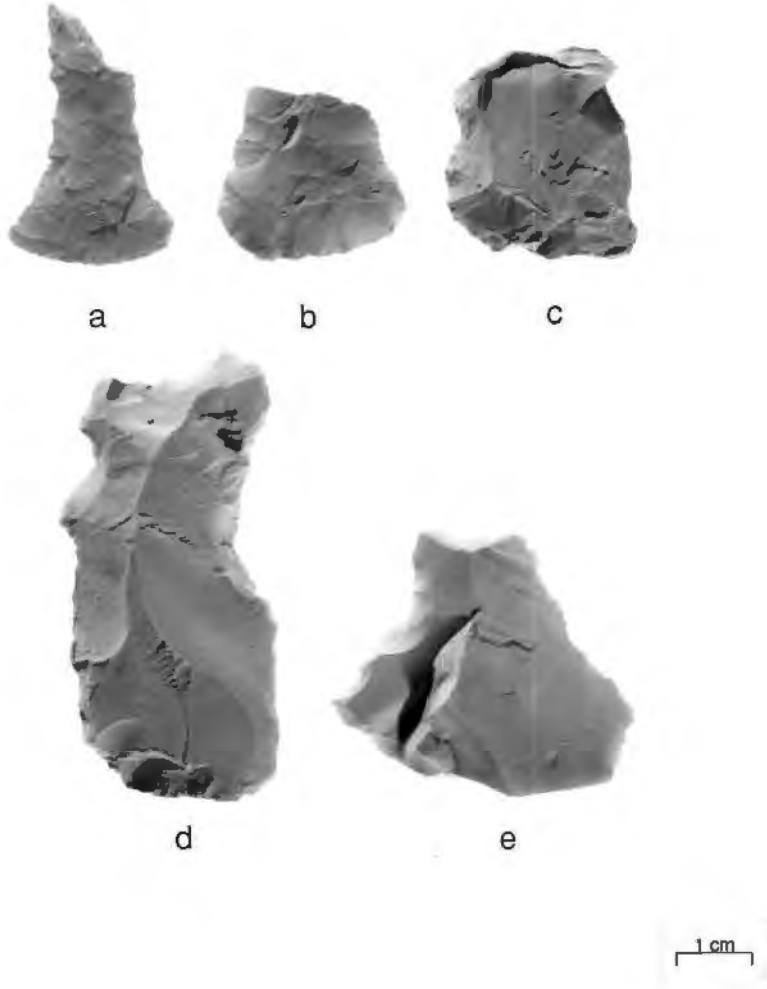


Figure 41. Selected small flake tools.

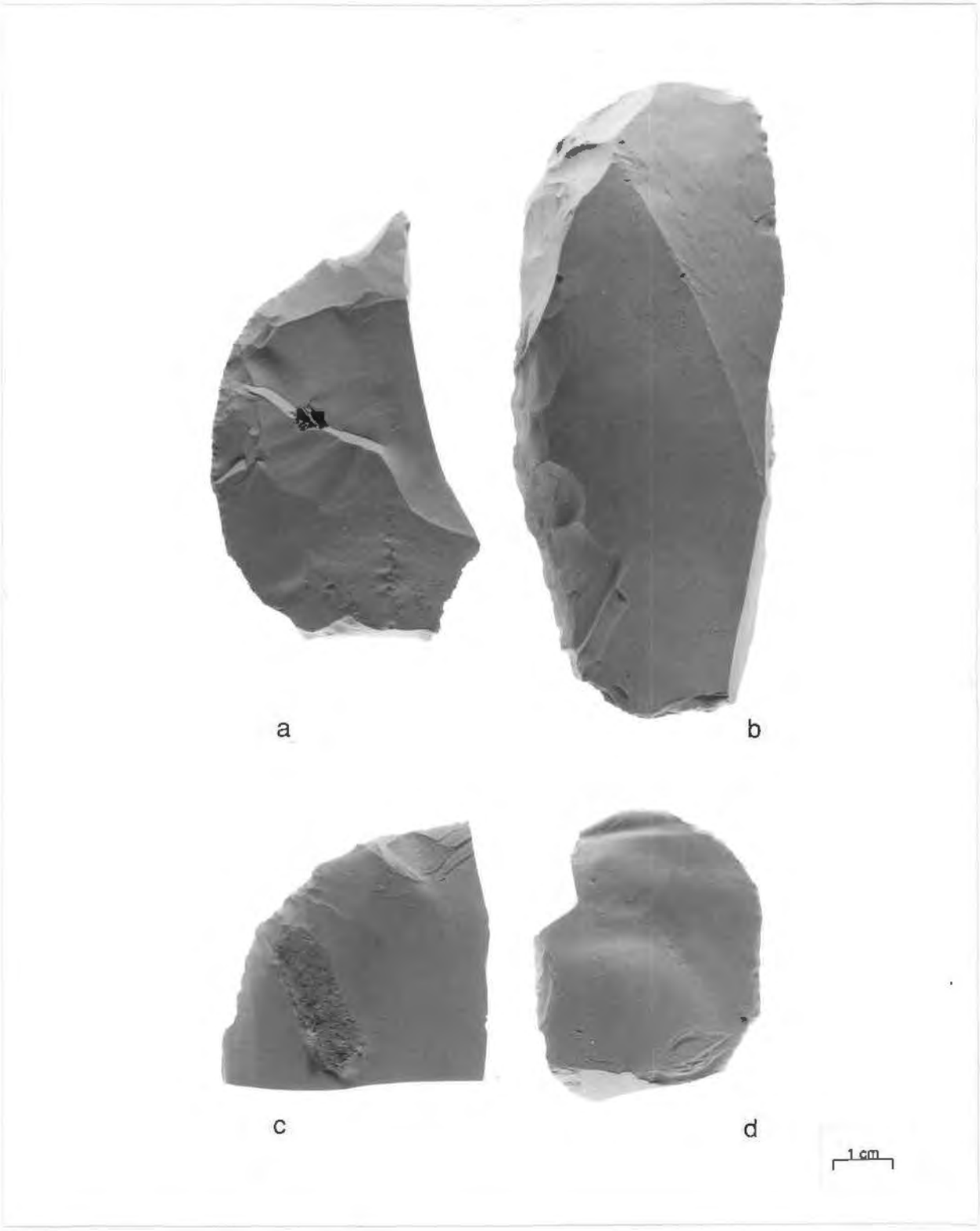


Figure 42. Selected large flake tools.

Flake tools at Locality 36 suggest primarily expedient use for a variety tasks. The flake tools appear to be made on local material, and they are extremely variable in form, blank type, blank shape, and edge angle. Few are made on biface thinning flakes, perhaps reflecting the early nature of reduction at this site. Many would be useful in manufacturing and maintaining quarrying tools such as those observed archaeologically and reconstructed through experimental quarrying. Most of the utilized stone tools exhibit moderate or heavy use intensity.

Projectile Points and Preforms

Four projectile points were recovered from Locality 36. Typological criteria and temporal constraints employed in this analysis follow those outlined by Thomas (1981). This system assigns projectile points to temporal series on the basis of morphological observations including length, width, thickness, weight, basal width, and notch angles: the "series is the time-bearing unit and the type is merely a morphological modifier" (Thomas 1982:160). Chronological and morphological attributes for the Great Basin Stemmed Series, not addressed by Thomas (1981), follow Layton (1979), Clewlow (1968), and Frison (1978).

The points consist of two Great Basin Stemmed points, one Gatecliff Split-stem point, and one Desert Side-Notched (DSN) point (Figure 43). One of the stemmed points was made of a light colored chert while the remaining three points were made of obsidian. Whether the chert specimen was Tosawihi opalite could not be determined, having been burned after deposition. Under an ultraviolet light the piece reflects orange light characteristic of burning.

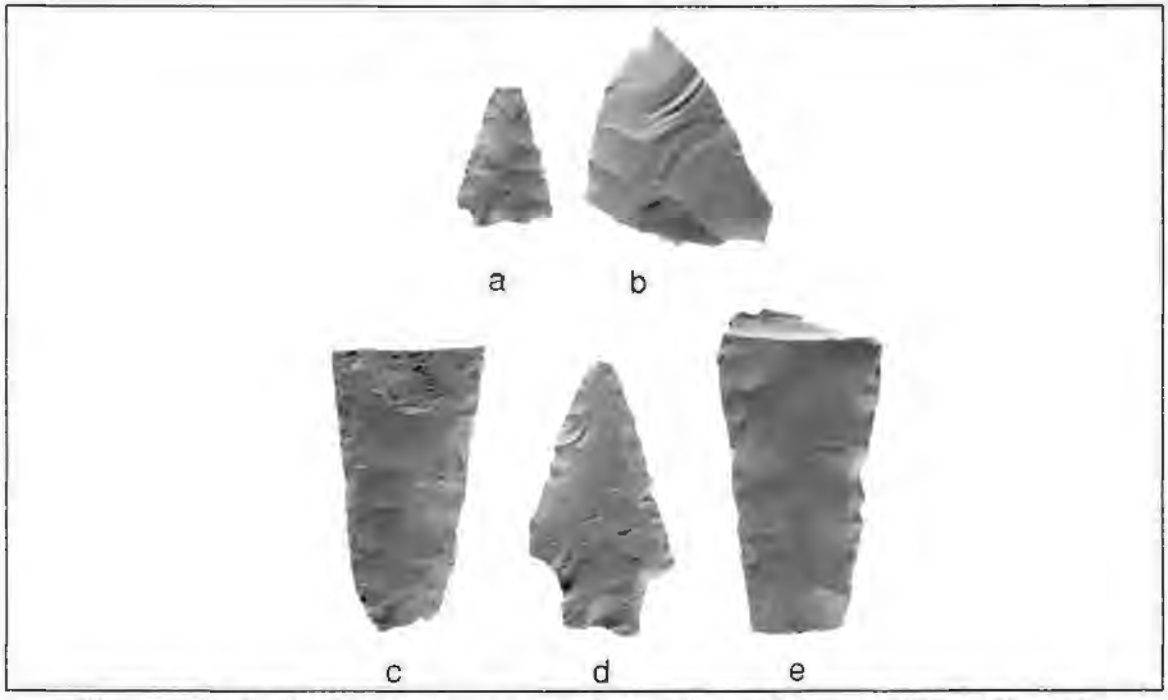


Figure 43. Projectile points and preforms. a. obsidian Desert Side-notched; b. opalite preform; c. chert Great Basin Stemmed; d. obsidian Gatecliff Split-stem; e. obsidian Great Basin stemmed.

Three of the points (DSN, obsidian stemmed, and Gatecliff Split-stem) exhibit traces of use. None exhibits clear evidence of reworking.

The two Great Basin stemmed points are basal fragments with bending breaks, the DSN was broken both at tip and through the notches; the Gatecliff point was unbroken. None can be seen to have been made directly on a flake blank and only the stemmed points exhibit percussion flaking (and no pressure-flaking). Both stemmed points have ground edges. Four points were recovered from surface contexts and do not provide clear evidence for contemporary use of the quarries.

The three obsidian points were examined for sourcing and hydration information (cf. Appendix A). Both the sourcing and hydration data are compatible with those from the previous Tosawihi investigations (Elston and Drews 1992). The stemmed point derives from the Brown's Bench source, while the obsidian of the two later points is from Paradise Valley. The stemmed point has a mean hydration rind thickness of 10.3 microns, the Gatecliff, 2.5, and the DSN of 1.5.

Most radiocarbon dates from Locality 36 reflect dates later than those suggested by obsidian point hydration, but there are several dates from the bottom of quarry pits that cluster around 4000 B.P. Considering the distribution of stemmed points in the Tosawihi area as a whole, the stemmed points may have been discarded during visits to Tosawihi unrelated to opalite extraction and processing.

One preform fragment was recovered (Figure 43b). It is made of white opalite that was heat-treated as a flake, and exhibits edge abrasion and pressure flaking along its only intact edge.

Cores

A core is defined here as a block of raw material from which pieces intended for use or modification have been detached, a by-product of reduction. In a biface industry, cores may resemble failed bifaces. Similarly, a single piece may function as both a core and biface and, as a result, the two often are difficult to distinguish. For this reason we have identified pieces as cores only when they do not exhibit biface morphology. The core assemblage from Locality 36 is very small, numbering 16 artifacts.

The objective of core analysis is to determine whether a flake/core technology was used to produce flake blanks for the production of bifaces and other tools, or for export as flakes. Cores may be reduced to bifaces, or they may be discarded when they fail or become exhausted. Only in the latter case can core reduction be recognized easily. Another objective of core analysis is to determine patterns in core reduction technology.

All the cores are made of grey or white opalite and are quite variable in size. Of ten complete specimens, the average weight is 567.9 g (s.d.=327.3, CV=0.58). Overall core shape is primarily blocky or irregular, although two are conical and two are globular (Figures 44, 45). The number of platforms on each core varies but most bear two or three platforms. Most worked faces are unidirectional, bearing a single platform. In a few cases, platform faces exhibit opposed or crossed platforms. On six examples, all worked faces have unidirectional removals, but four have both single and multiple faced platforms, either opposed or crossed. In addition, four examples have multiple platforms with randomly oriented worked faces.

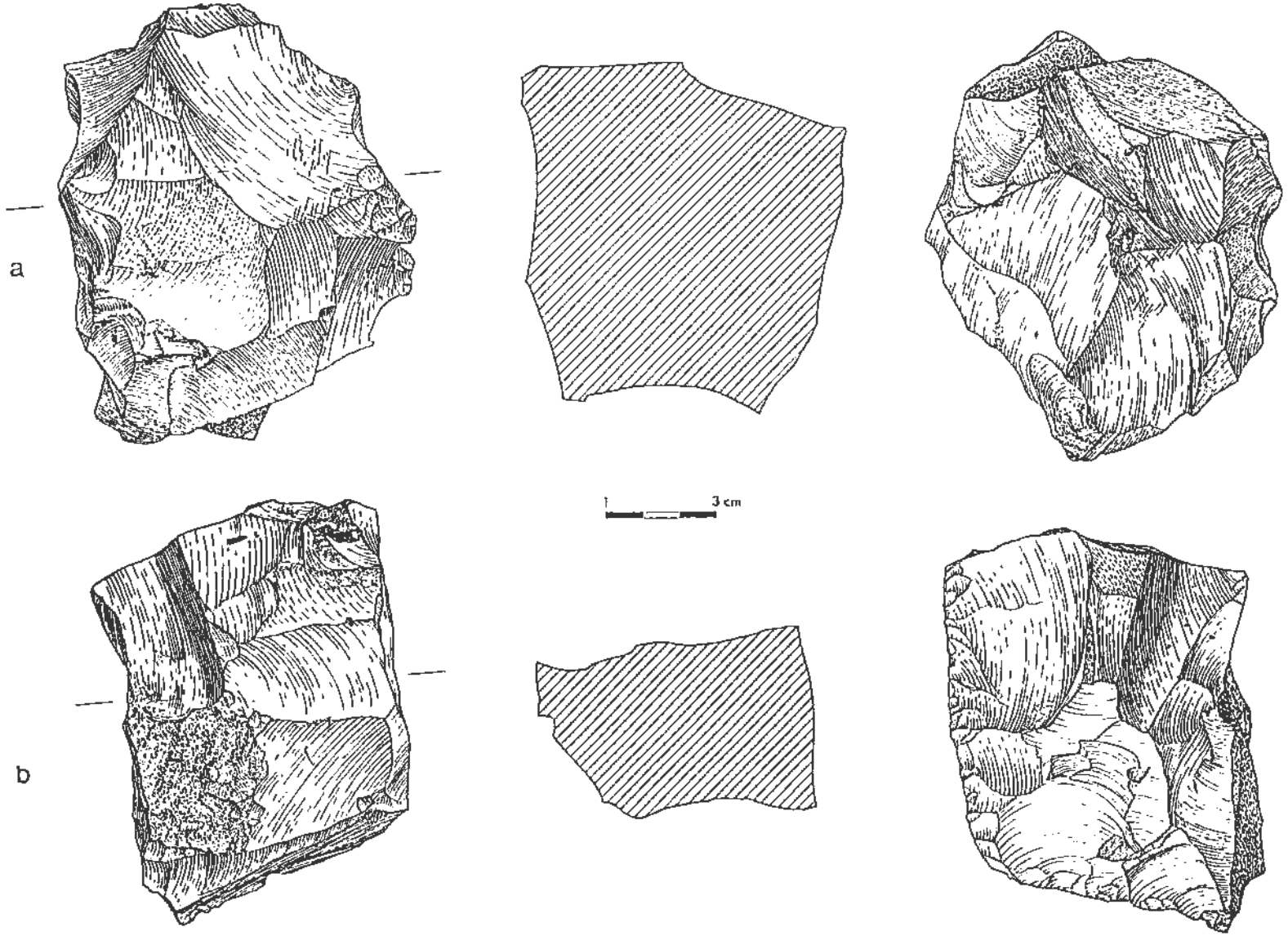


Figure 44. Selected cores: a. globular core; b. blocky core.

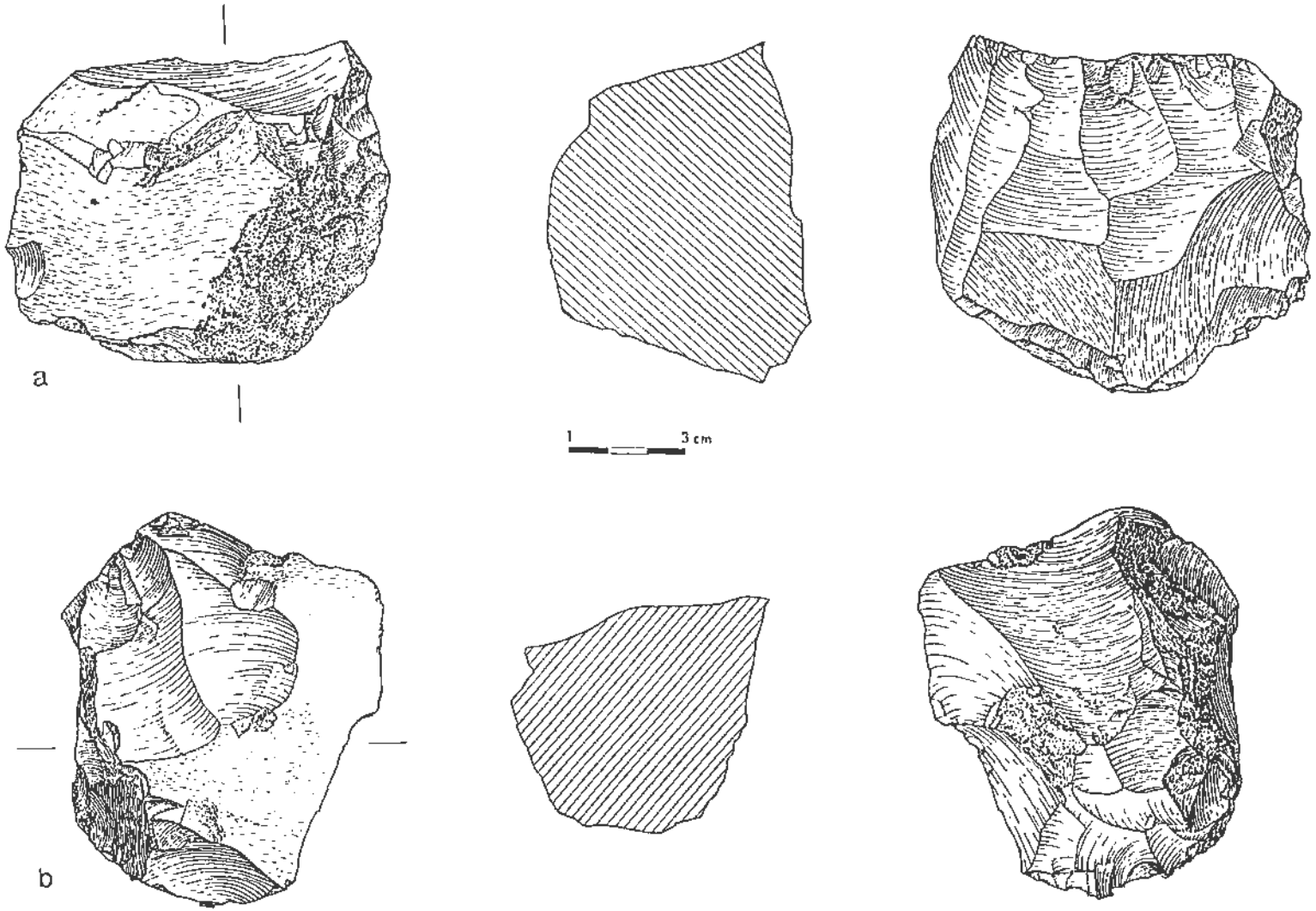


Figure 45. Selected cores: a. single platform core; b. conical core.

For many specimens, we could not determine the reason for their failure and discard. However, six appear to have been exhausted, (*i.e.*, no suitable platform remained) and three broke, two as a result of material flaws.

The number of cores is so small, and their sizes, forms, and platform orientations so variable, that it is difficult to evaluate their place in the lithic industry of Locality 36. On the other hand, at least 13% of all recovered bifaces were made on flakes and the recovered core assemblage does not begin to account for that number. Thus, much of the core reduction technology employed at Locality 36 is invisible. Whether or not flake production for export was practiced seems doubtful but cannot be discounted entirely. The lack of patterning in the identified core assemblage, however suggests that flakes could not have been a primary export product.

Modified Chunks

Modified chunks are angular pieces of debitage, often as large as cores or bifaces, that have been modified deliberately, but that do not exhibit the morphology or patterned flake removals of *either* core or biface reduction. They may represent assayed pieces, expedient cores, failed bifaces, or unique products of quarry-related reduction.

Weights, presence or absence of cobble cortex, and number of deliberately produced flake scars present on each piece were recorded. One hundred twenty-seven modified chunks were collected in the course of work at Locality 36, weighing in total a little more than 62 kg; mean weight is 490.2 g. The standard deviation for weight is 454.6 g and the coefficient of variation 0.927, indicating that these artifacts are highly variable in size. Weight does not seem to be associated with number of flake scars on a modified chunk, so it seems unlikely that chunks represent exhausted cores (in which case, weight might be expected to decrease with increase in number of flake scars).

Nor is there any apparent relationship between number of flake scar and presence/ absence of cortex. The number of pieces with cortex (n=14) suggests that some portion may represent assayed cobbles or large hammerstone fragments (colluvial opalite cobbles were common choices for large hammerstones). The number of flake scars present on modified chunks ranges from one to nine, most having from one to five. The greater number of scars on some pieces suggests they actually may have served as cores but were not classified as such due to lack of patterning and relatively small size of flake scars.

From this brief analysis we conclude that modified chunks recovered from Locality 36 represent discarded fragments of a variety of implements related to quarrying or early stages of toolstone reduction. The highly variable size among chunks suggests that extracted block size also may have been highly variable. The locations of these pieces indicate areas where the very earliest stages of reduction were conducted; thus, we might expect to find them concentrated in and around quarry pits. This is, indeed, the case. Of the 127 modified chunks in the assemblage, 66% were recovered from quarry pits, 18% from reduction features, 14% from non-feature contexts, and 2% from hearth features (cf. Chapter 10).

Summary

With the exception of most projectile points, the flaked stone artifacts reviewed in this chapter were produced from Locality 36 raw material. They differ however, in manufacture and

function. Bifaces were the focus of production at Locality 36: modified chunks and cores were by-products of that industry. Along with bifaces, they constitute the majority of the flaked stone artifact assemblage. Flake tools, rare as they are, seem to have been produced expediently, then used, and finally discarded in aid of quarrying activities.

Modelling biface breakage and transport rates showed that bifaces commonly were exported from Locality 36 as early Stage 3, non-heat-treated, unfinished tools. On the basis of indirect evidence, we think bifaces were removed from the quarry to nearby campsites for further reduction prior to export from Tosawihi.

Bifaces maintained a standard form throughout the 4000 years of quarry use, and production techniques show slight evidence of change through time. Variation in biface production techniques evident at Locality 36 seems due to the characteristics of particular deposits exploited.

Chapter 6

HAMMERSTONES AND ADDITIONAL ARTIFACTS

Dave N. Schmitt and Caitlin M. Carroll

Archaeological investigations at Locality 36 returned numerous stone and bone implements employed in toolstone extraction and fabrication and ground stone tools used to process subsistence resources. The following discussion segregates assemblage components into four analytic categories: hammerstones, metates, bone artifacts, and other artifacts. Functional ascriptions are based on observations of overall morphology, provenience, and comparison with regional archaeological assemblages.

Hammerstones

Excavations and surface collections yielded one of the largest collection of hammerstones recovered from a Great Basin site. Represented by a wide range of shapes, sizes, and material types, 145 hammerstones were collected from various contexts, including extra-feature surface finds, quarry pits, and isolated reduction features (Table 31).

Table 31. Hammerstone Frequencies by Material at Locality 36.

Type of Investigation	MATERIAL					
	Basalt	Quartzite	Rhyolite	Opalite	Other	Total
Non-feature						
Surface	4	3	9	1	-	17
Subsurface	-	2	-	1	-	3
Misc. Trench Backdirt	7	7	5	11	9	39
Feature						
Misc. Feature						
Inventory-Surface	6	6	8	5	4	29
Excavated/Profiled Contexts						
Quarry Pits*						
Feature 13	-	-	2	-	-	2
Feature 22	-	3	-	2	-	5
Feature 30	-	1	-	-	-	1
Feature 31	-	1	-	-	-	1
Feature 32	-	-	-	2	1	3
Feature 42	1	2	2	1	1	7
Feature 42/44	2	2	-	-	-	4
Feature 49	2	2	1	-	2	7
Feature 72	2	3	-	-	-	5
Feature 102	6	4	5	1	1	17
Reduction Features						
Feature 6	-	1	-	-	-	1
Feature 63	-	1	-	-	-	1
Feature 84	-	1	-	-	-	1
Feature 86	1	-	-	-	-	1
Feature 87	-	-	1	-	-	1
Totals	31	39	33	24	18	145

* Includes specimens collected from pit surfaces prior to trench excavation.

Raw materials employed as hammerstones include at least seven rock types (cf. Table 31). Quartzite specimens are most abundant (n=39, 27%), followed closely by rhyolite and basalt. Opalite hammerstones are relatively common (n=24, 17%), probably employed most frequently in expedient rough percussion tasks and/or the excavation of tuff layers overlying toolstone. Even given its tendency to fracture easily, opalite is an economical hammerstone alternative in a quarry setting; if the cobble breaks, it can be replaced easily at low cost.

The assemblage exhibits sizes ranging from small fist-sized cobbles that can be held and used with one hand, to large, two-handed implements, probably employed as "throw stones" (i.e., projectile hammer) in the removal of opalite from bedrock exposures (cf. Schmitt 1992b). Based on morphology and weight (range = 2600–4800 gm), seven throw stones were identified, all discovered in or adjacent quarry pits; some additional fragments (46% of the specimens are incomplete) may be spalls from these large hammers.

Shaped hammerstones (n=33) were recovered in various contexts. Although use-wear and fragmentation obscure some evidence of manufacture, most were shaped by pecking and abrasion (cf. Figure 46b) or bifacial flaking. Ten specimens were flaked bifacially along all margins to create thin, disc-shaped hammers (mean diameter = 12.5 cm; cf. Figure 46c). Although edge damage (spalling, crushing) indicates they served as hammerstones, they also may have served as excavation tools to remove tuff and other debris while isolating toolstone in bedrock exposures. Overall, shaping is most common on opalite hammerstones (n=17, 53%); in fact, most (71%) opalite specimens are shaped.

Unshaped hammerstones (n=85) commonly are ovoid or subrectangular hand-held cobbles (cf. Figure 46d), of shape and weight useful for toolstone acquisition and subsequent controlled flake removal without further modification. Most unshaped specimens are rhyolite (n=27), followed closely by quartzite (n=23) and basalt (n=16).

One specimen from the surface of Feature 72 is an unshaped basalt hammerstone with multiple, deep striations truncating cortex on all surfaces; these probably resulted from use in biface edge preparation during mid-to-late stage reduction (cf. Schmitt 1992b). Because most activities performed at Locality 36 were directed towards toolstone acquisition and early stage bifacial reduction, the paucity of other hammerstones exhibiting striations is not surprising; elsewhere at Tosawihi, we collected scratched and battered cobble tools from reduction and habitation features in the Eastern and Western Peripheries (cf. Schmitt 1989; 1992b).

We also recovered a fossilized shell (cf. brachiopodia) quartzite hammerstone fragment (Figure 47). This unique artifact was recovered from the surface of Trench 5 in quarrying debris adjacent Feature 42.

Discussion

The wealth of hammerstones recovered from quarry pits, adits, and reduction features at Locality 36 is predictable. Intrasite analyses are discussed in Chapter 10; regardless of context, the data revealed an heterogeneous mix of shapes, sizes, and raw materials. However, when comparing the Locality 36 assemblage to hammerstones recovered from the Eastern and Western Peripheries, some interesting patterns emerge relative to "function" and raw material selection.

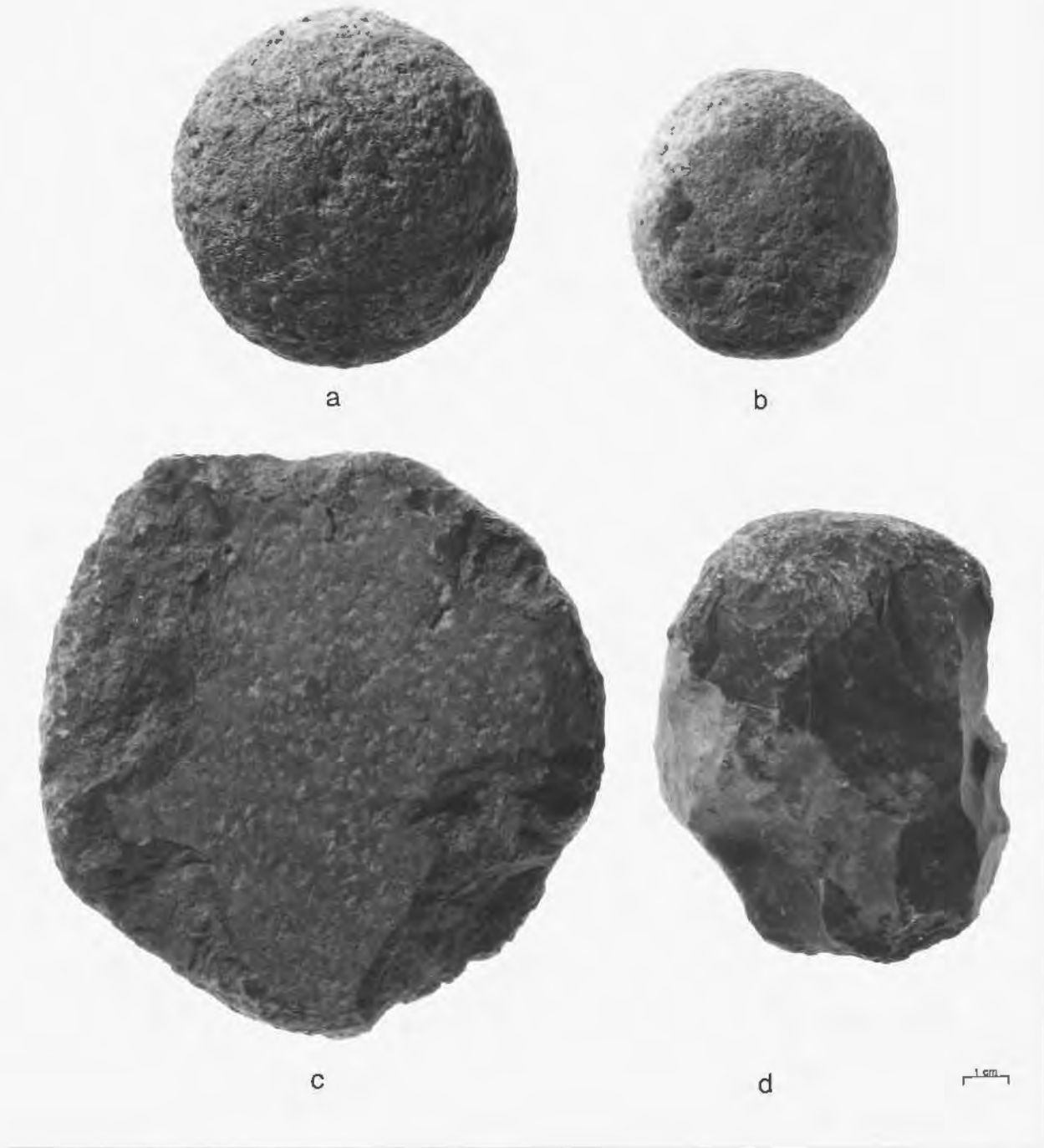


Figure 46. Selected hammerstones.



Figure 47. Fossilized (quartzite) cf. brachiopod hammerstone fragment.

Although hammerstones clearly were employed in percussion, most of it probably related to toolstone reduction, initial scrutiny of the Locality 36 specimens found them more massive than hammerstones recovered elsewhere in the Tosawihi vicinity. In order to evaluate our assumptions quantitatively, we calculated mean weight per item for complete specimens in order to compare them to hammerstone assemblages from the Eastern and Western Peripheries (cf. Schmitt 1992b; Appendix I). The results (Table 32) support our initial assumptions; on the average, hammerstones from Locality 36 are twice as heavy as those recovered from non-quarry sites. Although some Locality 36 specimens are small and shaped (probably employed in late stage, controlled flake removal), and some specimens peripheral to 26Ek3032 are large cobbles from quarry contexts, the overall abundance of large hammerstones at Locality 36 reflects functional differences. This conclusion is supported by data from investigations at other quarry sites in the Tosawihi area (Elston, Raven, and Budy 1987, Elston and Raven 1992, Leach and Botkin 1991, 1992). The mean weight of hammerstones recovered from these sites is much higher than those from the predominantly non-quarry sites of the Eastern and Western Peripheries and the Northern Corridor (Table 32). Specifically, smaller hammerstones found peripheral to the quarries signal use in late stage controlled flaking, while the large Locality 36 specimens and those from other quarry sites apparently were employed in toolstone acquisition and subsequent early stage reduction.

Table 32. Mean Weight/Item of Complete Hammerstones by Subarea.

	No. Complete Hammerstones	Mean Weight (g)/Item
Locality 36	78	968.9
Western Periphery	33	547.2
Eastern Periphery	28	508.2
Northern Corridor	6	406.1
87-89 Quarry Sites	17	755.8

These data are consistent with observed patterns of biface reduction. Biface and debitage studies (Bloomer, Ataman, and Ingbar 1992; Bloomer and Ingbar 1992) indicate that early stages of biface reduction were conducted at or adjacent quarries, while increasingly later stages of reduction took place with increasing distance from quarries.

Elsewhere, Schmitt (1992b) examined hammerstone material type from two areas peripheral to the center of the Quarries and found each to contain higher frequencies of locally available rock types suggesting most were acquired from nearby drainages and/or outcrops. As presented in Figure 48, material types in the assemblage from Locality 36 are distributed more evenly than in the eastern area (Eastern Periphery), where quartzite dominates the assemblage, or the western area (Western Periphery), where basalt dominates. This pattern suggests that hammerstones used at Locality 36 were collected throughout the region in logistical forays, while camping at peripheral water sources, or while en route to the quarries. Quarriers may have favored certain materials for use in certain tasks (i.e., extraction versus controlled reduction/ thinning; cf. Chapter 10). Temporal patterns of such preferences are not evident in our assemblage.

Metates

Five fragmentary metates were recovered from surface contexts. Two were collected as extra-feature isolates in the northern portion of the site amid numerous reduction features. Manufactured on a large basalt tabular cobble, one displays moderate use-wear (polish and striations) on both planar surfaces (Table 33). Another is a welded tuff metate with pronounced polish and striations on its concave working surface; numerous pits truncating the working surface reflect resharpening.

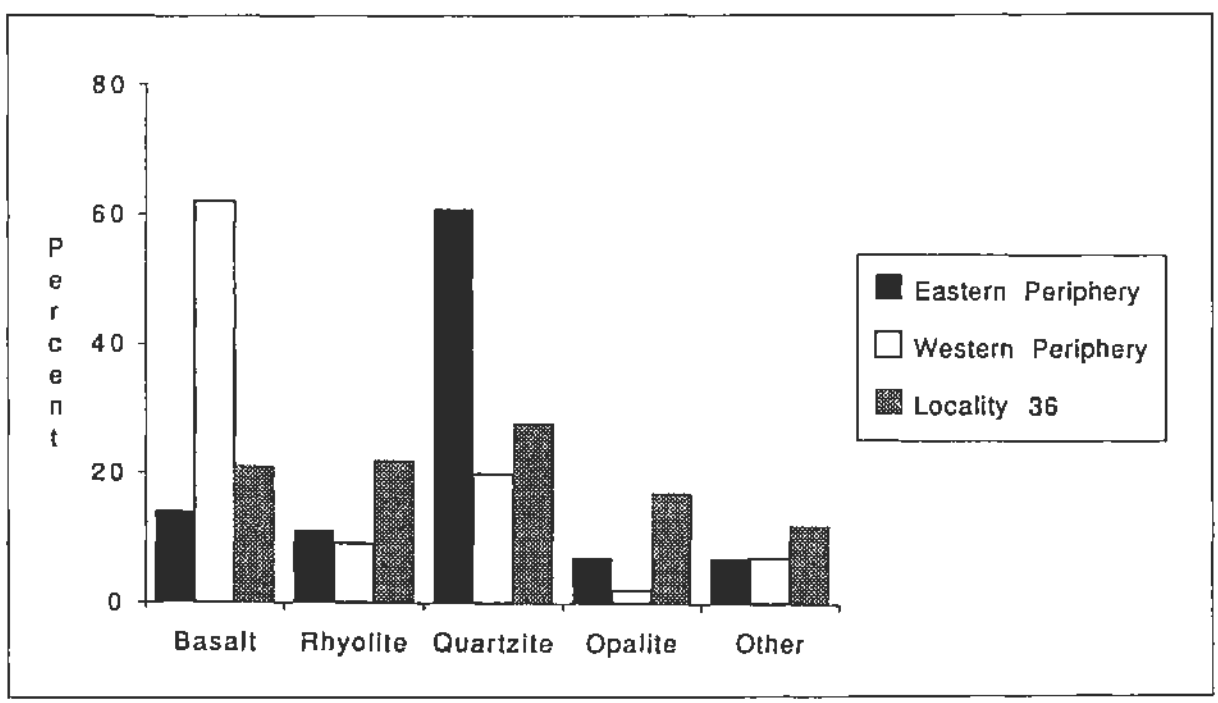


Figure 48. Proportions of hammerstones by material type and area.

Table 33. Provenience and Attributes of Various Artifacts, Locality 36.

METATES

Specimen No.	Fea.	Material	Plan Outline	Facial Use	Use Surface Profile	Use Wear	Length	Width	Thickness	Wt. (g)
							cm			
01-3	-	Basalt	SR	B	PL	M	28.3	14.0	4.6	2475.2
01-4	-	Tuff	IN	U	CN	H	17.0	12.3	4.4	376.3
3063-2	63	Tuff	OV	U	CN	M	33.5	18.4	7.4	3000.0
3069-2	69	Sandstone	SR	U	PL	M	7.0	5.8	1.5	71.9
3086-2	86	Rhyolite	TR	B	PL	M	30.4	23.5	7.2	4000.0

BONE ARTIFACTS

Specimen No.	Trench	Fea.	Depth (cm B.S.)	Species	Element	Length	Width	Thickness	Wt. (g)	Type
						cm				
2599-101	1	103	85	*Bison bison*	Thoracic spine frag.	25.2	4.8	1.7	109.7	WE
2599-108	7	103	84	cf. *Cervus elaphus*	Antler frag.	20.6	5.8	3.5	163.3	WH
2599-156	3	49	78	Artiodactyla	Rib or spine frag.	6.4	2.8	1.8	5.4	UN
2599-166	3	49	100	Artiodactyla	Rib frag.	-	-	-	2.7	UN
2599-217	5	-	6	Artiodactyla	--	5.5	1.5	0.6	4.5	WE

OTHER ARTIFACTS

Specimen No.	Trench	Fea.	Depth (cm B.S.)	Material	Length	Width	Thickness	Wt. (g)	Type
					cm				
2599-182	3	49	130	Basalt	15.5	4.7	2.5	342.6	WE
2599-202	4 ca.	22	10-40	Tuff	2.6	2.4	2.3	11.6	SE

Key:

Plan Outline
SR = Subrectangular
OV = Ovoid
TR = Triangular
IN = Indeterminate

Facial Use
B = Bifacial
U = Unifacial

Use Surface Profile
PL = Planar
CN = Concave

Type
WE = Wedge
WH = Wedge/Hammer
SE = Sphere
UN = Unknown

From the surface of Feature 63, we retrieved two fragments of thick, welded tuff ground stone exhibiting moderate surface fatigue (cf. Table 33); use-wear is most pronounced within a circular, slightly concave (diameter ca. 12 cm) polished and striated facet; the piece may have served as an expedient mortar (cf. Schmitt 1992c). From Feature 69 we collected a thin milling stone fragment with unifacial use-wear. Although fragmentary, it appears shaped and may represent a small, portable metate or palette used with a pebble-sized handstone (cf. Juell 1990; Kramer and Thomas 1983). Finally, a thick rhyolite metate fragment was discovered at Feature 86; it weighs more than 4000 grams and exhibits extensive bifacial use.

Bone Artifacts

Four artiodactyl bone fragments and a proximal antler fragment were collected from backhoe trenches. In Feature 103 (Trench 1), we recovered a bison thoracic spine from Stratum 14 (cf. Table 33). Although its dorsal end exhibits no use-wear (i.e., it is fragmentary; Figure 49a), the articular process of its ventral surface is rounded from "hands-on" use, suggesting that the dorsal end served as the working end, probably employed in tuff excavation and/or as a wedge. Investigations at Feature 103 (Trench 7, Stratum 12) also discovered a large, artiodactyl (cf. *Cervus elaphus*) antler fragment (cf. Table 33, Figure 49b). Both ends exhibit use-wear (the distal end is scarred and rounded, and the horn core is battered), suggesting use as an excavation tool and as a billet; we recovered a remarkably similar artifact from Locality 23 (Schmitt 1992a).

Two highly fragmentary large mammal bones were recovered from deposits adjacent the Feature 49 adit. Although they lack evidence of use and may simply represent subsistence residues, their context suggests that they probably served as quarrying implements (e.g., wedges and/or digging tools); our investigations at a number of sites in and adjacent the quarries have yet to identify "food bones" in quarry contexts (cf. Leach and Botkin 1991; Schmitt 1992a).

The remaining bone artifact is a small wedge collected from Trench 5 (cf. Table 33; Figure 50). Manufactured on an unidentified large mammal bone, both ends display modification; the proximal end is rounded and faintly battered, and the other is beveled to a chisel-like working edge (cf. Figure 50). While conducting quarrying experiments at Locality 36, Carambelas and Raven (1991) employed similar (wooden) wedges and found them useful in isolating and extracting toolstone, especially to loosen blocks of opalite in bedrock exposures.

Other Tools

Five distinctive tabular basalt tools were recovered from Locality 36. On the basis of use-wear analysis, provenience, and results of actualistic experiments, we infer that they served as wedges in quarrying.

Each is made of platy andesitic basalt which weathers into elongated triangular or rectangular tabular fragments, as much as ca. 50 cm long in their natural state (Figure 51). All of the tools are considerably shorter (Table 34) and probably represent distal end fragments. Two appear to have been used after breakage. They evidence bipolar battering, suggesting their use in an indirect percussion technique. Three specimens exhibit small impact scars in addition to the battering present on all specimens.

Table 34. Dimensions of Basalt Quarrying Tools.

Specimen No.	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
2599-182	15.5	5.1	2.1	342.6
2599-361	13.8	7.5	1.8	227.0
2599-362	8.4	7.5	2.6	288.5
2599-363	21.5	6.8	2.1	523.5
2599-364	12.3	6.7	1.9	221.2



Figure 49. Selected bone artifacts.

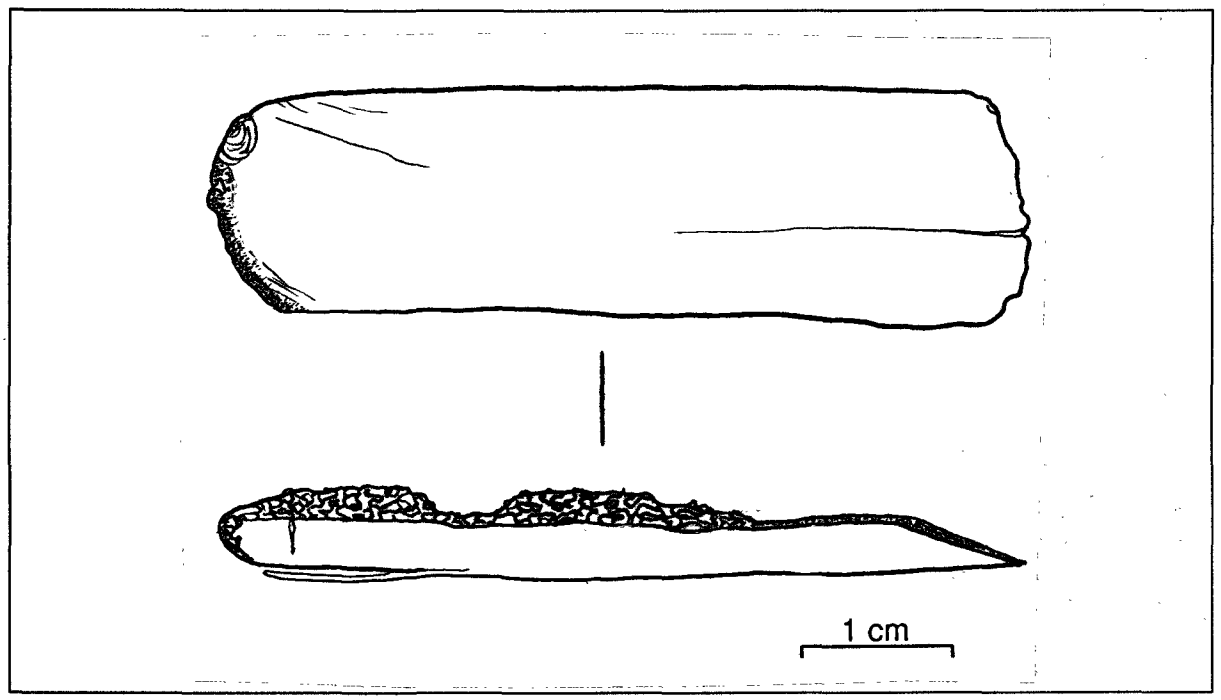


Figure 50. Split bone wedge.

One piece is very similar to another basalt tool recovered from quarry contexts during previous fieldwork at Tosawihi (Ataman 1992:Figure 49a). Both are roughly triangular in shape, of similar size, with battering on either end and tuff embedded in the battering scars on at least one end.

The context of each of the five tools reflects their quarry-related function. Four were recovered from the backdirt overlying the several quarry pits exposed in Trench 3, and one was found *in situ* within the adit there (cf. Chapter 8). Basalt does not occur naturally at Locality 36, and thus was transported to the site, presumably to be used in quarrying.

Although references to the use of stone axes and picks for toolstone extraction are not uncommon in quarrying literature (Wilson 1897; Holmes 1919; Lewenstein 1987), discussions of stone wedges are relatively rare. A few correlates to archaeological specimens from Locality 36 are cited in experimental quarrying studies. Basalt implements were used effectively as wedges for toolstone extraction by Carambelas and Raven (1991) in quarrying experiments at Tosawihi. In these experiments, a basalt wedge was inserted into a crack in the opalite bedrock and tapped lightly with a hammerstone to free a piece of toolstone from surrounding bedrock. A chert wedge was used for removal of overburden and toolstone extraction in a quarrying experiment by Greiser (1983).

The remaining artifact is a tuff sphere ("ball") from Feature 22 of Trench 4 (cf. Table 33). Measuring approximately 2.5 cm in diameter, it exhibits faint overall polish and a few manufacture striations; it may represent an ornamental preform, or perhaps an expedient, non-functional curiosity.

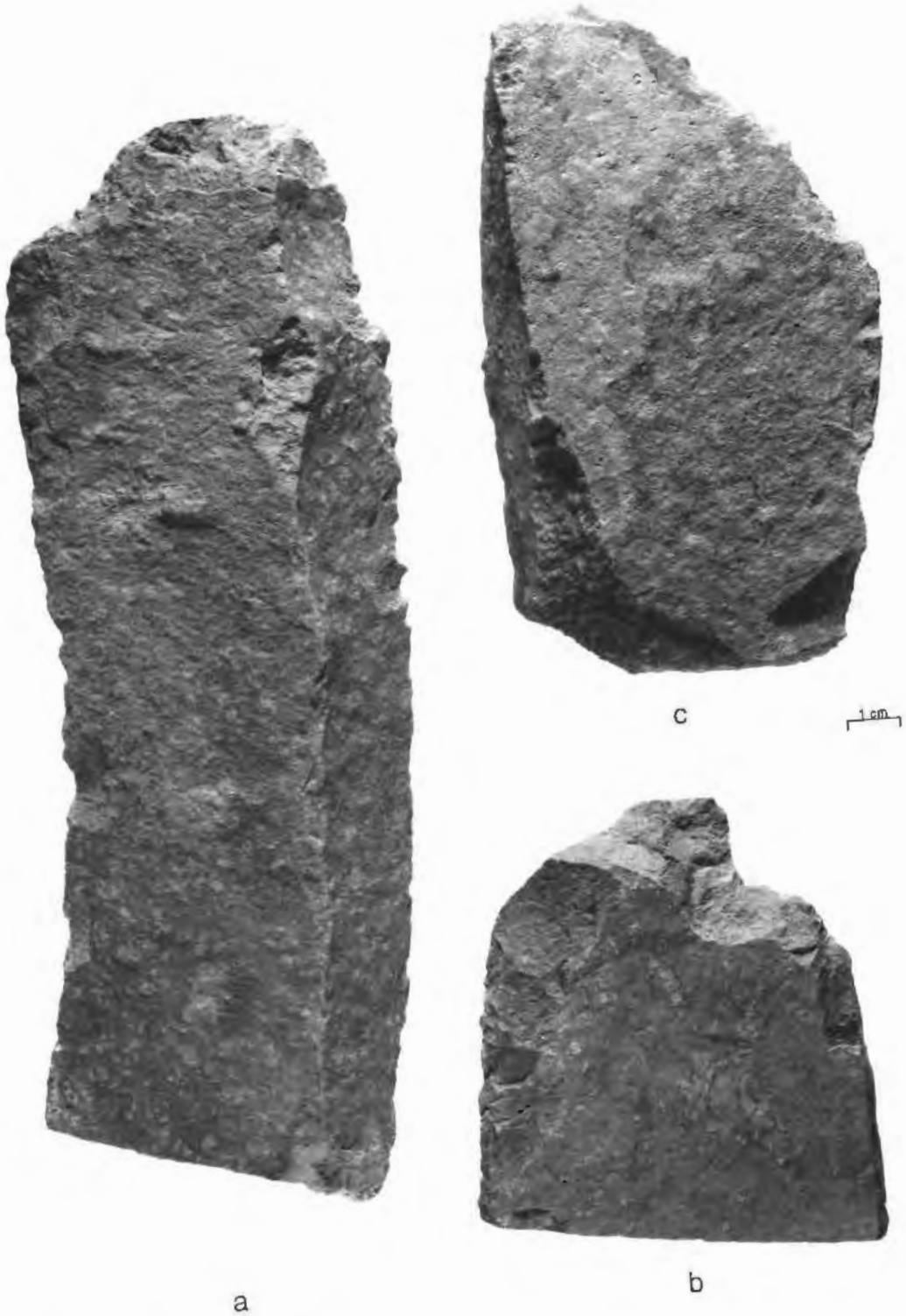


Figure 51. Basalt quarrying tools.

Chapter 7

BEDROCK GEOLOGY, GEOMORPHOLOGY, AND SITE FORMATION PROCESSES

Daniel P. Dugas and Robert G. Elston

In this chapter we describe the surface morphology and bedrock geology of Locality 36, and outline changes in geomorphology resulting from cultural modifications. The occurrence of toolstone is determined by geological forces; the benefits and costs of extraction and processing it are influenced strongly by the type of stone available, its quality, and the degree to which natural forces of faulting and erosion have shaped it and made it accessible. Since these factors also constrain the possible approaches to quarrying, variability in bedrock morphology should be accompanied by variation in quarrying techniques and their effects on both bedrock and overlying soil and clastic material.

The Shape of the Quarry

The site is situated on a ridge formed on a bedrock core of Tertiary volcanics (Figure 52). The ridge top is relatively flat, with increasingly steep slopes on the east, south, and west. Quarry pits and processing debris are concentrated in a band about 30 m wide running northwest-southeast along the upper western and southwestern slopes. Three large groups or clusters of quarry pits are designated Areas A, B, and C (Figure 52).

The Tertiary volcanics contain roughly horizontal to slightly eastward dipping, bedded airfall and waterlain tuffaceous deposits (Figure 53). A zone or "cap" (Bartlett, Enders, and Hruska 1991; Elston 1992a:Figure 20) of this material several meters thick was silicified by hydrothermal activity propagating horizontally along bedding planes and joints. The silicified zone contains beds and stringers of chalcedonic opalite ranging from 5 cm to at least 80 cm in thickness, and from a few centimeters to scores of meters in lateral extent. The opalite is frequently inclosed by unsilicified or partially silicified tuff, or brittle opal. Above the silicified tuff lies up to 80 cm of unsilicified tuff. The reddish silty clay of a well developed B soil horizon lies on tuff and opalite bedrock, below eolian silts and silt loams of the modern soil surface. Sands and gravel of a remnant Pleistocene terrace occur northeast of the main concentration of quarry pits (cf. Figure 52), as well as various sediments and debris resulting from disturbance of the natural surface cover and bedrock during prehistoric quarrying.

Three slope regimes prevail on the ridge (Figure 53): the flat surface of the ridge top, a moderate slope, and a steep slope. The flat surface conforms to the planar, silt covered surface of the uppermost tuff unit. Between the flat surface and the steep slope, the moderate slope (where soils are thinnest and quarry pits are concentrated) is formed by the partially eroded edge of the silicified zone. The steep slope is the result of faster erosion of the softer tuff below the silicified zone.

The silts and silt loams of the modern surface are thickest (over 60 cm in the Trench 2 exposure) nearest the ridgecrest and the upper northeastern hillslope flank. This pattern of silt deposition on hillslopes to the lee-side of the prevailing wind has been noted in several locations in

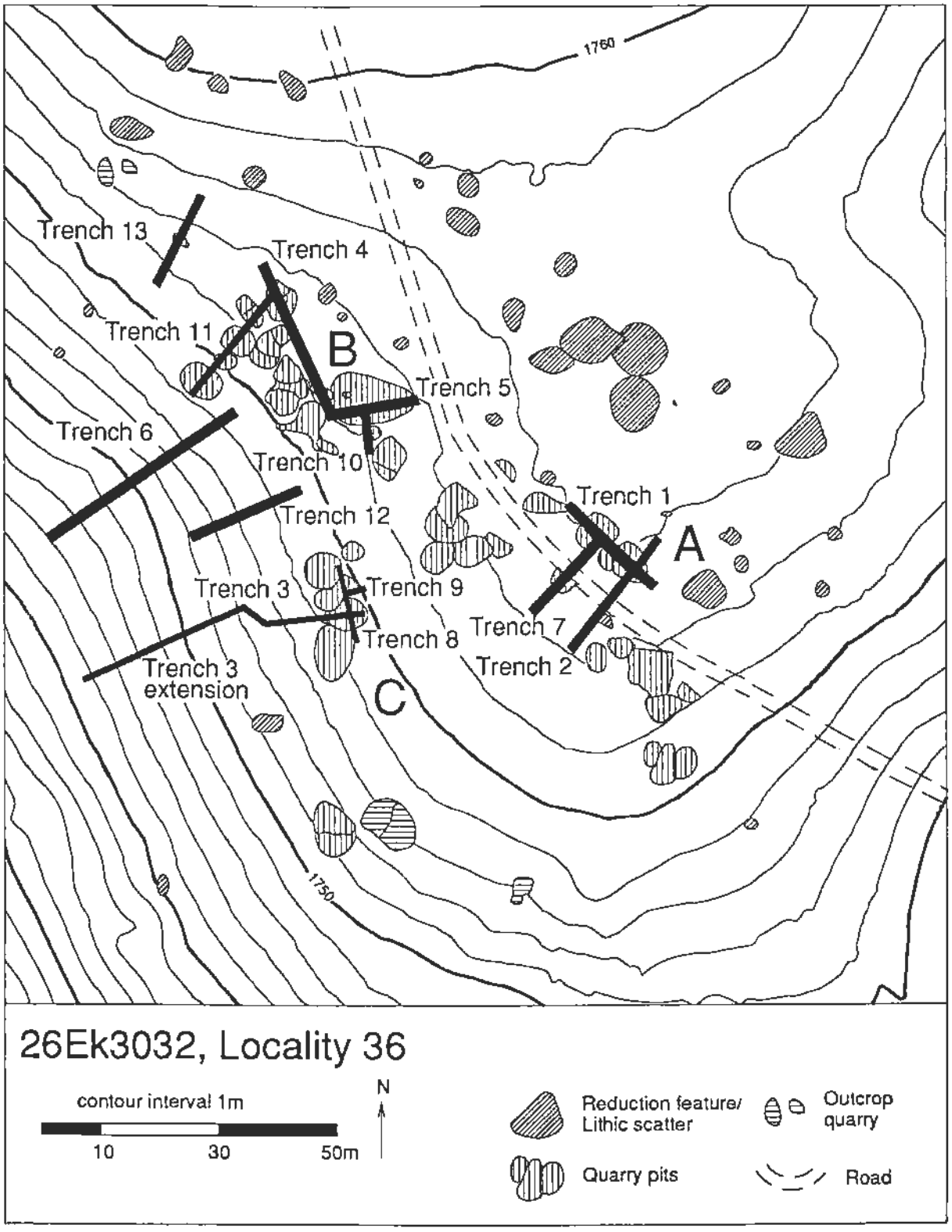


Figure 52. Quarry pit complexes and backhoe trenches.

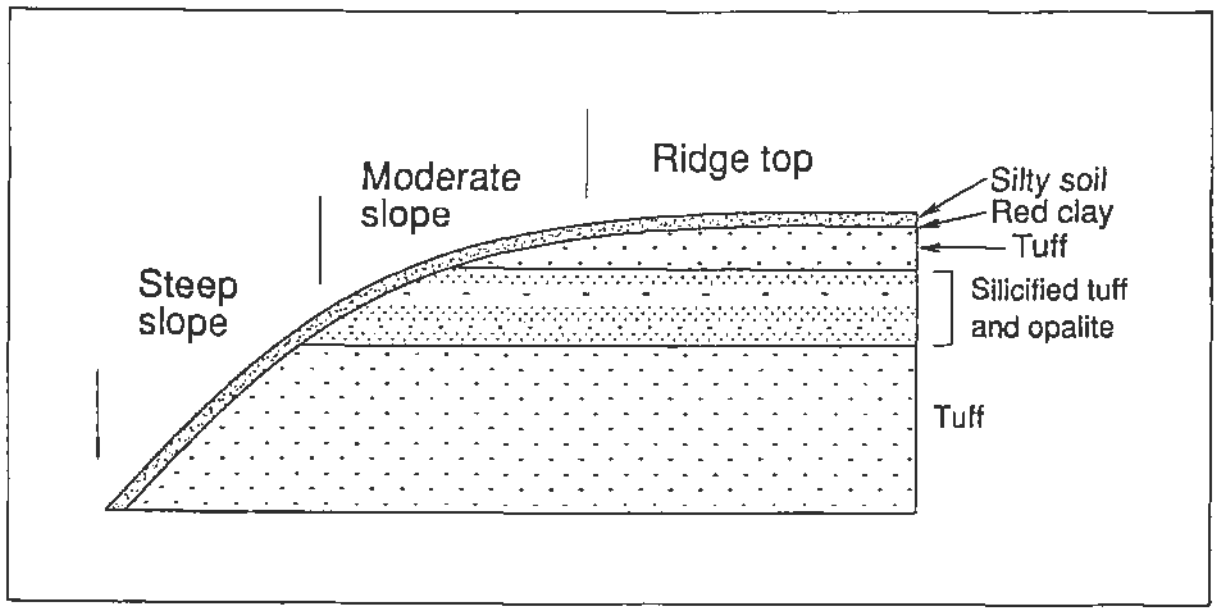


Figure 53. Schematic cross-section of Locality 36, looking north.

the Tosawihi area (Elston and Raven 1992). Significant eolian transport and redeposition of these silts may still be occurring, as evidenced by the burial of quarry pits and hearth features by silt in flat-lying areas on the ridgecrest and just to the east of it in Area A. Radiocarbon dates from these hearths indicate that as much as 30 cm of silts have been deposited between 410 and 150 years ago.

The buried red clay B horizon is most extensive on the southwest aspect slope below the ridgecrest. We assume this horizon has been developing at least since the end of the Pleistocene, but it possibly is much older. It tends to be thinnest to the north, becoming thicker downslope and to the southeast. This trend seems to be related to the greater proportion of tuff bedrock compared to opalite in this general direction. Presumably, weathering of tuff is faster and produces more clay than does weathering of opalite. This apparent relationship of bedrock type to soil development was noted in detail in the soil profile of Trench 6 (cf. Chapter 8).

Bedrock is most accessible where exposed at the surface and where overlying deposits are thinnest. At Locality 36, this condition prevails in Area B where the moderate slope intersects the edge of the silica cap. Here, most of the upper tuff has been removed by erosion and clay and silt soil cover is thinnest. Erosion of surface sediments by slopewash and soil creep is most intense where the relative lack of sediment-trapping vegetation probably prevents the accumulation of eolian deposits or sediments eroding from the flatter portion of the site. Small, poor quality opalite outcrops occur at the northern and southern ends of the locality. These are battered but not quarried, suggesting they were tested from time to time but found wanting. Under pre-quarry conditions, other opalite outcrops may have been present as well. Thus, the original discovery of quarryable opalite at Locality 36 is not surprising.

Types of Quarry Settings

Bedrock morphology influences the costs of toolstone extraction and hence the quarrying strategies that can be utilized profitably. Bedrock settings at Tosawihi can be idealized as three types

(Elston and Dugas 1992), depicted schematically in Figure 54. As discussed below, two of these settings were at Locality 36, and the third may have been present prior to landscape modification brought about by aboriginal quarrying. Detailed stratigraphic descriptions of select backhoe trenches are offered in Chapter 8.

In Type 1 morphology, toolstone is exposed at the surface in a ledge or outcrop (Figure 54a), and its presence is obvious. Such settings are common at Tosawihi along fault scarps above steep slopes and in stream cuts. In both situations, geological processes (gravity and water) transport weathered debris away from the outcrop and prevent its burial. Quarrying proceeds in a Type 1 situation by clearing weathered rock and removing fresh material from the outcrop, working it back into the slope (e.g., site 26Ek3208; cf. Leach, Dugas, and Elston 1992). This may be accomplished by undermining at points where beds of weaker rock underlie more massive rock; frequently this technique creates a short tunnel or adit. Work also may proceed laterally, back and forth along the face of the outcrop; if the face is large enough, more than one area can be worked simultaneously. No outcrop presently visible on the surface of Locality 36 has been quarried, but it is possible that some Type 2 settings once had Type 1 morphology (surface outcrops) removed through quarrying or buried by quarrying debris.

In Type 2 settings, more or less horizontal beds of toolstone are intersected by a sloping surface (Figure 54b). Because of the slope, gravity and water transport may prevent burial of the toolstone by *deep* accumulations of soil and colluvium. Although the bed does not quite outcrop at the surface, the presence of subsurface toolstone will be signaled by toolstone clasts in colluvium on the slope below the bed. Type 2 settings usually are worked into the slope of the hill, with lateral movement along the face of the ledge; adits may be created where possible. Type 2 morphology is common across the lower portion of the moderate slope, particularly in Area C.

Type 3 morphology occurs where the toolstone stratum parallels the present ground surface, but is buried by soil and colluvium (Figure 54c). Type 3 settings usually are quarried by

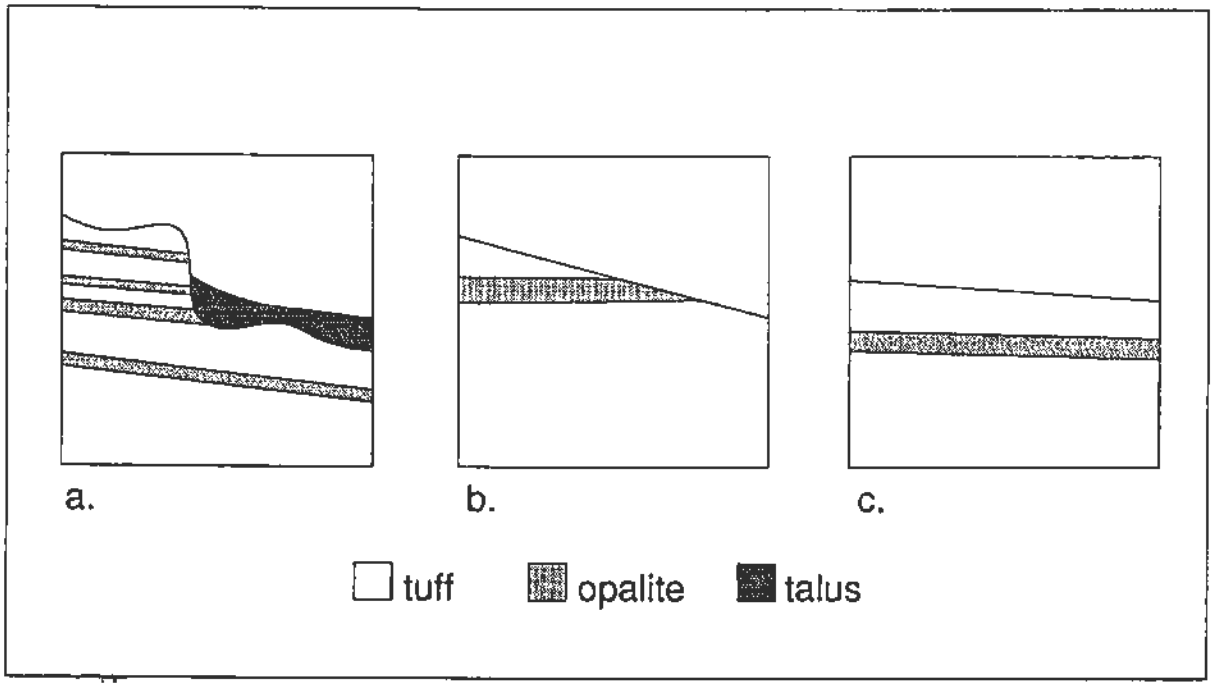


Figure 54. Morphologies of opalite occurrence. a. Type 1: surface outcrop; b. Type 2: intersected by surface slope; c. Type 3: parallel to surface.

excavating vertical pits. Where there is slope, work tends to proceed uphill, but lateral movement in any direction is possible, and coalescing pits may result in either a broad, saucer-shaped pit (e.g., Feature 7, 26Ek3171; cf. Botkin, Dugas, and Elston 1992) or a crude planing of the bedrock surface. At Locality 36, such settings are found in the upslope portions of Areas A and B just either side and along the flat top of the ridgeline where bedrock lies horizontal or at a low-angle dip to the east. The Type 3 setting grades into Type 2 downhill as the increasing angle of the slope intersects horizontal bedrock.

Spatial Variation in Cultural Modification of Bedrock

Because of variation in the bedrock setting, the quarrying strategies utilized at Locality 36 also vary. In the Type 3 settings of Areas A and B, quarrying progressed vertically downward through overlying soil, then laterally across the opalite and tuff bedrock creating broad pits. Within these occur numerous smaller pits excavated deeper into places of higher quality opalite (and where jointing in the opalite favored easier extraction). Although there seems to have been a general tendency to work into the slope, the surface of Area B in particular was cratered with a welter of intersecting pits and berms in no discernible pattern, and the bedrock is crudely planed, suggesting that quarrying moved laterally in all directions. In the Type 2 settings of Areas B and C, the tendency to work into the slope, or laterally along a bedrock ledge, is expressed more strongly and is obvious in profiles presented in the following chapter.

Where there was a change in bedrock morphology between Types 2 and 3, (as in Areas B and C), the approach to quarrying shifted as well. For instance, along Trench 4 in Area B, there is a north to south transition from lateral planation of the bedrock, to broader pit-like quarrying, then to the utilization of higher relief faces and deeper pits and adits.

We note also that quarry debris and other sediments capping the bedrock become thicker and the bedrock surface slopes considerably down to the southeast through Area B, forming a broad depression. Although it is unclear whether the slope was created by quarrying or is a natural feature, this depression has been filled with a significant amount of quarry debris. Its lowest observed point lies at the intersection of Trenches 5 and 10 in the south side of Area B. Here, a combination of lateral pitting, rough planing, and adit excavation has created an elongate pit in the opalite bedrock some 3 m wide and at least 1.7 m long. When exposed by the backhoe, this pit was filled with water to a depth of 50 cm; in fact, lesser amounts of water trapped in bedrock pits and adits were observed in several places at Locality 36. That bedrock quarry features can function as cisterns for water collection and storage suggests that strategies for positioning people and procuring resources at Tosawihi might have changed as development of the quarries progressed through time.

Although lateral pitting and planing are dominant along Trench 4, it also is evident that a low relief face of tuff and opalite was worked uphill in a combination of small pits and adits. Small adits exposed at the junction of Trenches 4 and 5 and at the south end of Trench 10 indicate that some pits were expanded laterally when the possibility of isolating an overhanging opalite segment materialized. The small scale and rarity of adit features in this Type 2 setting of Area B, however, suggests that large outcropping opalite ledges underlain by softer tuff were not always present, providing infrequent opportunities for the formation of adits. It is possible, however, that extensive quarrying removed any outcropping ledges.

It is likely that a Type 1 setting was once present in Area C, with a bedrock ledge exposed at the surface prior to quarrying. A series of rubble-filled quarry pits were revealed by trenching

to be aligned along a ledge of massive opalite underlain by highly fractured opalite and tuff. This ledge is several meters long and arcuate (convex uphill), with a large adit quarried under it. The adit and other overhangs in the bedrock were filled and covered with quarry debris and slopewash, although the overlying material is very thin in places. The upper surface of the bedrock appears to be weathered, with a yellowish patina and abundant fine cracking and jointing. At other Tosawihi locations where bedrock currently is exposed as surface ledges, opalite overhangs are common above negative-relief weathered tuff beds.

Quarrying along this ledge is likely to have concentrated first on the removal of weathered materials from the surface of the outcrop, followed by working back into and laterally along the freshly exposed opalite face, isolating opalite overhangs by removing softer tuff beds below and above them.

A buried quarry feature not visible on the surface occurs in Trench 3 several meters down slope from the large adit. The feature is isolated from the adit and associated pit features by a segment of un-quarried bedrock and overlying surface sediment; the quarrying activity in each area is unrelated, and was separated by several thousand years of time. The buried quarry feature is one of the earliest at Locality 36 (cf. Chapter 8). It was produced mainly by working low relief faces, concentrating on two or three isolated lenses of opalite within massive tuffs. Currently, the opalite bedrock is more than a meter below soil and colluvium in a Type 2 setting, but whether or not it was exposed at the surface in the past is uncertain. Once buried by colluvial processes, it apparently was forgotten.

In the following chapter, we describe the stratigraphy and chronology of subsurface features.

Chapter 8

STRATIGRAPHY AND CHRONOLOGY

Robert G. Elston and Daniel P. Dugas

The natural and cultural deposits of Locality 36 preserve a record of quarrying and other cultural activity, and the timing of events is measured by radiocarbon dates. These data contribute to local and regional culture history, but they are more interesting viewed from the theoretical questions raised by the benefit/cost model of economic behavior presented in Chapter 1. The model predicts that quarriers first should pursue toolstone in places where the presence of quarryable toolstone is evident from surface indications, where extraction costs are lowest, and where toolstone quality is sufficient to insure profitable returns from search and extraction. Only thereafter, should quarriers ply toolstone "patches" that are increasingly difficult to find and expensive to quarry. Different bedrock settings were described in the previous chapter and evaluated with respect to the costs of toolstone extraction. Type 1 settings (surface outcrops) are found easily and, toolstone quality being equal, are the least expensive to exploit. Since Type 1 settings were not quarried at Locality 36, we can assume that the quality of toolstone they offered was too poor to yield adequate returns. Type 1 settings may have occurred originally at Locality 36, being destroyed by subsequent quarrying; aspects of this question are explored below and in the following chapter. The description and analysis of the stratigraphic and radiocarbon record presented here focuses on tracing the progress of quarrying at Locality 36 through time and space. Chapter 9 explores how bedrock topography affected methods of extraction; Chapter 12 examines how intensity of quarrying varied in response to toolstone quality and ease of extraction.

Stratigraphic Nomenclature

Investigations in the Tosawihi Periphery suggest that similar quarry and processing deposits tend to appear in a few recurrent situations (Leach, Dugas, and Elston 1992; Botkin, Dugas, and Elston 1992). Coarse units in which pieces of rock lie on or against one another, with open spaces between the clasts, are characterized as *open framework*. Open framework is divided into *poor, moderate,* or *typical* depending on the relative amount of open space and finer matrix present. When finer matrix is abundant and the larger clasts do not rest on one another, the deposit is *matrix supported. Hash* is a deposit of very fine opalite chips and chip-like fragments mixed with fine-grained materials such as pulverized tuff, silt, and clay, usually found in contact with bedrock in the bottoms of quarry pits. In experimental quarrying, primary deposits of hash were produced on quarry pit floors by battering bedrock with hammerstones during extraction. We also observed the formation of hash when rain washed coatings of dust off pit walls and large clasts to accumulate in pit bottoms.

Typical quarry deposits are comprised of coarse units (mostly tuff and opalite chunks and debitage) alternating with layers of fine sediments. The coarse units probably represent episodes of quarrying and processing that accumulated instantaneously in archaeological terms. Fine-

grained strata other than hash, and some matrix supported strata, more probably were created by natural processes (ie., colluviation, slopewash, eolian accumulation, and infiltration) over longer periods when quarrying was not active. Greater compaction and signs of weak soil development (increased carbonates and phosphorous, decreased iron and aluminum) in older deposits and in fine strata underlying truncation surfaces suggests that some surfaces were stable through relatively long intervals (Leach, Dugas, and Elston 1992).

In some cases, strata can be grouped into major *horizons*, each a time-stratigraphic unit comprised of one or more strata. Horizon boundaries are indicated by surfaces formed on truncated strata of the underlying horizon, each truncation surface marking an episode of human excavation. Layers of sediment comprising the subsequent horizon are usually internally conformable (oriented with relation to the same grade), but unconformable on, and often inset into, earlier deposits. Coarse and fine-grained sediments within horizons may indicate episodes of quarrying and processing alternating with intervals of inactivity, but each horizon represents a period dominated by deposition. While horizons appear to represent piles of debris created during extraction and processing from a pit at one location, horizon boundaries seem to be created when quarrying excavations are moved laterally into old debris, or during vertical re-excavation of an old pit. That truncation surfaces often may have remained exposed for extended periods is suggested by signs of weak soil development (described above) with which they are sometimes associated. Horizons seldom can be correlated between trench exposures; their value is to group sets of local strata.

We begin the discussion by listing all the radiocarbon dates from Locality 36 (Table 35). We then briefly discuss the dates from the Ridge Top hearths, and describe the natural profile of the unquarried area in that vicinity. Stratigraphic descriptions of the three subareas (A, B, and C) described in the previous chapter (cf. Figure 52; Figure 55) follow; each was sampled by intersecting backhoe trenches. The ridge crest was sampled with 1 m x 1 m excavation units, and the upper 30 cm of silts were removed with a road grader in small increments. Quarry Area A occupies the southeastern portion of Locality 36 nearest the crest of the ridge where silty soil is deepest, and was sampled by Trenches 1, 2, and 7. In Quarry Area B, Trenches 4, 5, 10, and 11 reveal sediments over bedrock ranging from a very thin silt and red clay veneer to a moderately thick silt with a clay B horizon. Quarry Area B trenches also exhibit a sediment deposition and quarrying style transitional between Areas A and C. Quarry Area C is located slightly downhill between Areas A and B. Here, Trenches 3, 8, and 9, display the most clay-rich quarry debris and the most extensive adit quarrying of all three areas. In addition, Trench 6 was excavated to provide a view of the culturally undisturbed, natural soil profile on the steep slope below the quarry areas.

Tables of formal stratigraphic unit descriptions are provided in Appendix D. For the sake of simplicity, wall profiles are named by their dominant cardinal face (north, west, south, east).

Radiocarbon Dates

Radiocarbon dates from Locality 36 are summarized in Table 35 below. Dates are referred to by their lab numbers throughout the following discussion.

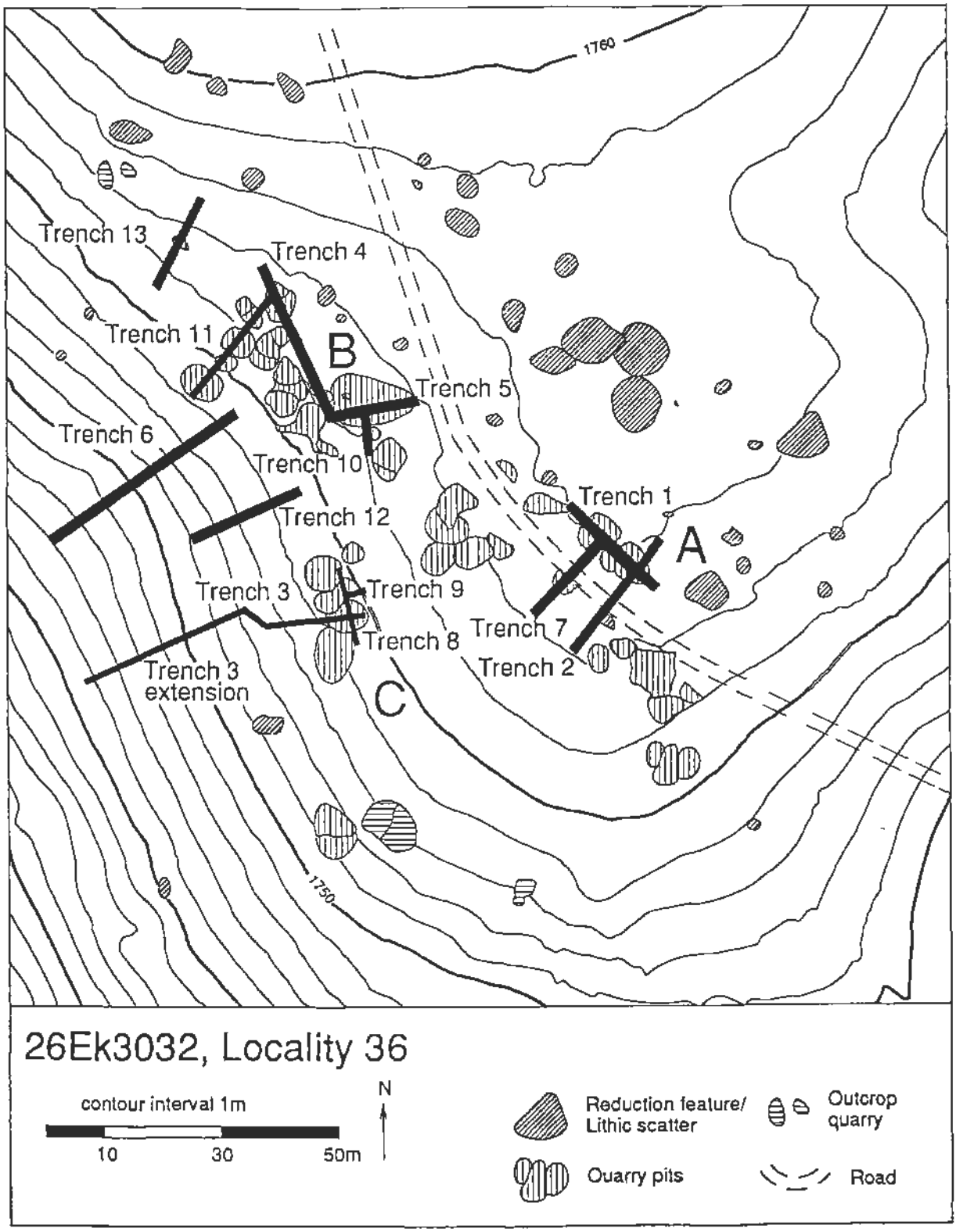


Figure 55. Features and backhoe trenches.

Table 35. Radiocarbon Dates From Locality 36, 26Ek3032.

Lab No.	Sample No.	Area	Trench/Wall	Feature	Unit	Date, B.P.
Beta-39485	2599-168-45	C	3, West	102	46	3890±60
Beta-42474	2599-160-7	C	3, North	102	44	3810±60
Beta-42475	2599-161-8	C	3, North	102	35	3830±80
Beta-42476	2599-162-9	C	3, North	102	42	3670±90
Beta-42477	2599-107-15	A	2, North	72	23	310±70
Beta-42478	2599-109-16	A	7, North	71	15	370±50
Beta-42479	2599-110-17	A	1, bottom	104	n/a	170±60
Beta-42480	2599-112-19	A	7, North	71	17	390±60
Beta-42481	2599-113-20	B	11, bottom	11	n/a	230±70
Beta-42482	2599-201-21	B	4, West	22	28	720±60
Beta-42483	2599-205-22	B	5, North	42	25b	550±80
Beta-42484	2599-207-24	B	5, North	42	31	620±90
Beta-42485	2599-211-28	B	4, bottom	27	n/a	190±50
Beta-42486	2599-213-30	B	5, bottom	42	n/a	690±90
Beta-42487	8001-1-31	Ridge		105	n/a	330±50
Beta-42488	8041-1-33	Ridge		106	n/a	410±60
Beta-42489	8081-1-35	Ridge		107	n/a	280±50
Beta-42490	8161-1-40	Ridge		109	n/a	310±60
Beta-42491	8201-1-42	Ridge		110	n/a	150±70
Beta-42492	2599-165-44	C	3, South	49	99/108	570±60
Beta-42493	2599-176-47	C	8, East	49	104	500±50
Beta-42494	2599-179-50	C	8, West	49	104	510±60
Beta-42495	2599-224-57	B	5, South	42	17	1090±130
Beta-42496	2599-114-61	A	1, West	104	*	50±50
Beta-42497	2599-180-62	C	8, West	49	*	520±70
Beta-43152	2599-159-6	C	3, North	102	32	3890±70
Beta-43153	2599-103-12	A	2, South	72	4	270±80
Beta-43154	2599-104-13	A	2, South	72	13	490±70
Beta-43155	2599-106-14	A	2, North	111	28	560±60
Beta-43156	2599-111-18	A	2, bottom	72	n/a	220±70
Beta-43157	2599-209-26	B	4, *	22	*	810±80
Beta-43158	2599-178-49	C	8, East	49	62	920±110
Beta-42159	2599-220-53	B	5, bottom	42	n/a	4090±100
Beta-43160	2599-223-56	B	10, East	42-44	8	1420±130

*Precise provenience uncertain.

The stratigraphic record of Locality 36 has two components. One is the natural stratigraphy of the bedrock and overlying soil prior to quarrying, the salient features of which were outlined in the previous chapter. Intact, pre-quarrying stratigraphy is preserved only in areas not subjected to intensive prehistoric quarrying; within quarried areas, only fragments of this record survive. This chapter focuses on deposits created by quarrying and processing toolstone, among which are layers of displaced soil, lenses of flakes, angular tuff, and opalite debris, mixtures of silt and debitage in quarry pit fill, and layers containing burned toolstone and charcoal. On the profiles accompanying the text, quarry deposits dominated by fine matrix and silty soil cover are represented by gray shading; open framework clast-dominated lenses of flakes, angular tuff, and quarry debris are unshaded.

Ridge Top Area

The top of the ridge is overlain by 30 to 60 cm of silty soil over a red clay paleosol developed on soft tuff bedrock. The silts are largely eolian and evidence little or no internal stratigraphy. Nevertheless, radiocarbon assays obtained from hearths exposed by test excavations and grader scraping show a tendency to sort by depth below surface. Dates of 410+60 (BETA 42488), 330+50 (BETA 42487), 310+60 (BETA 42490) and 280+50 (BETA 42489) were obtained from hearths lying between 10 and 20 cm below surface, while near-surface hearth, Feature 110, returned a date of 150±70 (Beta 42491). Insufficient charcoal was obtained from Feature 108, another near-surface hearth.

As discussed in the previous chapter and in the description of Quarry Area A, below, eolian silts have accumulated on the ridge top and upper portion of the moderate slope. Because of this, not all extant quarry features at Locality 36 are currently visible on the surface. For instance, Feature 70, located about 10 m northeast of Feature 71 (Area A) was recorded originally as a surface lithic scatter. Test excavation revealed the scatter to consist of debris from the berm of a buried quarry pit brought to the surface by bioturbation. We must assume that other pits lurk beneath the surface of untested and unscraped areas of the ridge, particularly around its southeastern and eastern margins along the same contours as Areas A, B, and C.

Trench 6: Natural Soil Profile

Trench 6 provides an ideal view of the natural soil profile along the southwestern aspect slope. So culturally undisturbed a view of the natural stratigraphy allows better comparison with cultural deposits, facilitates recognition of cultural deposits by their unique characteristics exclusive of natural features, and reflects how natural processes at this locality may have modified cultural sediments.

Figure 56 depicts both the general details of the north wall of Trench 6, as well as four detailed, 1.0 meter wide, soil profiles selected along the exposure. Unit 1 is a brown, granular to sandy silt loam that makes up the typical surface soil in this area (Appendix D: Table 9). Below an abrupt contact with Unit 1, Unit 2 is a strongly structured, blocky to prismatic, red clay paleosol remnant common under many surface silts in the Tosawihi area. This clay rests on Unit 3, a kaolinitic weathered tuff bedrock which grades into unweathered rhyolitic tuffs below. Variation of this general profile along the trench illustrates the dynamic nature of the slope.

Soil thickness reflects slope dynamics and the nature of the underlying bedrock. Unit 3, the weathered bedrock, is of fairly uniform thickness over tuff but thins markedly over opalite (compare Profile B to Profile D). Clearly, natural weathering has penetrated deeper into the softer, more porous tuff. Opalite bedrock occurs at three locations in the trench: near the west end of the profile, between the 3.0 and 4.0 meter marks where it appears to be an isolated bed, and finally near the 23 meter mark and beyond to the end of the trench where it occurs more extensively (and where quarrying activity was more intense).

The Unit 2 clay soil is thinnest and most disturbed, or nonexistent, on top and upslope of opalite bedrock, and thickest, retaining its blocky to prismatic ped structure, just downslope of the opalite. The Unit 1 silts are also thickest just downslope of opalite bedrock.

These patterns suggest that erosion and slopewash had their greatest effects upslope of opalite, while deposition and perhaps slope stability was greatest just downhill. Although no detailed studies of ongoing natural slope processes have been attempted here, these patterns suggest that differences in water infiltration and resulting variations in slopewash intensity are constrained by the presence of porous versus non-porous bedrock and by changes in slope gradient due to bedrock variation. Soil creep is operating on this slope as well, evidenced by a downslope 'bending' of the upper portions of the prismatic peds in Unit 2.

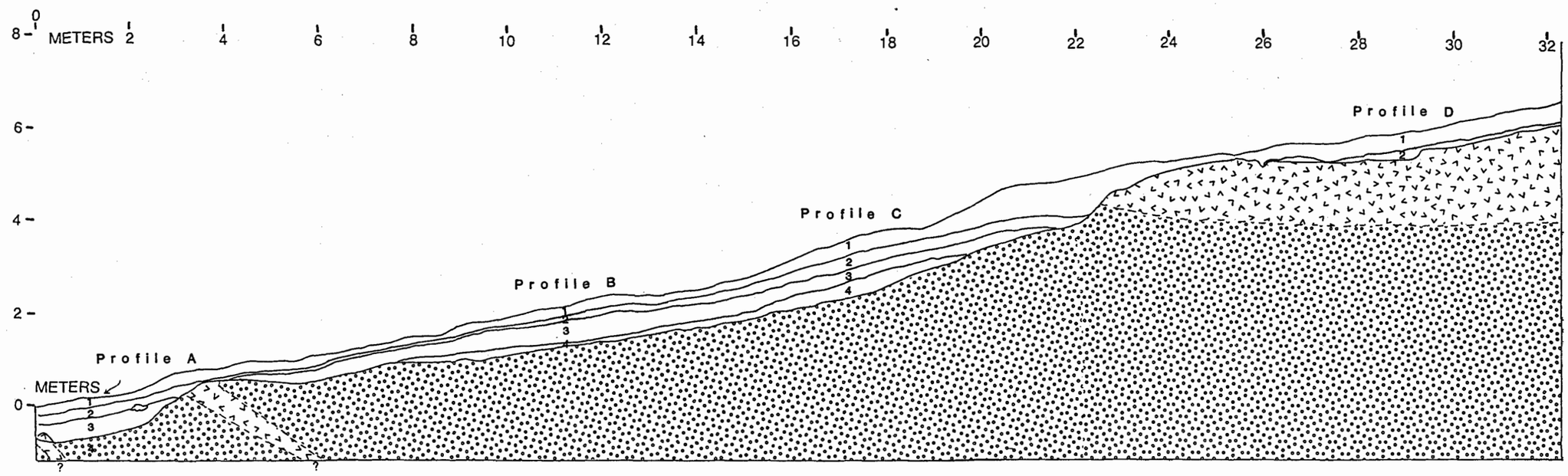
Stratigraphy of Quarry Area A

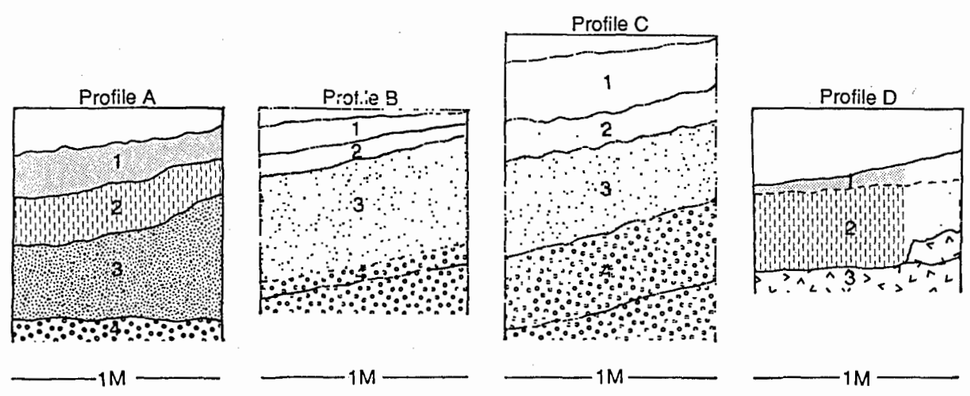
Features 71 and 72 (Figure 57) are among the largest quarry pits at Locality 36; too, they are the deepest from the surface, with well developed berms. They lie on the eastern margin of a cluster of more shallow pits traversed by the dirt track through the site. Inadvertent blading of the track in 1989 leveled many of the pits in this group prior to mapping. Three backhoe trenches in Quarry Area A (1, 2, and 7) were excavated to explore the subsurface character of Features 71 and 72 (as well as the smaller Feature 73 that lay between them) and examine the deposits below the leveled road (cf. Figure 55; Figure 57). Trench 1, running northwest-southeast, cuts Features 71, 72, and 73. Trenches 2 and 7 are more or less perpendicular to Trench 1. Trench 2 bisects Feature 72 and extends southwest across the road. Trench 7 begins at the western margin of Trench 1 in Feature 71 and also extends across the road. These trenches expose silt-rich quarry deposits and provide an exceptional view of the bedrock topography resulting from quarrying in a Type 3 setting.

Figure 58 shows the east wall of Trench 1 as it cuts through Features 71 and 72. The uppermost layer of bedrock is up to 95 cm of chalky tuff. Overlying the tuff are patches of sandy clay paleosol up to 25 cm thick. This paleosol has a granular structure and apparently has experienced considerable reworking from bioturbation (rooting and faunal activity); silt fills krotovina between the paleosol and the tuff bedrock, and within the soft tuff itself. Overlying the tuff and paleosol is up to one meter of brown sandy silt loam. The profile also clearly shows that Features 71 and 72 were excavated through as much as 130 of silt, clay paleosol, and tuff bedrock to reach opalite. Quarry deposits consist of lithic debris from the quarrying of chalky tuff and thinly bedded to massive whitish gray opalite, often mixed with silt by bioturbation and infiltration.

Silt depth averages around 50 to 60 cm at the east end of Trench 2 (Figure 59), but is as much as 2.4 meters deep in pit-like structures in the chalky tuff bedrock created by sagebrush roots. Bedrock cavities created by roots at first were interpreted as "failed" quarry pits, abandoned before reaching toolstone. The rooted areas are distinguished from quarry pits, however, by silty fill lacking quarried lithic material, by their location in generally soft tuff bedrock, and by the presence of bedrock segments detached and uplifted from the main bedrock surface by roots. The fill of Feature 71, for example (cf. Figures 60 and 61), exhibits abundant weakly bedded lithic debris, and was excavated into hard opalite bedrock.

Similar stratigraphy is displayed in all the profiles of Quarry Area A. At the surface is an extensively bioturbated unit comprised of silt with opalite flakes and chunks. Below this lie sediments more easily recognizable as individual depositional units. Some are silt-rich, moderately bedded to poorly sorted or jumbled units with abundant chunks, flakes, and chips of opalite and tuff. Others are moderate to poor open frameworks of opalite chunks and flakes, or are hash-like, with a predominance of fine to medium opalite and tuff chips in a slightly clayey





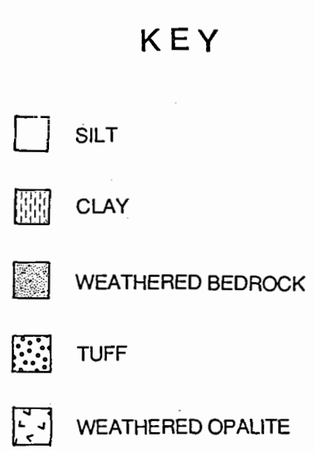


Figure 56. Trench 6, north wall profile, Area A.

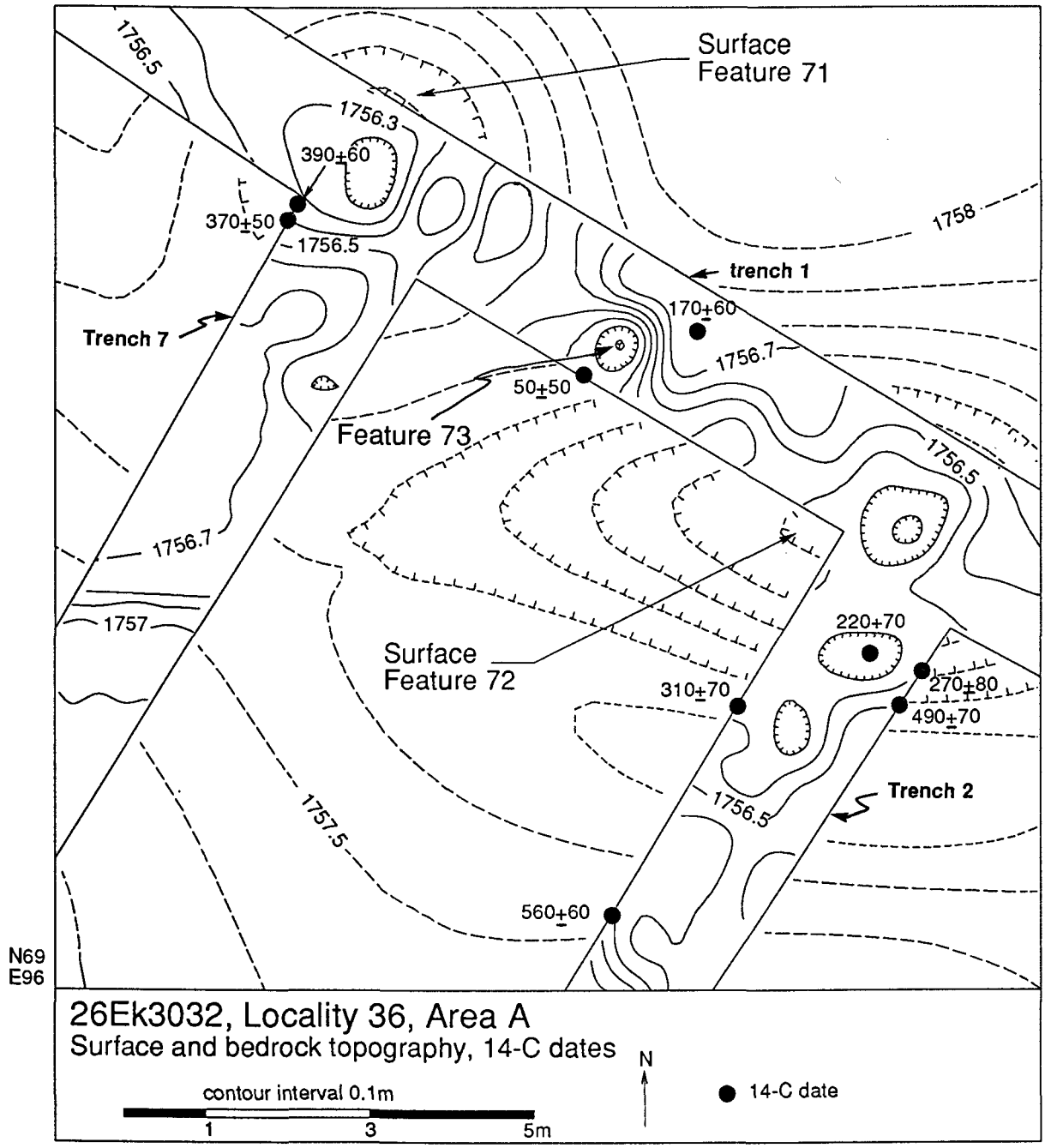


Figure 57. Surface and bedrock topography, Area A.

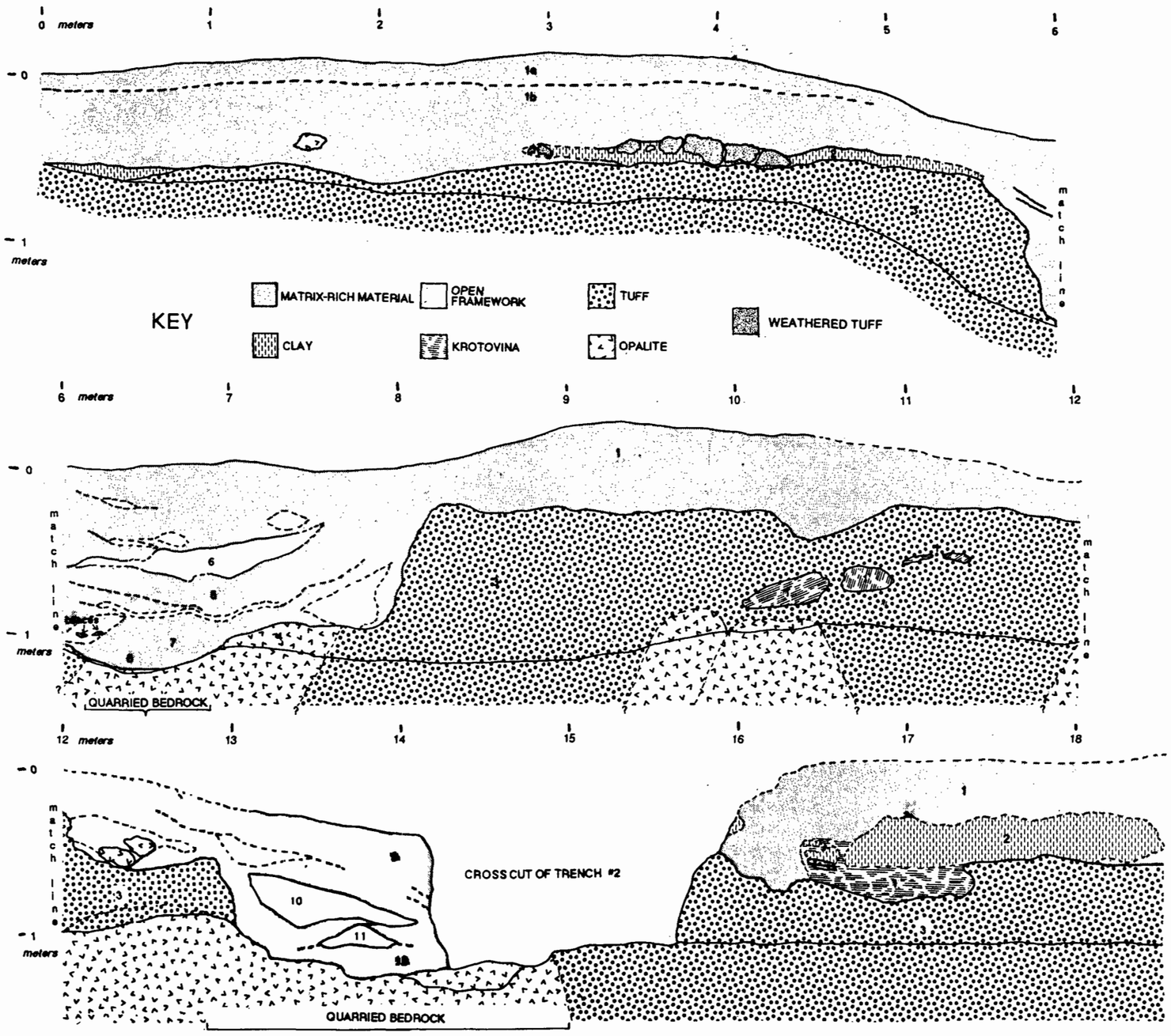


Figure 58. Trench 1, east wall profile, Area A

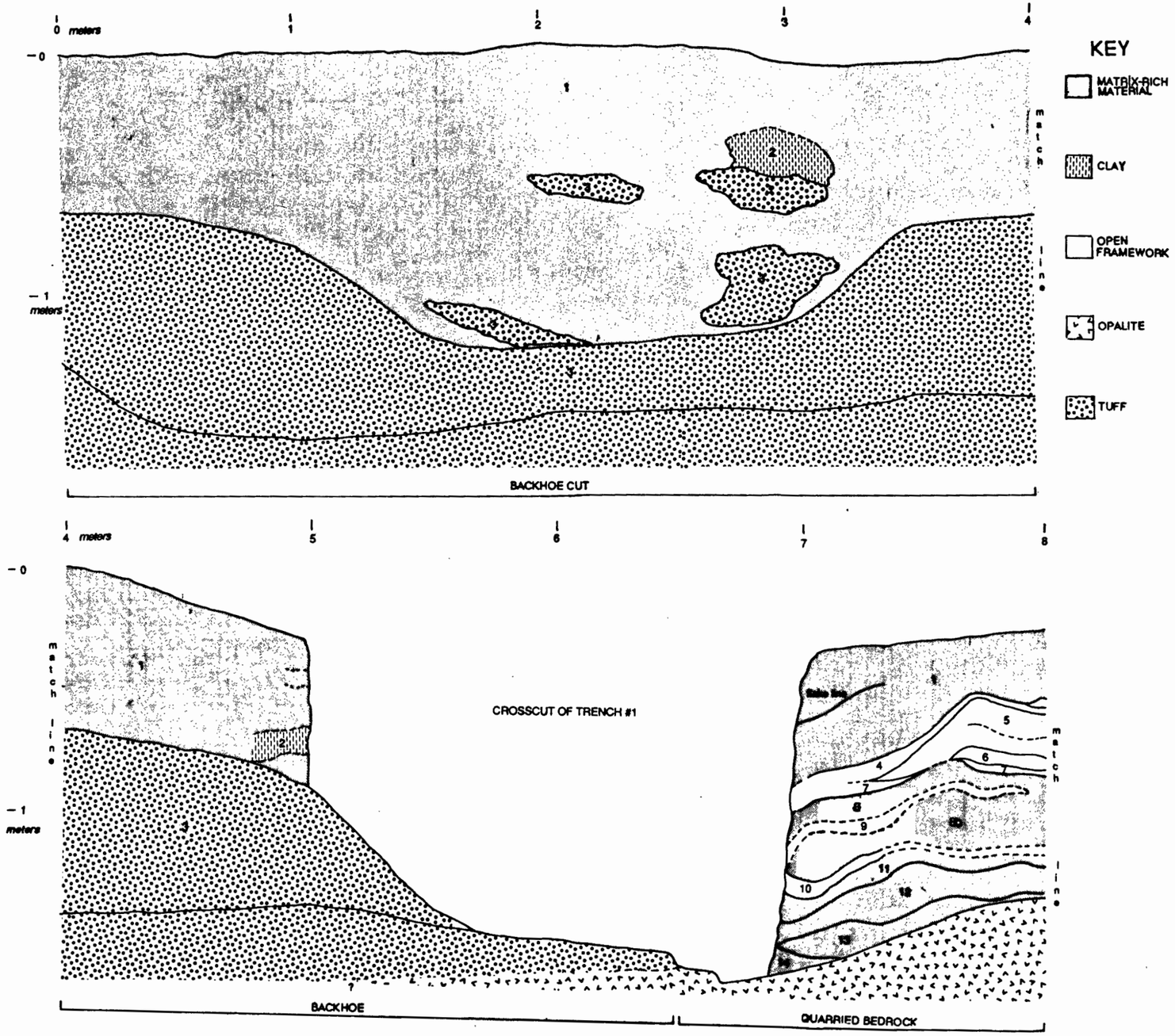


Figure 59. Trench 2, south wall profile, Area A.

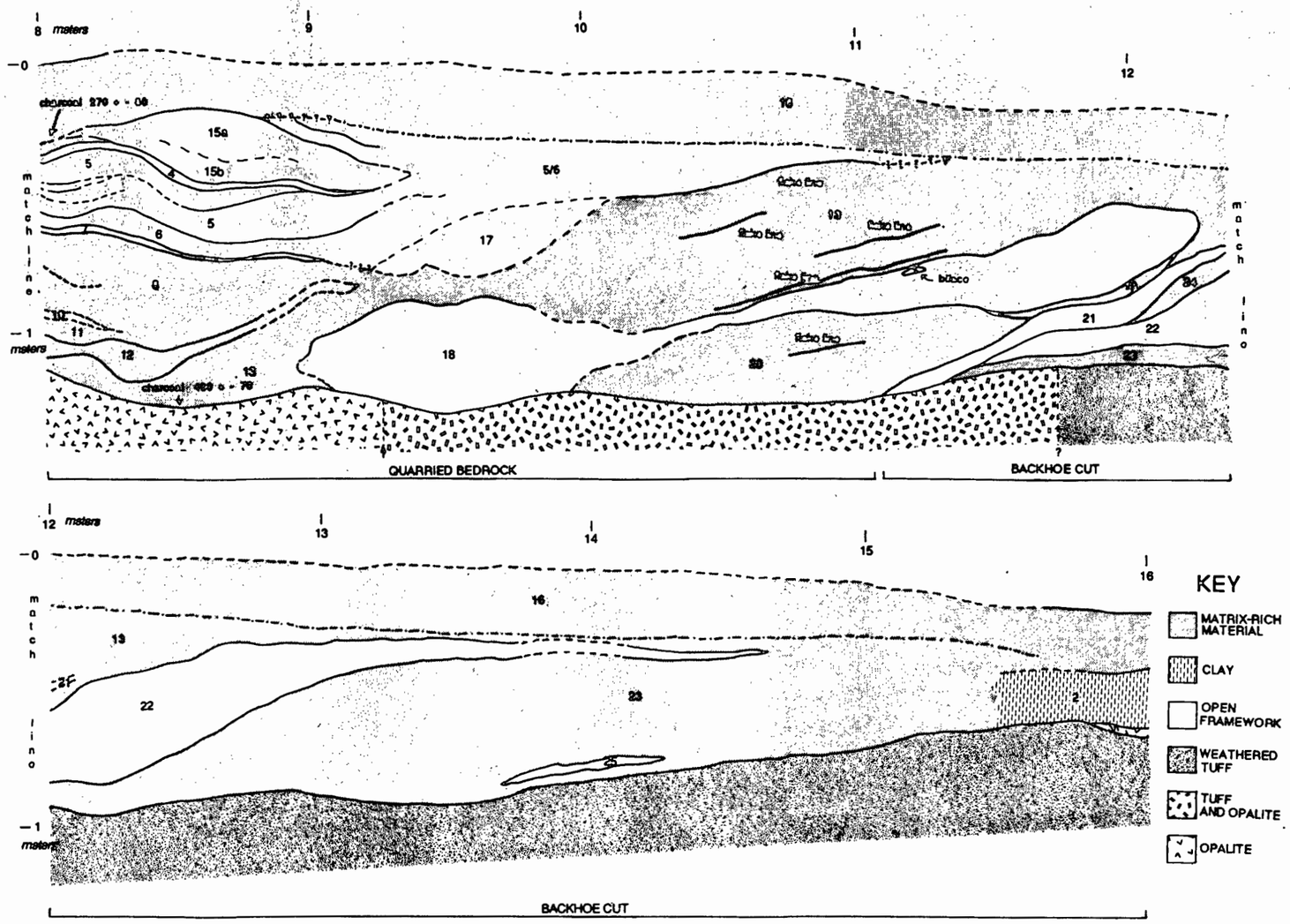


Figure 59, continued.

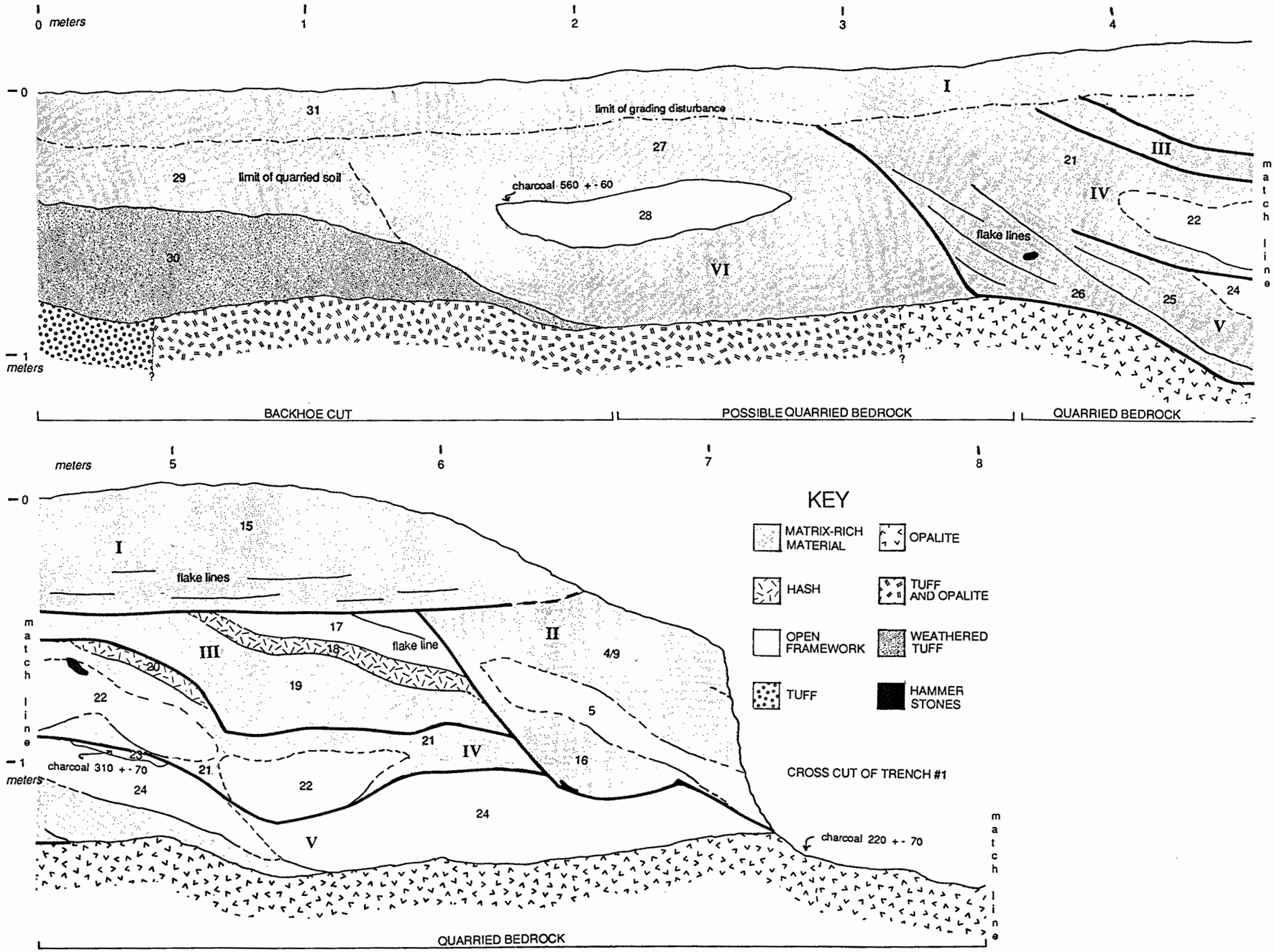


Figure 60. Trench 2, north wall profile, Area A.

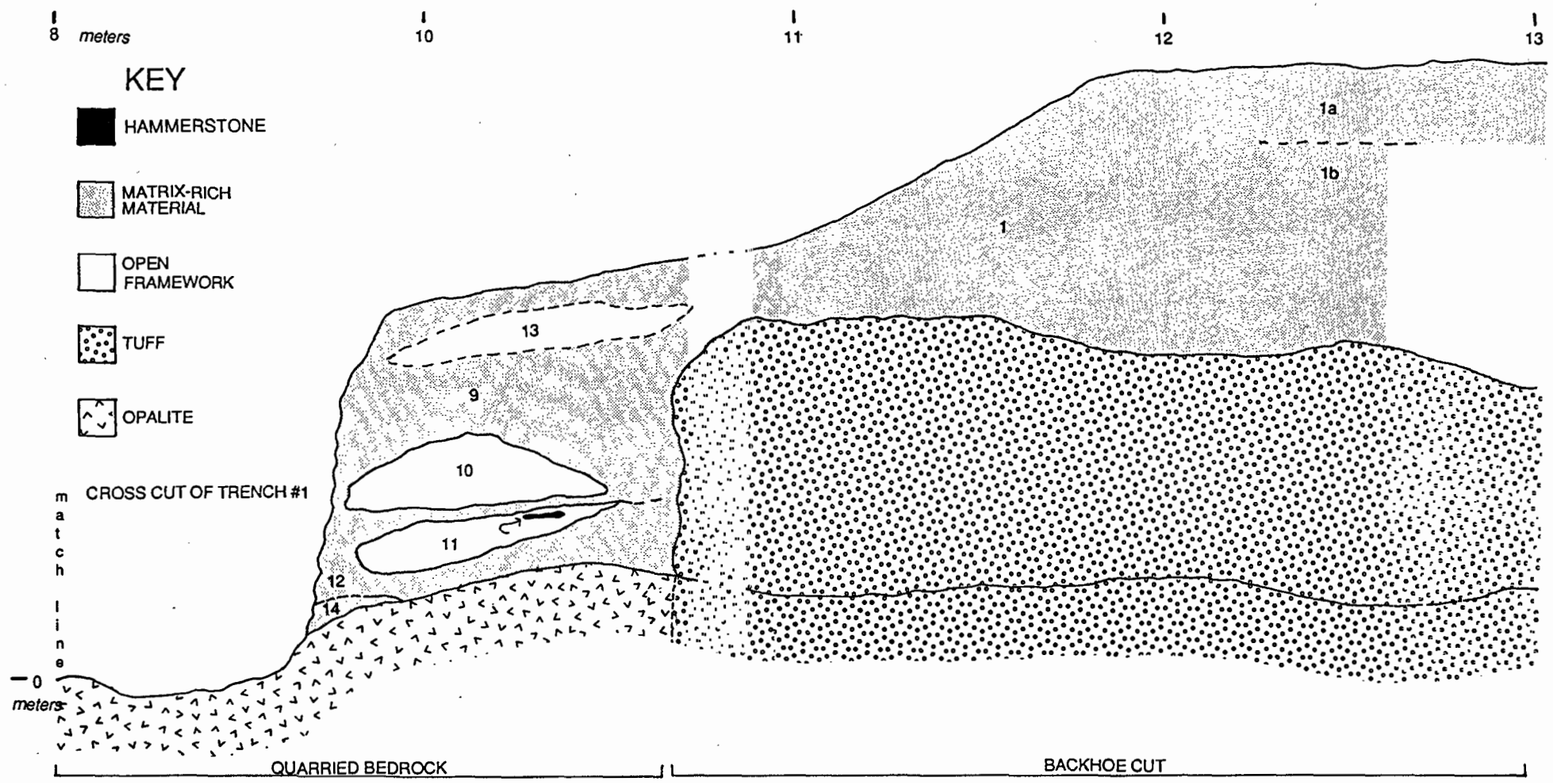


Figure 60, continued.



Figure 61. Silty quarry debris filling quarry pit in tuff, intersection of Trench 1, east wall and Trench 2, north wall, Area A (compare with Figure 60). Debris is resting on opalite; eastern pit margin is tuff.

sandy matrix. Nearest bedrock, units generally are well compacted with abundant hash-like matrix supporting opalite flakes and opalite and tuff chunks. Some slopewash units, such as Units 19 and 21 in the north wall of Trench 2, are present as well. Bone and antler artifacts (a *Bison* thoracic spine and a *Cervis* antler hammer/wedge) were recovered from coarse openwork deposits (Figure 62, Unit 17, west wall of Trench 1; Figure 63, Unit 12, south wall of Trench 7), where they probably were preserved by the inability of such sediments to retain water. Lenses of charcoal, found in all types of sediments, may represent fire setting as a quarrying technique, or may reflect warming hearths; all radiocarbon dates were obtained from such deposits.

Toolstone extraction in Quarry Area A appears to have been accomplished by digging down and laterally into the slope of the ridge to remove soil and tuff over opalite, then working downward into relatively small pits in the bedrock (cf. Figure 62), utilizing or creating joints and cracks in the opalite, isolating opalite segments by removing the surrounding tuff, or by following natural joints filled by more brittle secondary opalite. Since trenching revealed no adits in Quarry Area A, the presence of charcoal is perhaps less likely to represent fire setting, which seems to work best under an overhang or to weld tuff matrix. The increasing depth of soil and tuff overburden in an easterly direction is revealed most dramatically in the Trench 2 profiles (cf. Figures 59 and 60) and the east profile of Trench 1 (cf. Figure 59) that show the eastern margins of Features 71 and 72.

The presence of relatively intact clay paleosol over bedrock six meters (Trench 7) to 12 meters (Trench 2) west of Features 71 and 72 marks the western margins of quarrying in Quarry Area A. The morphology and orientation of strata suggests that quarrying started on the west, in the area now occupied by the road, where soil overlying bedrock was perhaps only 40 cm thick. The profiles of Trenches 2 and 7 (cf. Figures 59 and 60; Figures 63 and 64) through quarrying debris, clearly show the tendency of most strata to dip, and of most truncation surfaces to slope, down to the east, suggesting a succession of quarry pits and debris infilling eastward into the crest of the ridge.

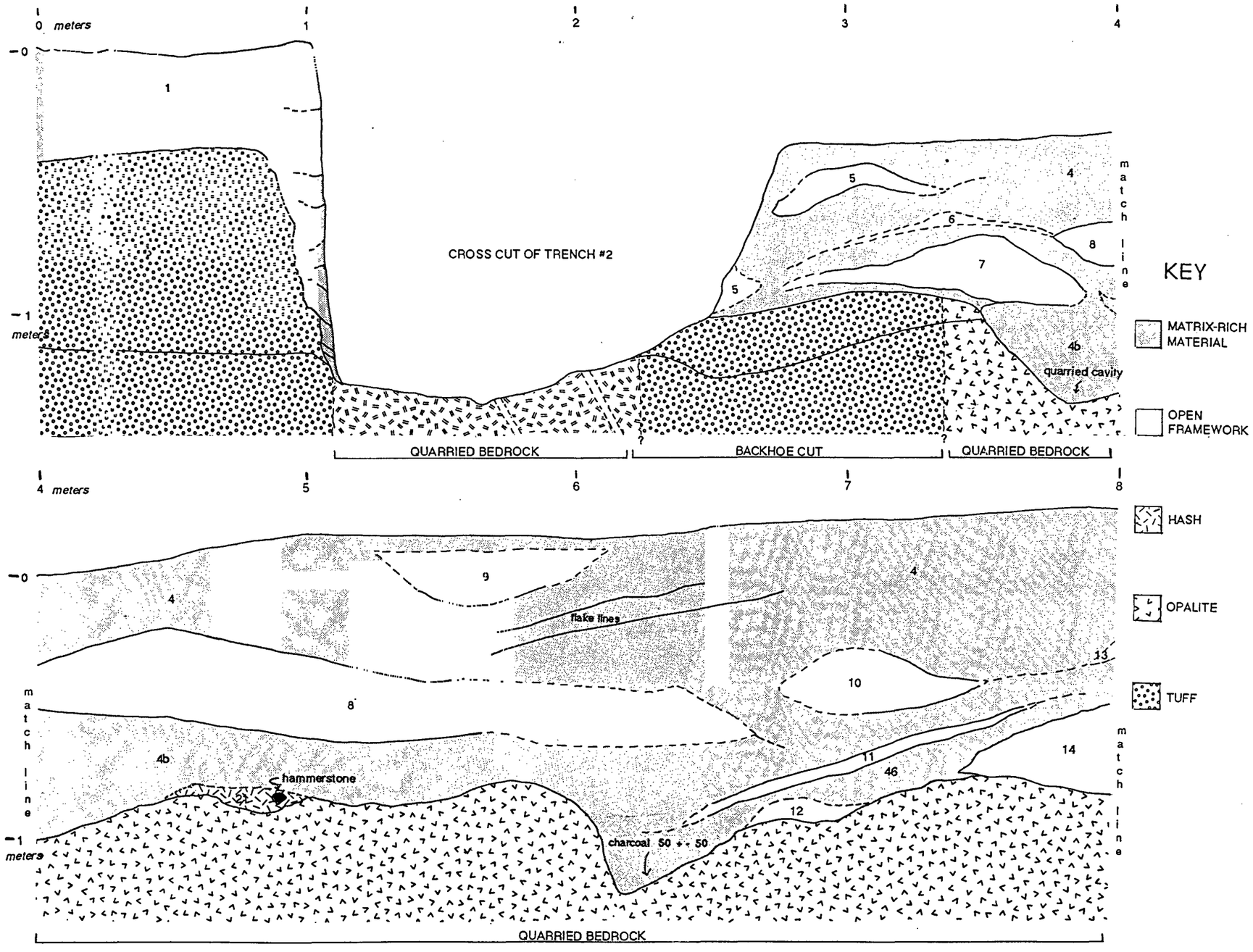


Figure 62. Trench 1, west wall profile, Area A.

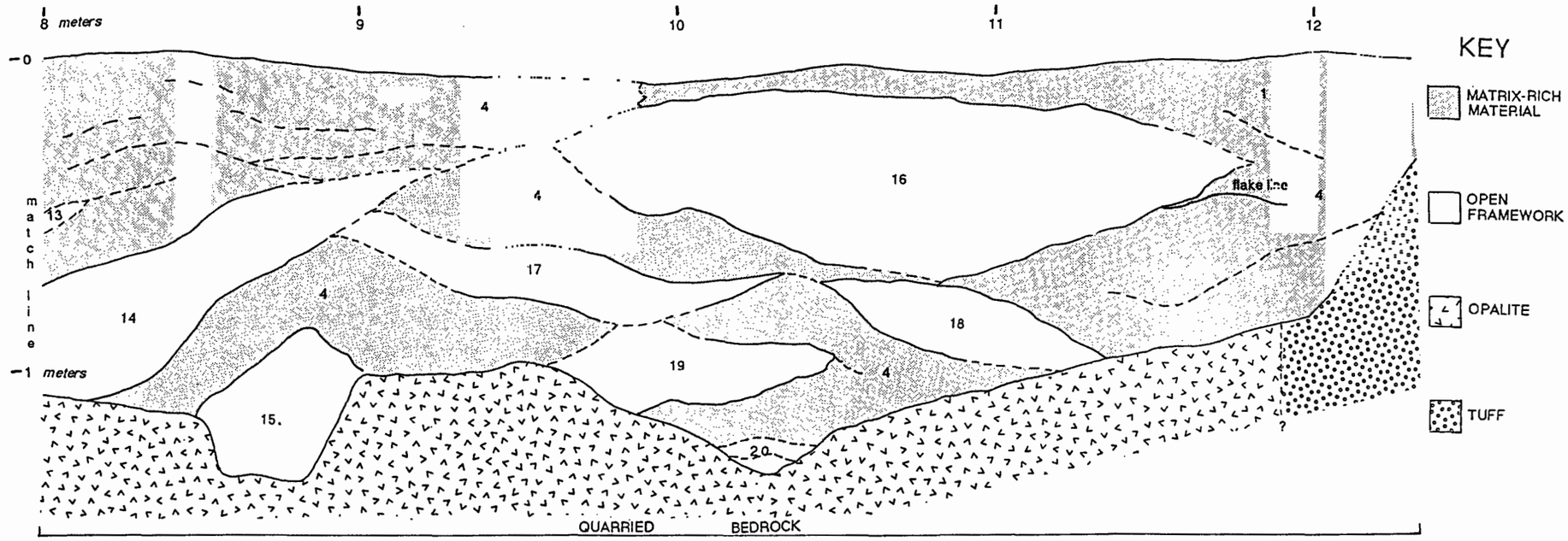


Figure 62, continued.

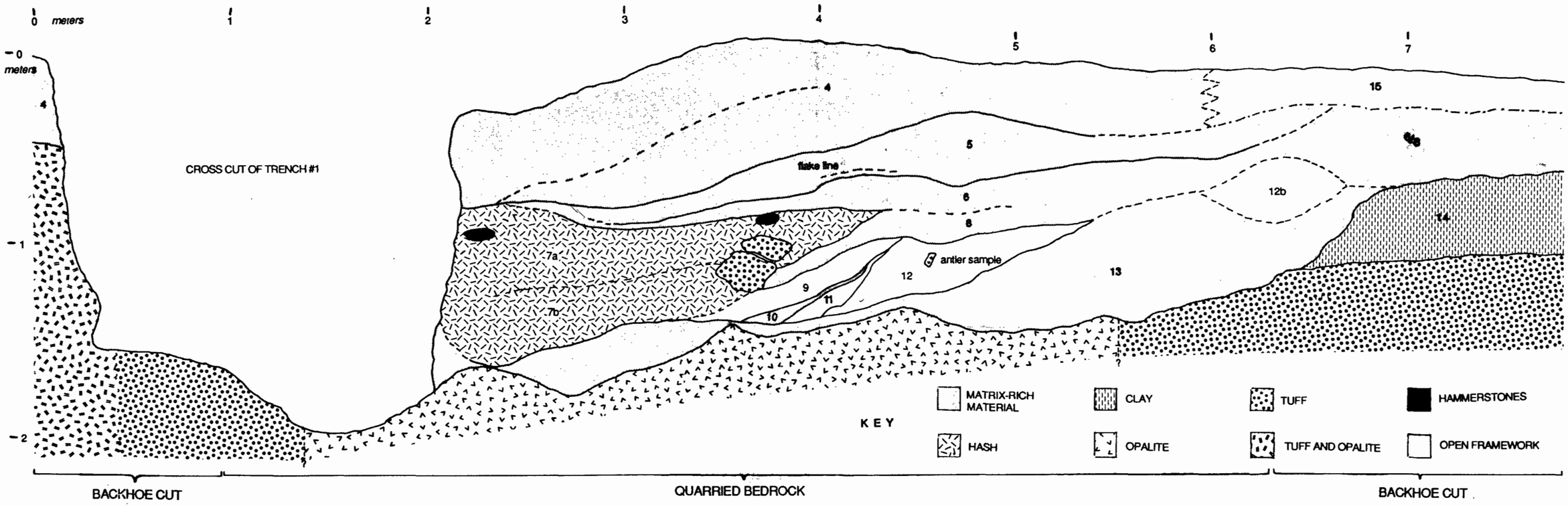


Figure 63. Trench 7, south wall profile, Area A.

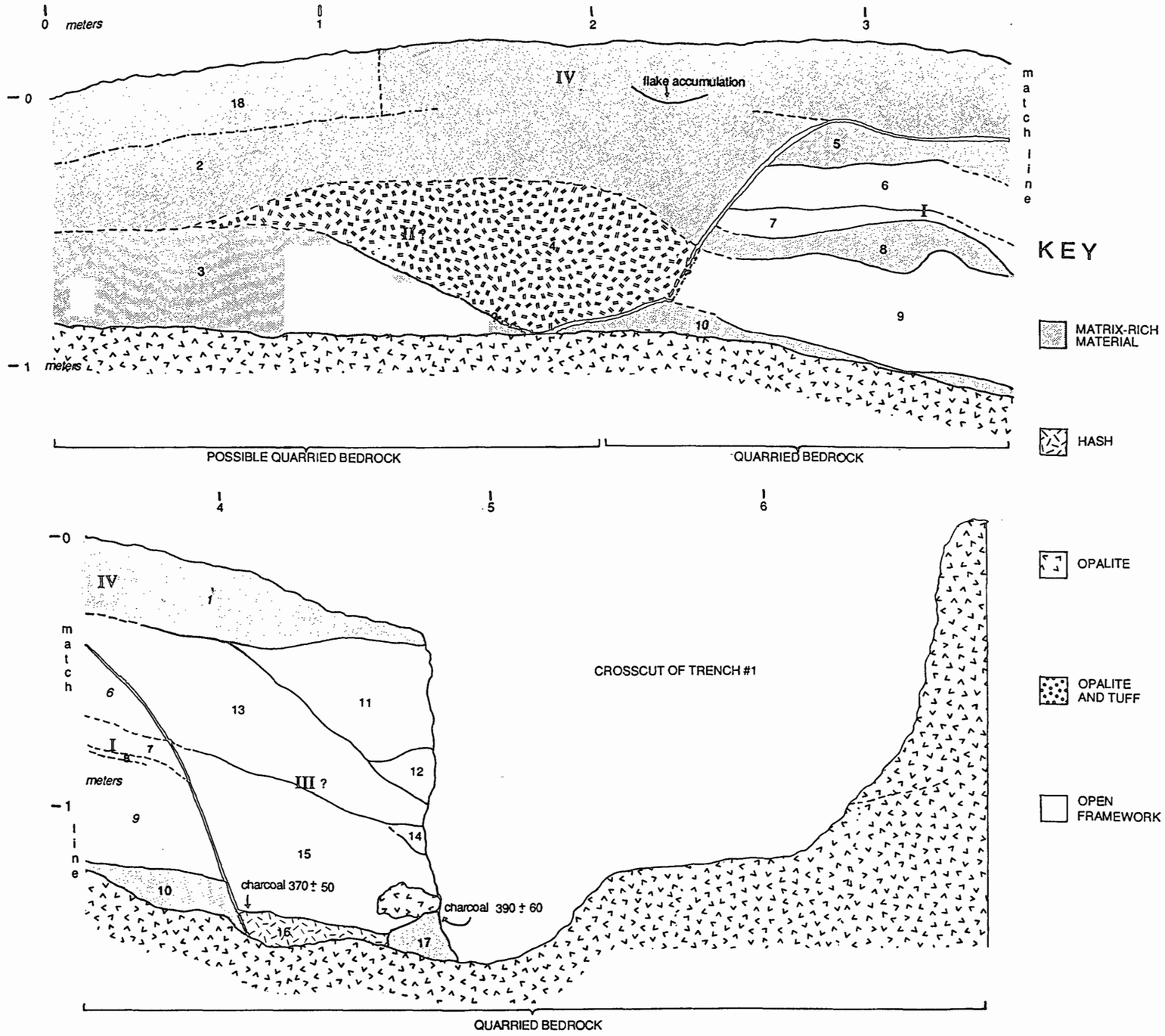


Figure 64. Trench 7, north wall profile, Area A.

Although the stratigraphy does suggest some lateral progression of quarrying perpendicular to the slope, there was a strong preference for quarrying eastward into the slope of the ridge. Indeed, this tendency probably accounts for the paucity of major stratigraphic breaks indicated by debris slumping, or truncation of earlier deposits, that makes it difficult to group Quarry Area A stratigraphic units into horizons. For instance, there are no obvious truncation surfaces in the south wall profile of Trench 2 (cf. Figure 59), and only one stratigraphic unit (Unit 12) is truncated in the south wall profile of Trench 7 (cf. Figure 63). In the north wall profile of Trench 7, however, at least six depositional horizons are apparent. Horizon I deposits (Units 5, 6, 7, 8, and 9) are truncated and overlain by Horizon II deposits (Units 11, 12, 13, 14, 15, 16, and 17) filling Feature 71, while Units 2 and 4 may represent a third horizon filling a pit west of Feature 71, not visible on the surface.

The most distinct series of horizons are seen in the north wall profile of Trench 2 (cf. Figure 60). A truncation surface cuts Units 30 and 29 of the pristine soil profile. Overlying this surface, the oldest cultural deposits, Units 28 and 27, comprise Horizon VI, dated by radiocarbon to 560±60 B.P. (BETA 43155). Horizon VI, in turn, is cut by a truncation surface and overlain by Units 26, 25, 24, and 23 (the latter, a charcoal lens) of Horizon V. The radiocarbon assay of charcoal from Unit 23 produced a date of 310±70 (BETA 42477). Units 20, 21, 22, and 24 comprise Horizon IV. The boundary between Horizons IV and V is relatively indistinct and based more on the steeper dip of Horizon V strata (compared to those in Horizon IV) than to actual truncation of Horizon V units. Horizon III contains Units 19, 18, and 17. Unit 19 truncates Units 20 and 21; weak soil-like development in Unit 19 may be due to incorporation of silty sediment developed during the break in deposition which occurred between the deposition of Units 21 and 19. Horizon II Units 16, 5, and 4/9 comprise the last fill of Feature 72. These overlay a truncation surface created by re-excavation of Feature 72 that cuts Units 17, 18, and 19 of Horizon III and Units 21 and 24 of Horizon V (Figure 60). Unit 16 of Horizon II was partly composed of debris slumped from Units 17, 18, and 19. Finally, Units 17, 18, and 19 of Horizon III and Units 16 and 4/9 of Horizon II in turn were truncated along their upper surfaces and overlain by Unit 15, comprising Horizon I.

The tendency toward eastward expansion of quarrying in Quarry Area A is further supported by radiocarbon dates that, in Trench 2, are progressively younger to the east: 560±60 B.P. to 310±70 B.P. (BETA 42477) on the north wall, 490±70 B.P. (BETA 43154) to 270±80 B.P. (BETA 42153) on the south wall, and 220±70 B.P. (BETA 42156) on the trench floor near its east end. At the east end of Trench 7 in the north wall (cf. Figure 64), dates from Units 15 and 17 of 370±50 B.P. (BETA 42478) and 390±60 B.P. (BETA 42480), respectively, are similar to dates from Trench 2 in an analogous stratigraphic position. Although this suggests that quarrying may have shifted ten meters laterally over one hundred years or so, or that the exposed working quarry face was at least ten meters wide (the distance between Trenches 2 and 7) at one time, the following evidence suggests a third alternative.

Radiocarbon dates of 50±50 B.P. (BETA 42496; Trench 1 bottom, Feature 104) and 170±60 B.P. (BETA 42479; Trench 2 bottom, Feature 104) from the surface of the bedrock between Features 71 and 72 are the youngest obtained from Locality 36 and indicate late bouts of quarrying. They are overlain, however, by material from the berms of Features 71 and 72, so both features must, therefore, be even younger. The youth of these features is suggested further by the depth of the open pits and the well defined berms surrounding them; erosion and deposition have not been long at work on them. Surface morphology suggests that Feature 72 is the younger, and this is supported somewhat by the stratigraphy of the east wall profile of Trench 1 (cf. Figure 59) where strata tend to dip southerly. Perhaps, then, the strategy in Quarry Area A was to work in two pits simultaneously; either could be expanded toward the other in case of a good toolstone strike, thus decreasing search time.

Stratigraphy of Quarry Area B

Quarry Area B is located on the upper reaches of the moderate, southwest-facing slope below the ridgecrest (cf. Figure 55); it was sampled by Trenches, 4, 5, 10, and 11 (Figure 65). The upper silt unit is thinner than in Area A, but the red clay paleosol is thicker where it has not been disturbed by quarrying. Quarrying has scoured the bedrock in Area B deeply, particularly in the vicinity of Trenches 5 and 10. The depth of deposits overlying bedrock therefore increases from 50 cm at the north end of Trench 4 to 180 cm at the south end of Trench 10. Although a Type 3 quarry setting (bedrock parallel to the ground surface) may have underlain the northeastern portion of Area B, a Type 2 setting (slope intersecting bedrock) seems likely for most of the area. In any case, quarrying sooner or later transformed nearly all of Area B into a Type 2 setting.

The slope of strata exposed in the south wall profile of Trench 11 (Figure 66) suggests that quarriers tended to work progressively into the slope here as they did in Area A. An adit excavated into the soft tuff below a layer of opalite about 25 cm thick is located at the north end of Trench 11 where it is intersected by Trench 4 (cf. Figures 65 and 66). A line parallel to the upper slope of the opalite layer intersects the surface about 5.5 m west of the adit and about 1.5 meters east of the point the slope begins to become steep. This suggests that the opalite layer once lay in a Type 2 situation at or near the surface at the break in slope, and has been worked back to its present position. The alignment of pits to the south indicates this strategy prevailed over several meters along the lateral extent of the same opalite bed.

The west wall profile of Trench 4 clearly displays the thickening of sediments over bedrock toward the south (Figure 67). At the extreme north end of the trench, the soil is typical of the Tosawihi area (Figure 68); essentially undisturbed by quarrying, it is comprised of 20 to 40 cm of brown to gray silt with an abrupt lower contact over 20 to 40 cm of reddish clay paleosol possessing well developed structure with blocky to prismatic peds overlying tuff and opalite bedrock. The vertical peds and the tendency for bedrock clasts to be detached and transported upward into the overlying soil through shrinking and swelling of the clay are well illustrated in Figure 68. In addition to natural bedrock casts, the clay often contains some quarry debris (tuff or opalite chunks, or opalite debitage) incorporated, either by bioturbation or by partial disturbance and mixing from quarrying. Further south along Trench 4, disturbance of the natural soil profile becomes more intense. The number of individual stratigraphic units increases along with the amount of quarry debris they contain. Although little or nothing remains of the clay paleosol, the clay and silt content of the matrix in Area B remains high.

Trench 4 was cut through an intersecting series of small pits visible on the surface that suggested alignment along the edge of a bedrock feature (running roughly northwest to southeast). Signs of quarrying are evident in the bedrock of the trench bottom as small pits, battered working surfaces, and minor adits, producing a scoured bedrock surface (Figure 69).

Trench 5 intersects the extreme southern end of Trench 4, cutting thick, lithic-rich quarry deposits overlying massive, whitish-gray opalite exposed near the east end (Figures 70 and 71). Extensive bedrock quarrying has resulted in a stepped exposure of opalite and tuff, sloping up to the east. The upper step is approximately 0.8 meters high, forming a face of nearly pure massive opalite. Figure 70 shows the small adit driven into the foot of the bedrock step that is not apparent in the south wall profile of Trench 5 (cf. Figure 71). An exposure of bedrock similar to that exposed in Trench 5 also includes a small adit at the south end of Trench 10 (Figure 72), suggesting that both are part of the same quarried face (now buried by debris to the east) and possibly extending as well to the north and south of the two trenches.

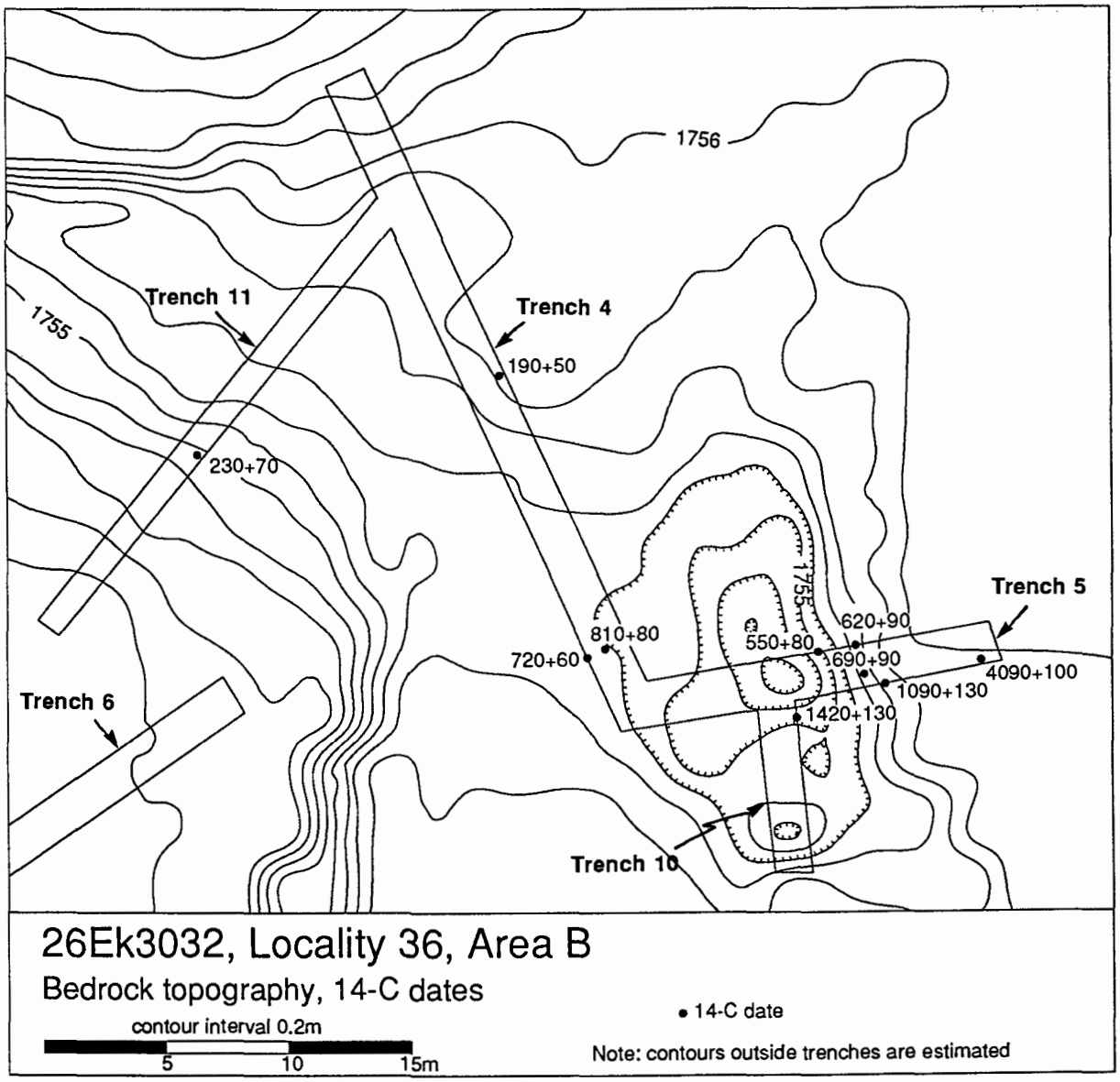


Figure 65. Surface and bedrock topography, Area B.

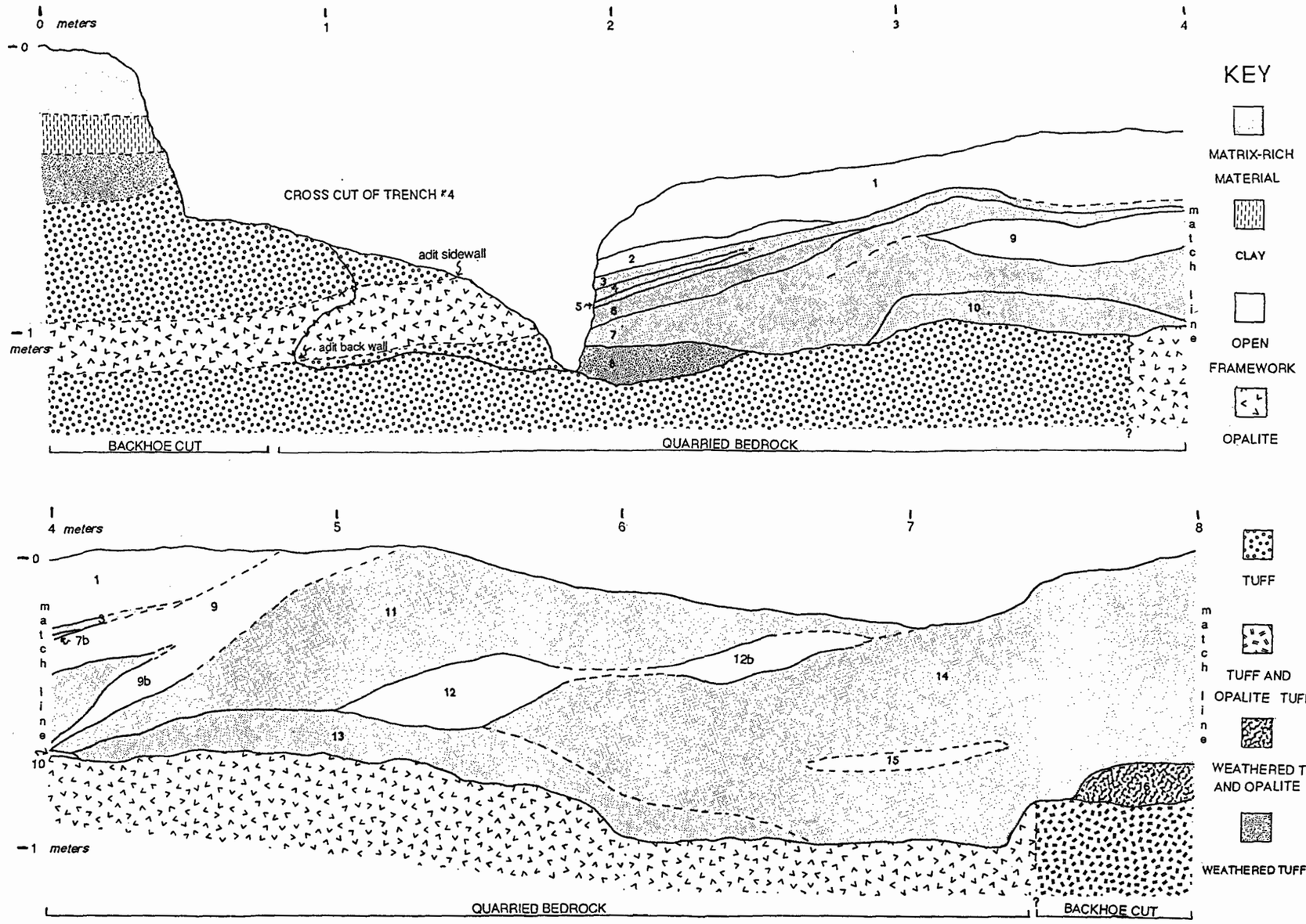


Figure 66. Trench 11, south wall profile.

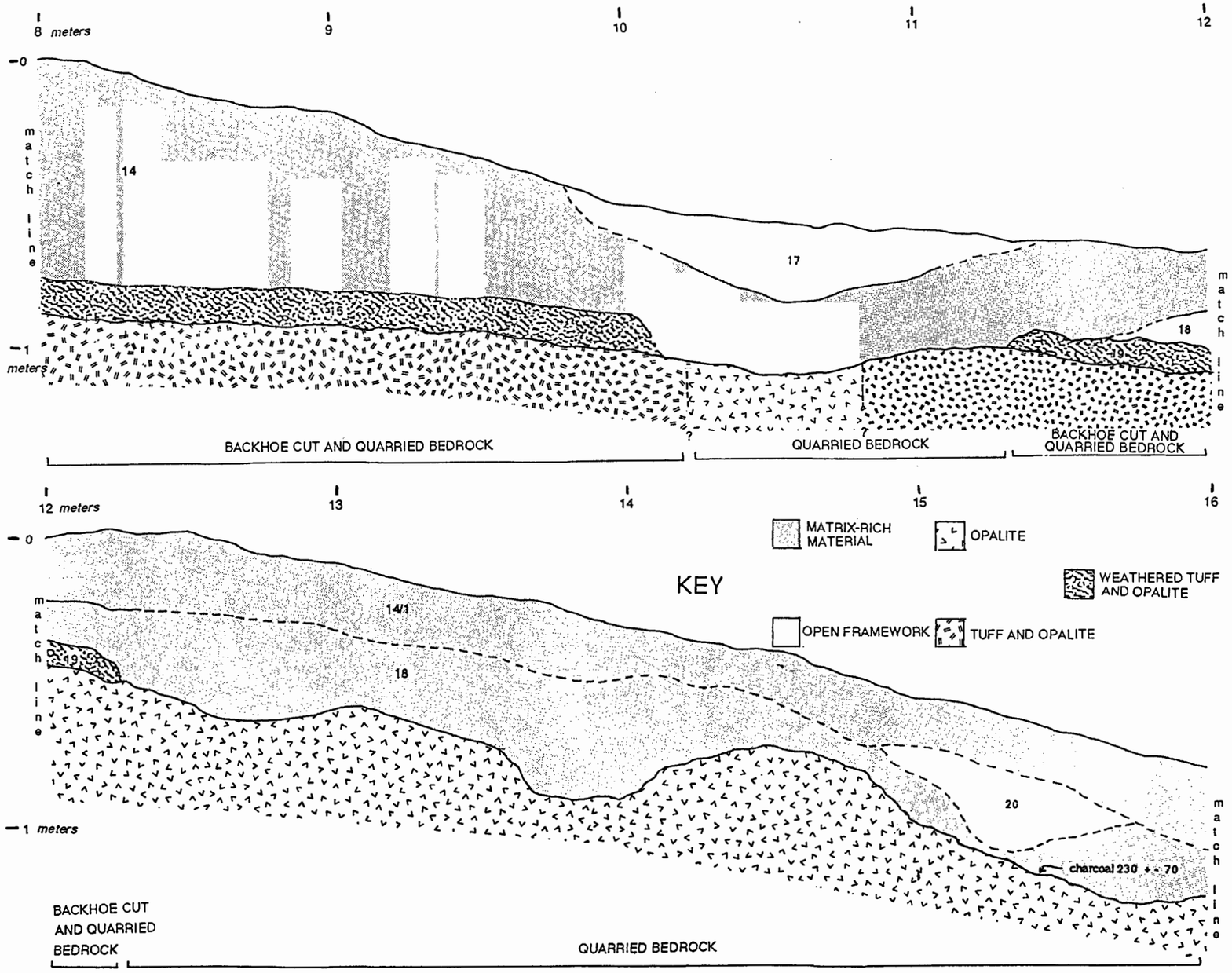


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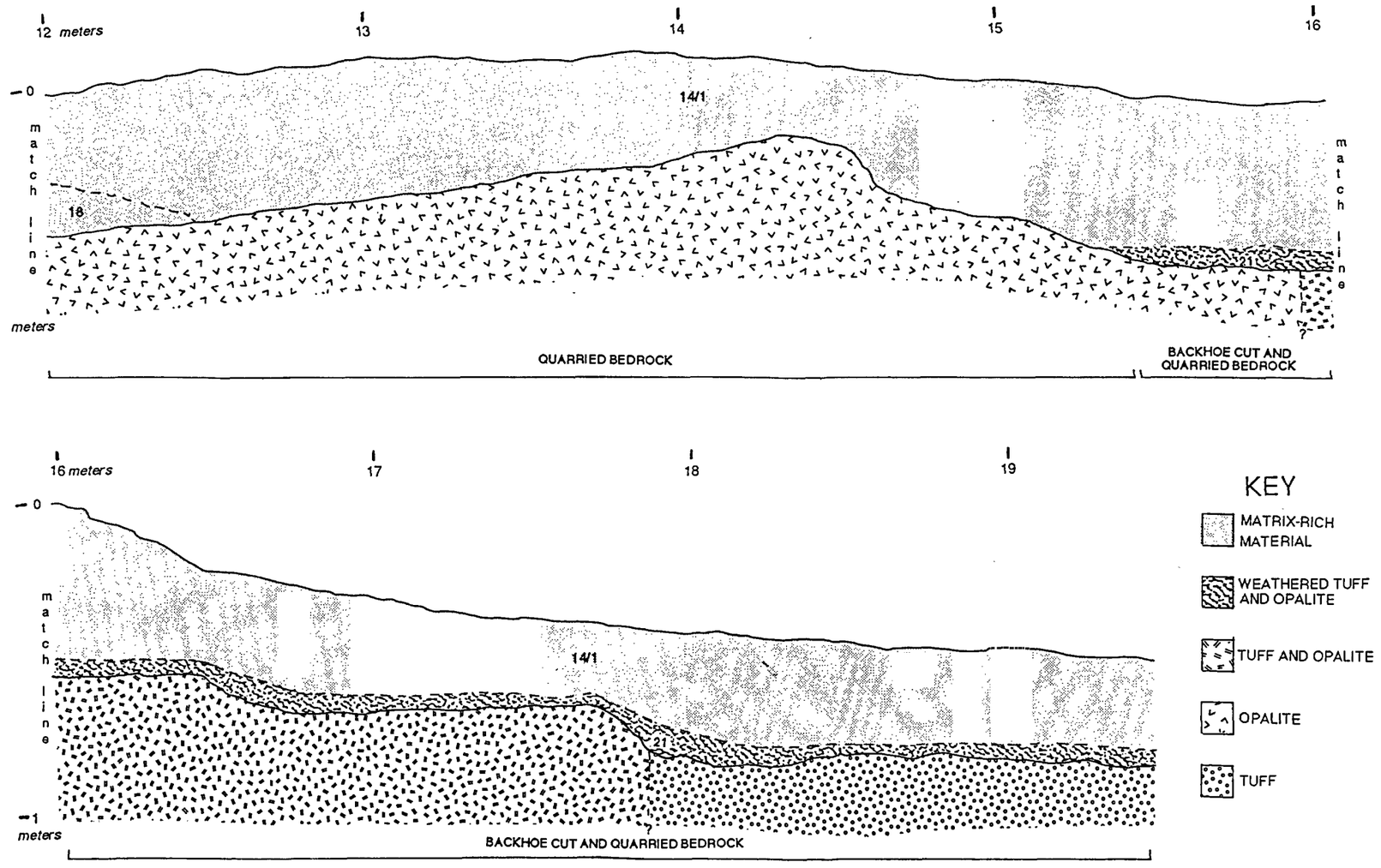


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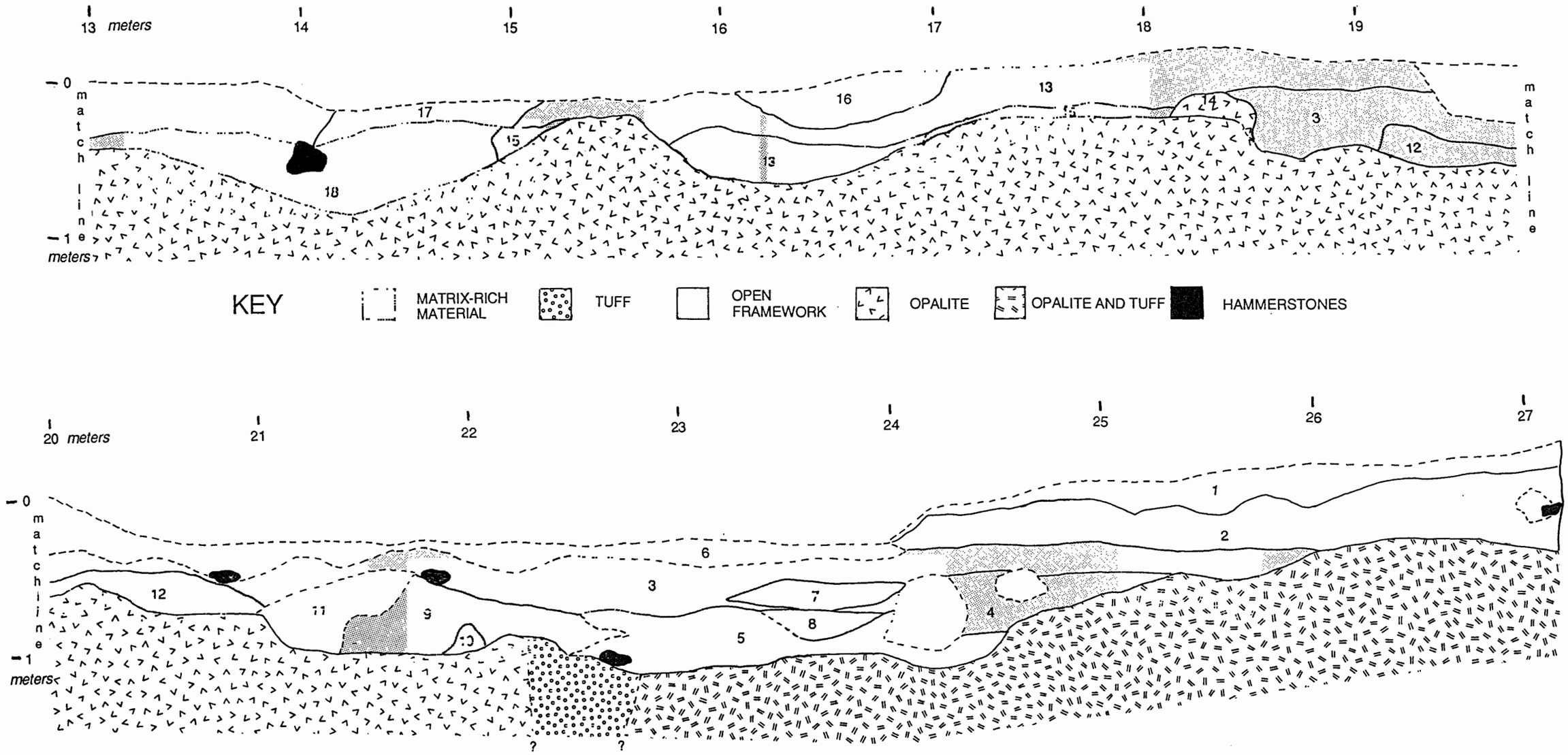


Figure 67. Trench 4, west wall profile, Area B.

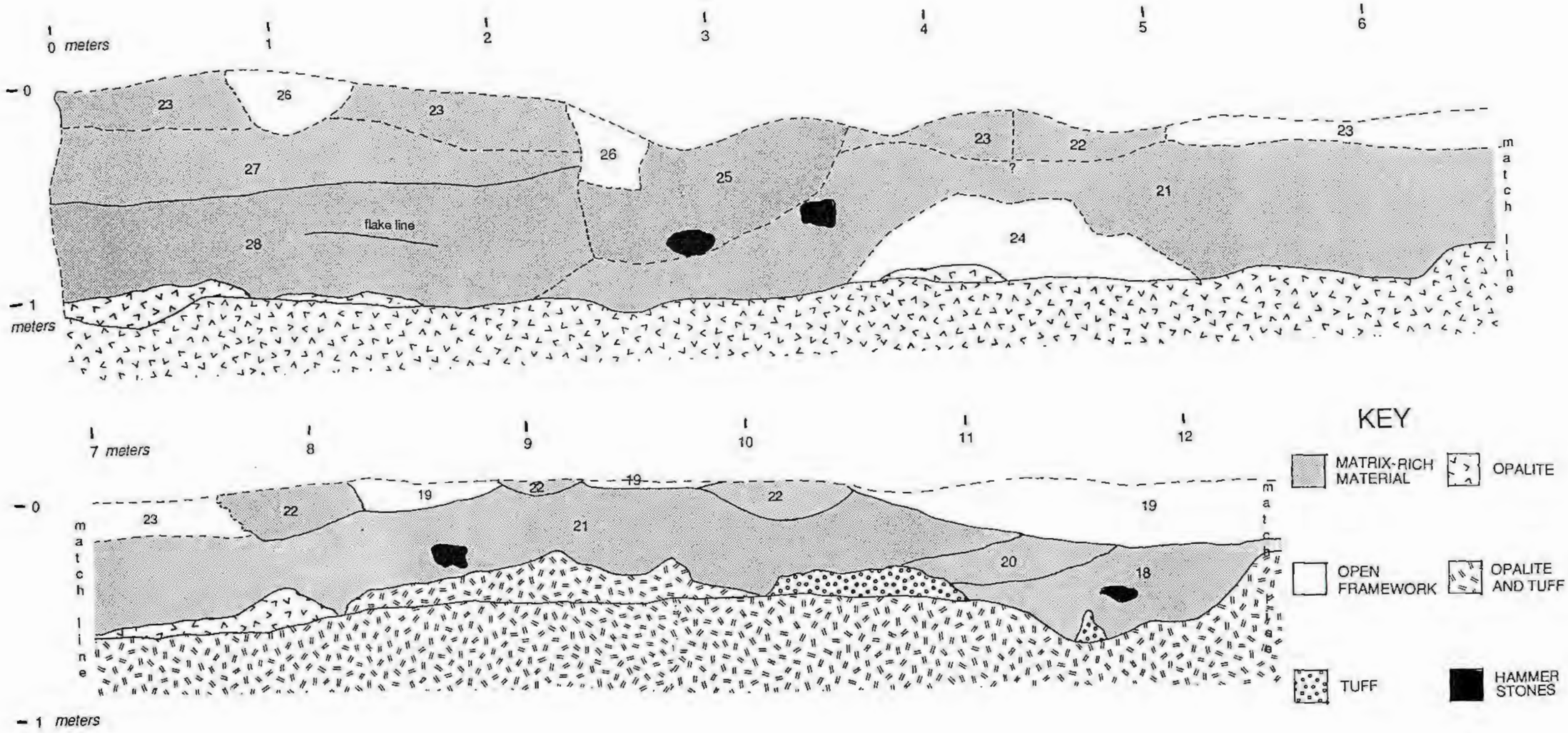


Figure 67, continued.



Figure 68. Weathered opalite bedrock and intact clay paleosol, Trench 4, north end of east wall.

The debris deposits of Trenches 5 and 10 were created by quarrying the massive face described above, with the result that all are dominated by opalite flakes and chunks with fewer tuff clasts than observed in Area A deposits (Appendix D: Tables 8 and 13). Area B deposits become more matrix-rich and more clay-rich towards the west end of Trench 5 where they are similar to the deposits encountered in Trench 4.

The exposed strata in Trenches 5 (cf. Figure 71) and 10 (cf. Figure 72) suggest a complex history in this portion of Area B, with multiple cycles of excavation, quarrying, waste disposal, pit filling, and re-excavation. The deposits of Trench 10 are similar to those of Trench 5, although somewhat richer in clay and silt. The more clay-rich character of the deposits exposed in Trench 10 and the lack of clear definition of a quarry feature at the surface suggests that the oldest deposits in Quarry Area B lie here. This is supported somewhat by radiocarbon dates, as discussed below.

The south wall profile of Trench 5 (cf. Figure 71), although interrupted by its intersection with Trench 10, shows that two pits were excavated into the bedrock floor. The east wall of Trench 10 (cf. Figure 72) intersects the east wall of the largest pit, ca. three meters wide at this point, with a flat bottom. A smaller pit, 1.8 meters wide with a more irregular bottom, occurs about 1.5 meters to the east; its eastern margin forms the high "step" in the profile mentioned previously (cf. Figure 70). Deposits here evidence abrupt, nearly vertical truncations of some strata, such as Units 6 and 7 by Unit 9, or Units 14 and 15 by Units 11 and 12. Other strata appear almost split, such as Unit 27 where it meets Unit 7. This configuration may owe to the slumping of the upper portion over the younger adjacent unit; more likely, there is an unrecognized stratigraphic break.

Although it is possible to group some strata into horizons, stratigraphic complexity is so great that it is difficult to order horizons in a meaningful way. For example, a stack of sediments (Units 52, 48, 46, 45, 40, 39, 38, 33, 31, 31a, 29, 28) that is convex upwards, represents the buried



Figure 69. Scoured opalite bedrock floor exposed in bottom of Trench 4, Area B (looking north). Note the increasing depth of overburden toward the viewer (south).



Figure 70. Stepped opalite bedrock floor exposed in bottom of Trench 5, Area B (looking east). East wall of large bedrock quarry pit with small adit below menu board (compare with Figure 71).

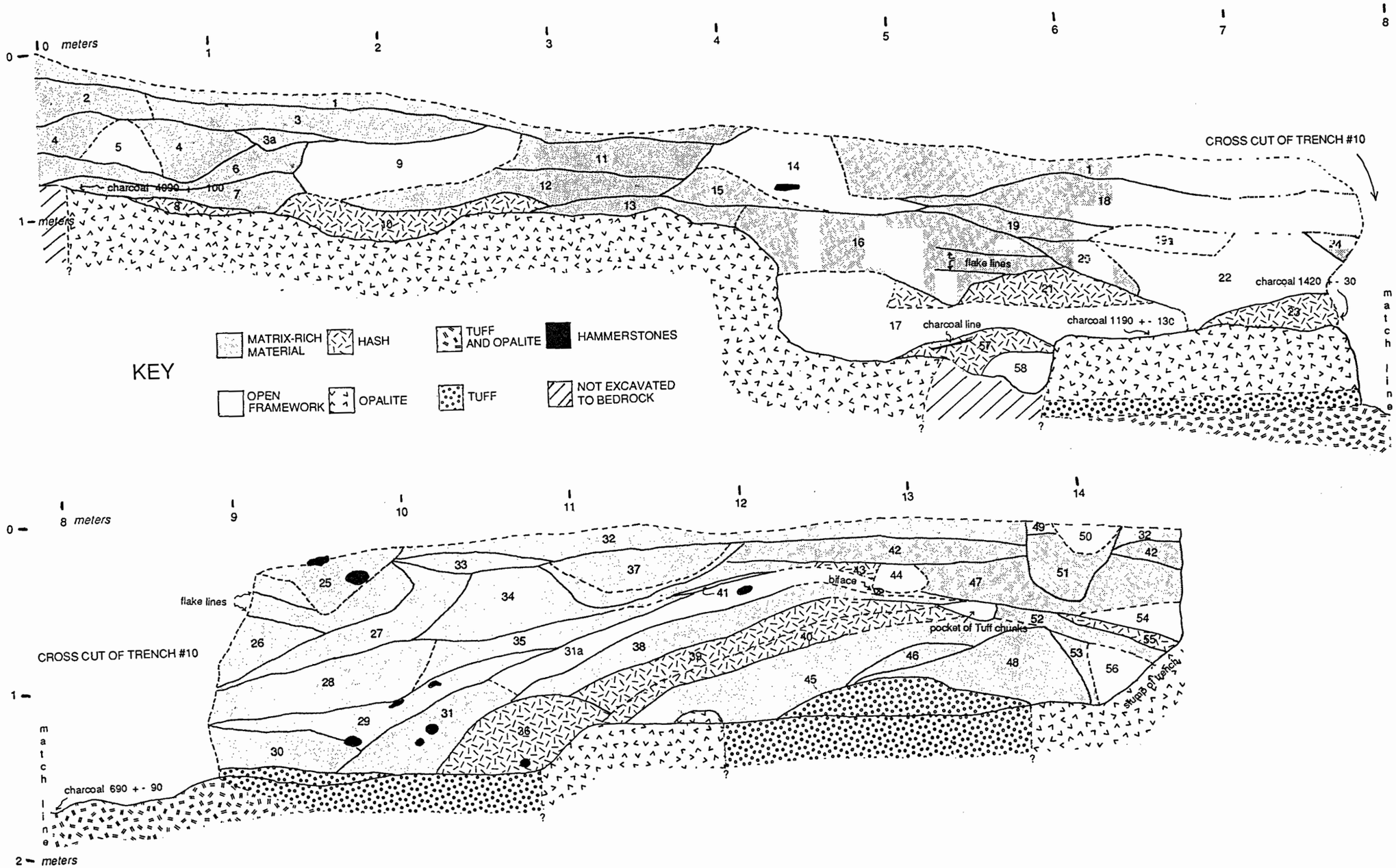


Figure 71. Trench 5, south wall profile, Area B.

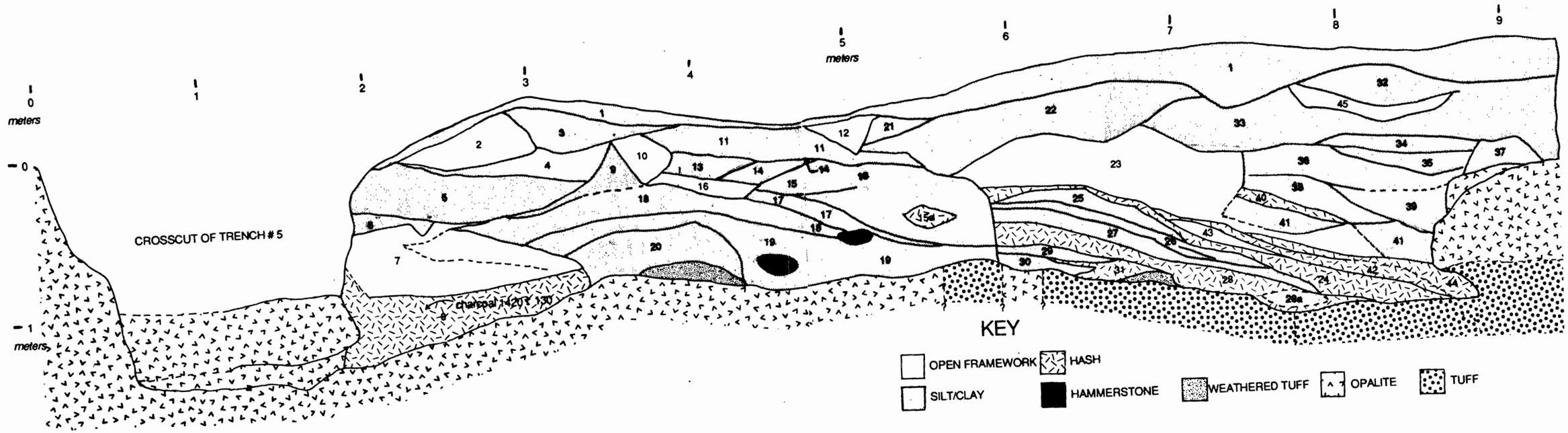


Figure 72. Trench 10, east wall profile, Area B.

berm of quarried debris excavated from the largest bedrock pit in the floor of Trench 5. This pit was subsequently filled with deposits (Units 30, 29, 28, 34) resting on its bedrock floor. A date of 690±130 (BETA 42486) was obtained from charcoal at the bottom of this pit, at the base of Trench 5. Another group of sediments (Units 61, 60, 17, 16, 15) are stacked into the easternmost bedrock pit. A radiocarbon date of 1090±130 (BETA 42495) was obtained from charcoal at the bottom of Unit 17, resting on bedrock between the larger and smaller pits; Unit 23 also rests on the same bedrock surface. Just around the corner of the intersection of Trenches 5 and 10, in the east wall of Trench 10 (cf. Figure 72), Unit 23 fills a small bedrock pit. Charcoal from the Unit 23 exposure was dated at 1420±130 (BETA 43160), making this the oldest dated pit-filling deposit. Nevertheless, the orientation of strata suggests that the excavation of the adit in the southern end of Trench 10, and its subsequent filling, occurred after the deposition of Unit 23.

Unit 8, a charcoal rich lens of hash resting on bedrock near the eastern end of Trench 5 (cf. Figure 71), contained charcoal, but not enough was collected for radiocarbon assay. Another charcoal sample was recovered from bedrock just 30 cm north of Unit 8 in the bottom of Trench 5. While we cannot be certain that this sample also represents Unit 8, it is likely that it does. In any case, the sample yielded the oldest radiocarbon (4090±100 B.P., BETA 42159) date from Locality 36. So old a date was unexpected; the shallow deposits overlying Unit 8 are divided into intercalated, truncated units suggesting no particular order or great antiquity.

The upper ten to twenty centimeters of deposits along Trench 5 consist of units more or less parallel to the present surface. They are, however, discontinuous, broken here and there by small pit excavations such as those filled by Units 37, 50 and 51 (cf. Figure 71).

While radiocarbon dates suggest a tendency for deposits in Area B to be younger toward the northeast (cf. Figure 65), stratigraphic relationships are less ordered, and suggest a less systematic quarrying strategy. This is particularly true in the vicinity of Trenches 5 and 10, where massive opalite bedrock seems to have offered a tempting target that was attacked whenever possible with adits, probably working back and forth along the quarried face. Re-excavation of old quarry waste was frequent, even though quarrying experiments have shown it to be a costly strategy. The concentration on lithic resources offered in the southern portion of Area B resulted in the large, scoured depression at the intersection of Trenches 5 and 10, the stepped bedrock slope to the east, and the welter of truncated and intersecting strata observed in the profiles.

Stratigraphy of Quarry Area C

The several quarry pits (Features 18, 47, 48, 49, and 50) of Quarry Area C are aligned roughly along the lower reaches of the moderate slope (cf. Figure 55). Area C was sampled by Trenches, 3, 8, and 9 (Figure 73). Trench 8 was cut through Features 48 and 49, perpendicular to the slope (Figure 74). Trench 3 was excavated parallel to the slope, beginning at the upper (eastern) margin of Feature 49, extending about 20 meters westward to cross Trench 8 and thence through the break between the moderate and steep slope (Figure 75). In order to expose the buried quarry feature discovered in the western portion of Trench 3 more fully, Trench 3 Extension was opened from the western end of Trench 3 in a 4.5 meter dogleg to the northwest, thence westward 30 meters down the slope; only the dog leg portion of the extension was profiled (cf. Figure 75). Trench 9 extends a few meters eastward from the Trench 8, but was very shallow and revealed nothing of stratigraphic interest, although it did help delineate the shape of the bedrock.

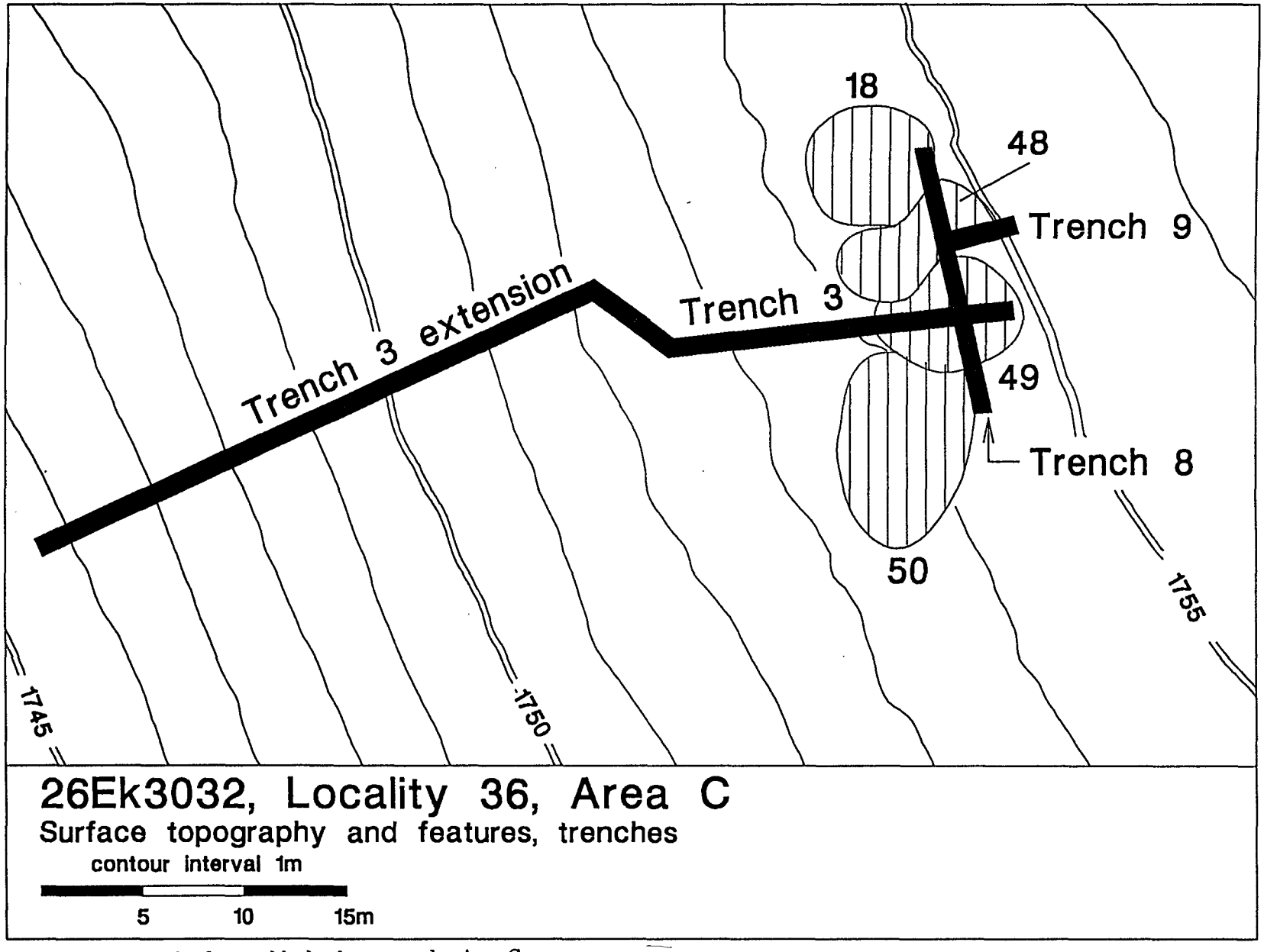


Figure 73. Surface and bedrock topography, Area C.

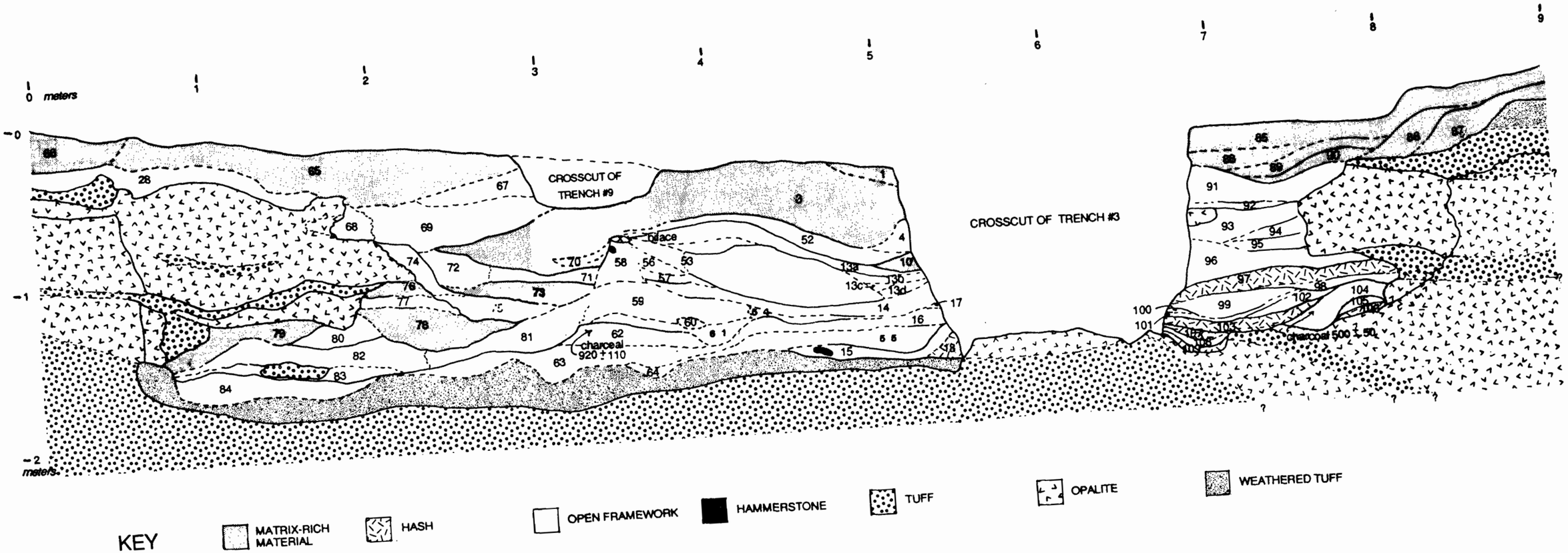


Figure 74. Trench 8, east wall profile, Area C.

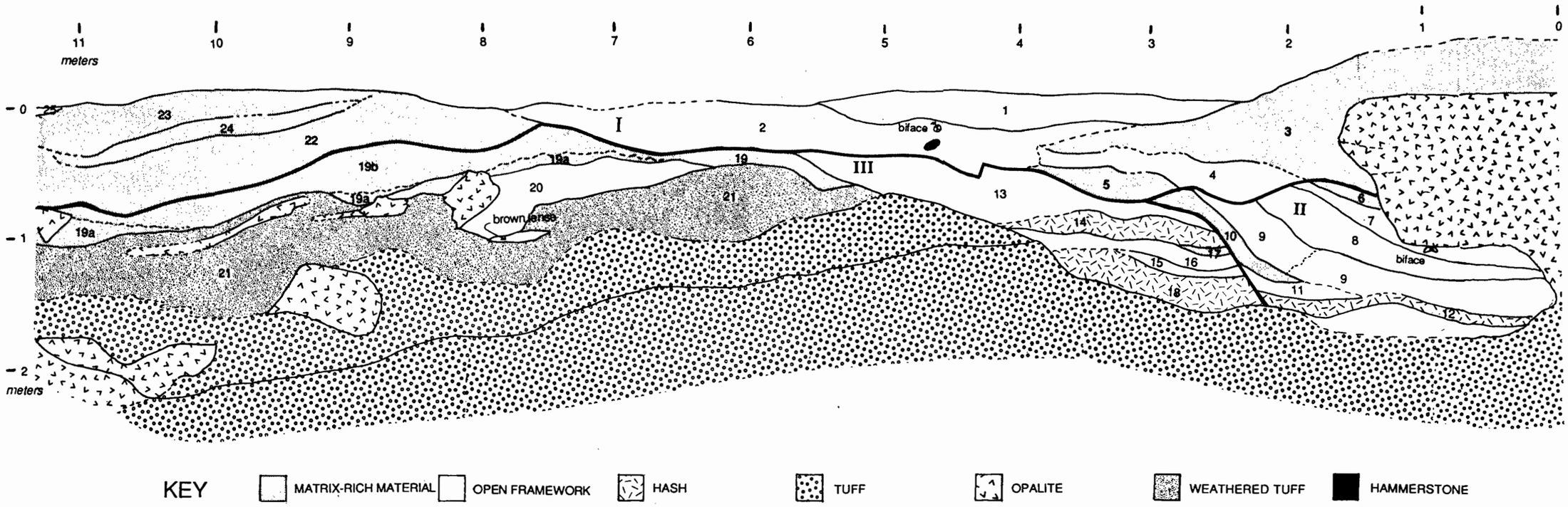


Figure 75. Trench 3 and Trench 3 extension, north and west wall profiles, Area C.

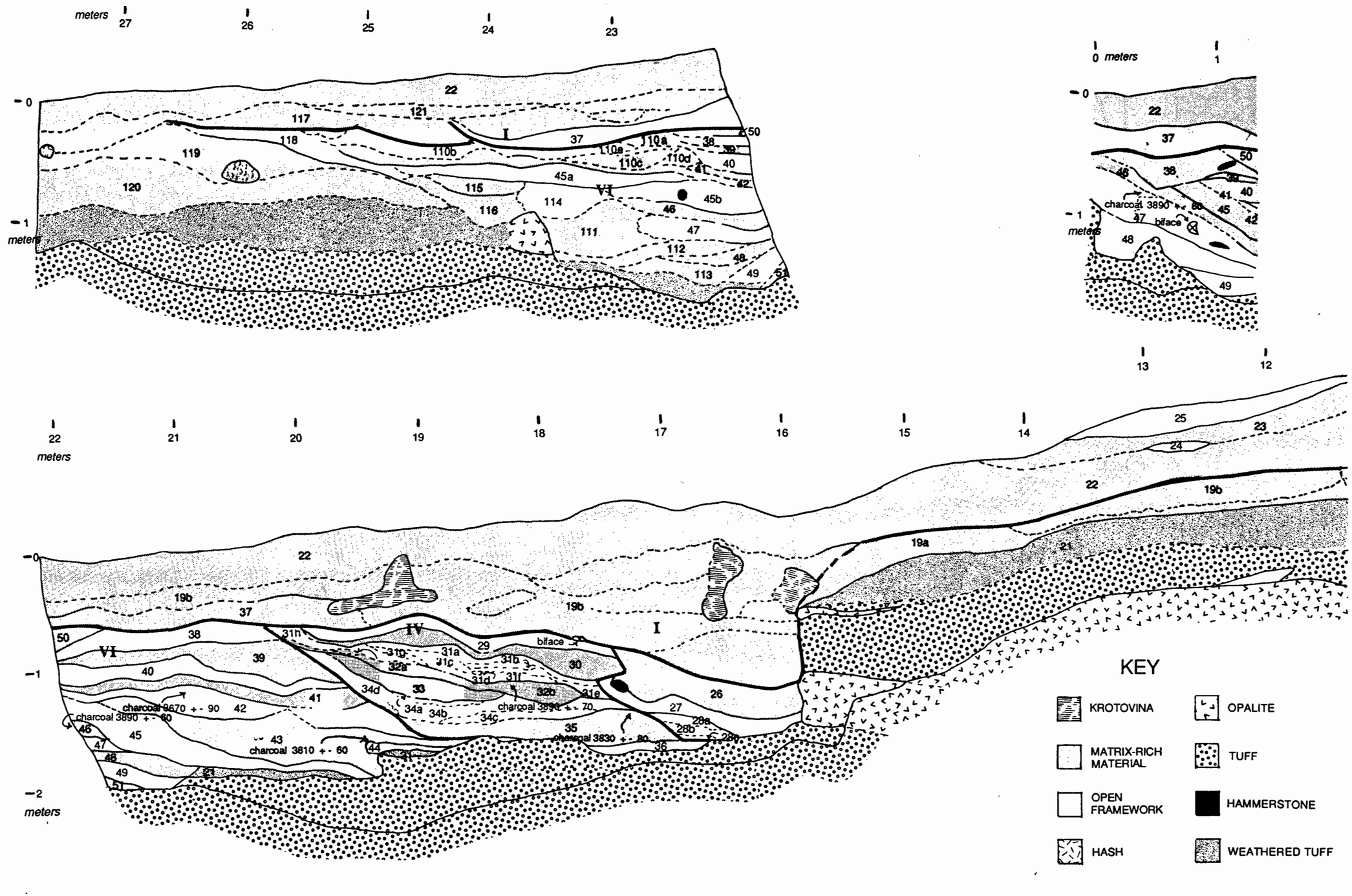


Figure 75, continued.

Bedrock Morphology and Stratigraphy

Bedrock morphology and stratigraphy in Area C is well exposed and quarrying strategies are revealed clearly. Trenching demonstrated that surface quarry pits are aligned along a bedrock face perpendicular to the slope. In Feature 49, quarrying by excavation of adits created an arcuate embayment (convex up-slope) about six meters wide, moving the bedrock face two or three meters eastward. The northern and southern edges of this feature are marked by bedrock exposed in Trench 8 (cf. Figure 74). Another arcuate embayment in the bedrock face to the north of Feature 49 is suggested by Features 48 and 47.

The bedrock face undermined by the adit in Feature 49 is apparently the lower edge of the opalite cap forming the ridge top, dipping down to the east. At the eastern end of north wall profile of Trench 3 (cf. Figure 75), the bedrock is comprised of alternating beds of opalite and tuff. The uppermost layer, 25 cm thick, is a vuggy, fractured, white to translucent opalite with patches of red and pink. Very little of this material was processed into tools. Beneath this lies 15 cm of tuff, below which is another bed of white opalite about 80 cm thick resting on tuff. This bed is the toolstone sought by the prehistoric quarries who created Feature 49. The adit visible in the eastern end of Trench 3 (cf. Figure 75, Figures 76 and 77) is presently one meter deep and one meter high at the entrance, narrowing to 40 cm high at its terminus, and would have required the quarrier to lie prone while working. It was apparently driven along a fracture zone (possibly a bedding plane) running through the middle of the opalite bed, removing the upper and lower tuffs to detach material from the roof as well as from the floor; roof material is of higher quality than that of the floor. The tabular basalt wedges found in Feature 49 debris (but nowhere else on the site; cf. Chapter 6) seem well suited for working the cracked opalite and soft tuff found here.

The tuff underlying the opalite of Feature 49 is at least 2 meters thick, containing lenses and large, boulder-sized nodular inclusions of white opalite with thin, swirling gray bands that is high quality toolstone. Between about 2.5 meters and 11 meters west of the present bedrock face, the tuff is overlain by 30 cm of sandy silty colluvium containing abundant opalite quarry debris and flakes. The upper 20 to 40 cm of the tuff is strongly weathered into angular fragments with clay skins. A pocket in the upper surface of tuff filled with clay (Unit 20) is probably a relict patch of the paleosol observed elsewhere on the site. This weathering profile is old, and, where it is intact, no quarrying ever has taken place.

Eleven meters west of the Feature 49 adit, the weathered tuff is truncated by the east wall of Feature 102, a quarry pit completely buried by the colluvial blanket and not visible on the surface. Feature 102 intersects a bed of high quality, swirling banded opalite about 30 cm thick that dips to the east (cf. Figure 73 and Figure 78); it rests on tuff of undetermined thickness. A line extending the upper surface of the opalite bed to the west intersects the present surface at the western edge of the Feature 102 pit, observed in the north wall profile of Trench 3 Extension (cf. Figure 75). The lateral extent of Feature 102 is unknown. The tuff enclosing the opalite bed exploited in Feature 102 is soft, suggesting that opalite could have been isolated easily and large chunks detached by percussion or fire setting. This situation seems ideal for the production of flake blanks, either struck from large detached pieces or directly from the isolated bedrock.

The Trench 3 Extension profile also shows a decrease in the slope of the present surface and the surface of the lowest tuff unit, west of Feature 102. The pre-quarrying weathering profile is similar to that observed between Features 49 and 102, where the upper 20 to 30 cm of tuff is highly weathered and overlain with a clay paleosol.

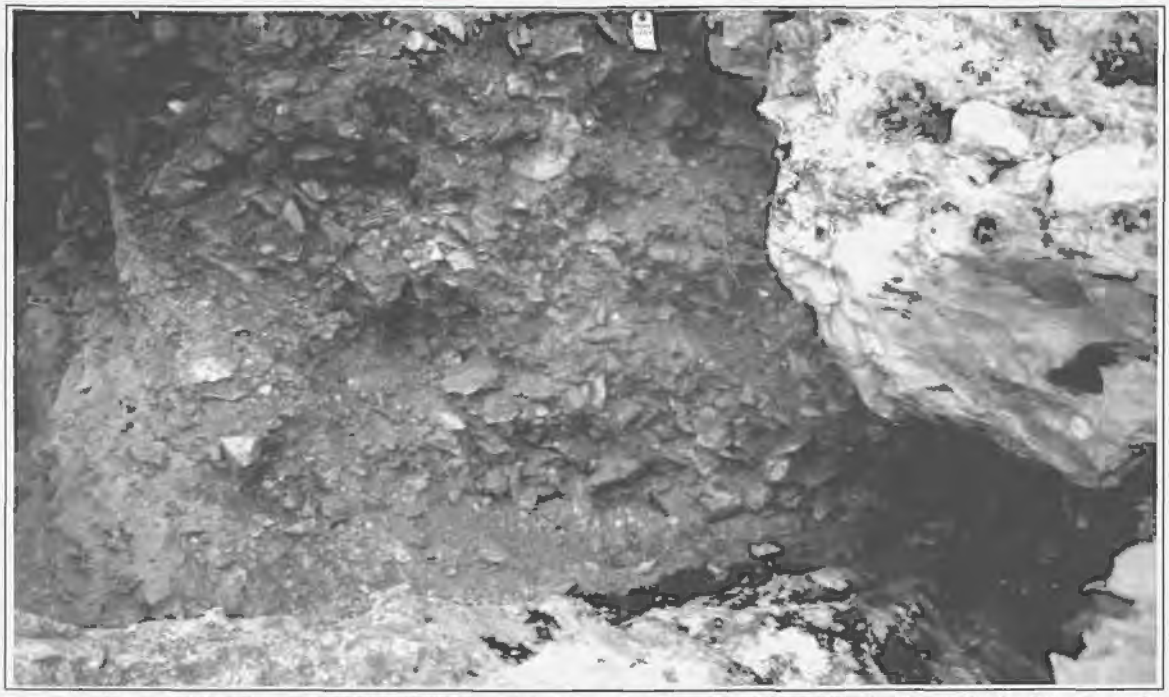


Figure 76. Quarry debris filling adit at eastern end of Trench 3, Area C (looking north, northeast). Tag at top of photo is 3.5 cm wide.



Figure 77. Cleaned adit, eastern end of Trench 3, Area C (looking east). Menu board just north of intersection of Trench 8 and Trench 3.

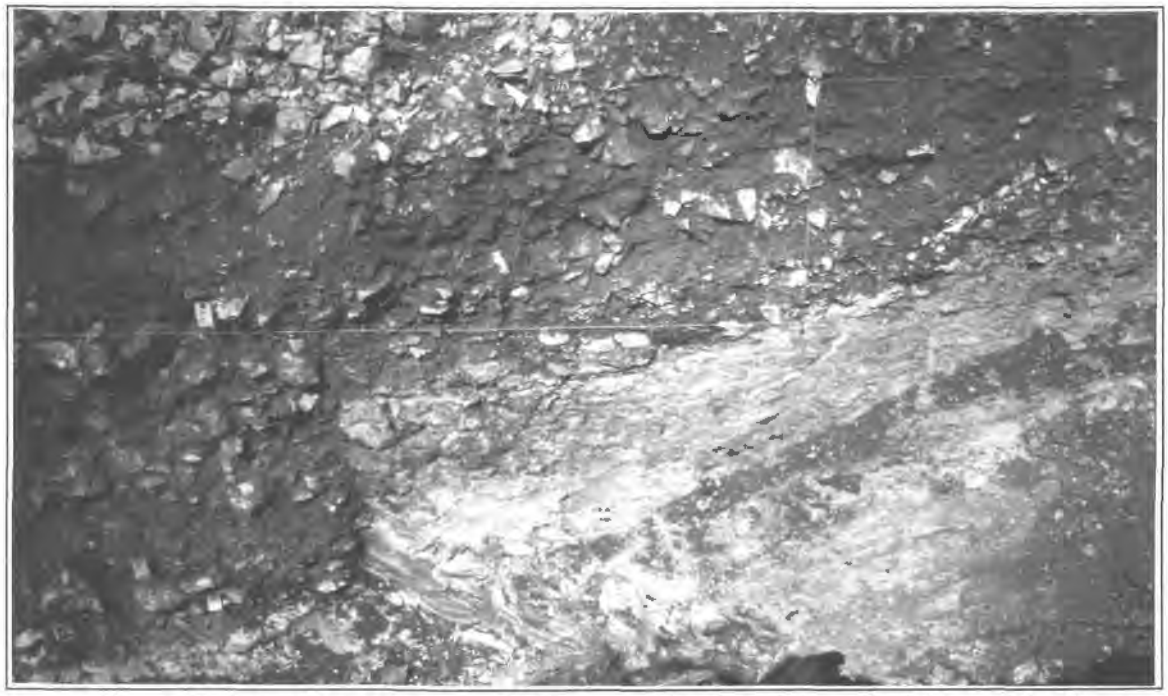


Figure 78. Quarry face at eastern end of Feature 102 and overlying colluvial material and quarry debris. Note the bed of banded opalite overlain by tuff in the pit wall (compare with Figure 75).

Quarry Deposits of Feature 102

The oldest quarry deposits at Locality 36 fill Feature 102 (cf. Figure 75), and are grouped into three horizons. Sediments of Horizon VI comprise Units 38-51 and Units 110-118 (the latter exposed in Trench 3 Extension). Overlying a surface cut through the paleosol and underlying bedrock in the western half of Feature 102, strata of opalite and tuff debris roughly alternate with silty clay-rich layers. Charcoal is a common component, especially in Units 46, 44, and 42, from which radiocarbon assays produced dates of 3890±60 B.P. (BETA 39485), 3810±60 B.P. (BETA 42474), and 3670±90 (BETA 42476), respectively. These dates are in the proper stratigraphic order, and the oldest and youngest dates fall within two standard deviations of each other. The youngest date is inverted, however, when compared to those from the stratigraphically superior Horizon V described below. The fine grained strata in Horizon VI (and throughout the fill of Feature 102) have weak granular to very weak blocky ped structure, and all the silt loam and clay loam matrix is noticeably red in hue. While redeposited natural surface silt and red clay paleosol may account partially for these attributes, the age of the deposits suggests pedogenisis; they probably have been buried for a long time compared to other quarry debris examples at Tosawihi.

The truncation surface of a later quarry excavation cuts Units 38, 39, 40, 41, and 42 of Horizon VI. This pit is filled with strata of Horizon V (Units 29, 30 31a-f, 32a-b, 33, 34a-d, 35, and 36), alternating fine and coarse units similar to those in Horizon VI. Charcoal also is common in Horizon V. Radiocarbon assays of charcoal in Units 35 and 32b produced essentially the same date: 3830±80 B.P. (BETA 42475) and 3890±70 (BETA 43152), respectively. These dates are similar to those from Units 44 and 46 in Horizon VI. The youngest date from Horizon VI (3670±70 B.P., BETA 42476) is younger than either date from Horizon V, and thus appears inverted. Nevertheless, it falls within one standard deviation of youngest, and within two standard deviations of the oldest dates, from Horizon V.

The youngest truncation surface is a pit excavation that cuts all of Horizon V and represents the latest quarrying episode at Feature 102. Horizon IV is a minor package of quarry debris and slopewash material, consisting of Units 26, 27, and 28a-c. The lowest stratigraphic units (28a-c) are hash, probably produced from battering and flaking tuff around the opalite face, while Unit 27 is a layer of medium to coarse opalite shatter, angular tuff clasts, and rare medium opalite flakes probably produced during toolstone extraction. Stratum 26 is a sandy clay loam (similar to overlying colluvial Unit 19), probably deposited by slopewash after the pit was abandoned.

Colluvial and Other Deposits Over Feature 102

Strata overlying the three horizons of Feature 102 include Unit 37, a silt loam grading to coarse open work down slope. This unit resembles quarry pit debris more than colluvium, but it cannot be assigned to any of the horizons described above. It may be related to quarrying south of Trench 3, since it seems to thicken southward in the west wall (the west end) of that Trench (cf. Figure 75). Unit 121 is a similar lens of flakes and chunks that also may be quarrying debris.

Units 19a-b and 22-24 are predominantly silt and clay loam soil and colluvial deposits that extend upslope over unquarried weathered tuff bedrock separating the quarry debris of Features 102 and 49 (cf. Figures 75 and 78). Unit 19a lies directly on the weathered tuff bedrock between the features, and grades down into it in places. Unit 19b overlies 19a on the bedrock, and fills the Feature 102 pit above Horizon IV. Units 19a and 19b differ mainly by the greater relative abundance of opalite flakes and chunks in 19b which are rare in Unit 19a. Unit 19a is truncated by (and thus predates) the east wall of Feature 102, and probably represents the original colluvial soil cover on the bedrock. The origin of Unit 19b is more enigmatic. One (identified as 19b) overlies 19a on the bedrock between Features 102 and 49. Here it is possible that Units 19a and 19b have the same origin as colluvial soil, and that the opalite flakes and chunks in 19b originated in bioturbation from overlying Unit 22, which is clearly colluvial quarry debris. Deposits of Unit 19b also fill the pit swale in Feature 102 above Horizon IV; this material seems to have originated as spoil from upslope quarrying and was distributed downslope by slopewash and colluvial action, as were Units 22, 23, and 24 above it. Unit 25, a poor to moderate open framework of medium to coarse opalite flakes and opalite and tuff chunks at the surface, probably is a slopewash lag deposit of quarry debris from Feature 49 or an adjacent quarry pit.

Quarry Deposits of Feature 49

Most stratigraphic units filling the arcuate embayment of Feature 49 (cf. Figure 74) are poor, moderate, or typical open frameworks of opalite and tuff chunks and opalite flakes with sparse to abundant silt loam, clay loam, or sandy tuff-hash matrix (cf. Appendix D: Table 12). The open framework deposits are most prevalent in the upper portions of the profile. Nearest the bottom, closer to the soft weathered tuff bedrock, they consist of compact hashes and hash-like materials. The general pattern in the matrix is more silt-rich nearest the top, with sandy tuff-hash matrix more common lower. Three nearly identical radiocarbon dates were obtained from charcoal in units near the pit floor from the south end of Trench 8: 500±50 (BETA 42493), 510±60 B.P (BETA 42494) and 520±70 B.P. (BETA 42497). The earliest date from Feature 49, 920±110 B.P. (BETA 43158) from Unit 62 further north, suggests that quarrying may have moved southerly, but this is not strongly supported by the stratigraphy observed in the east wall profile of Trench 8 (cf. Figure 74).

Although Trench 8 runs directly through Features 48 and 49, the best view of the structure and relative relationships of the stratigraphic units associated with the large adit is provided by the northern wall of Trench 3 (cf. Figure 75); its orientation parallels the direction of progressive uphill quarrying.

The tuff bedrock and clay paleosol (Unit 20) are cut by a truncation surface that forms the eastern wall of the Feature 49 pit. Unit 19a is draped over the clay paleosol and tuff bedrock on the truncation surface, perhaps as slopewash. This suggests that Unit 19a must have been in place before the excavation of Feature 49. It is impossible say whether Unit 19b also was cut by the truncation surface. Deposits of Horizon III overlying Unit 19a and the bedrock surface comprise Units 13-18. Units 13 and 15 are poor open frameworks of opalite and tuff debris, while Units 14, 16, and 18 are typical hashes with varying amounts of opalite flakes and chips. Unit 17 is a charcoal accumulation within Unit 14, but it failed to produce enough carbon for dating. The date of 500±50 B.P. (BETA 42493), from the intersecting wall of Trench 8, however, shares a similar stratigraphic position.

Subsequent quarrying and creation of the present adit produced a truncation surface that cuts all of units of Horizon III. Horizon II deposits (Units 4, 5, 6, 7, 8, 9, 10, 11, and 12) fill this pit and the adit, and can be traced around the corner intersecting with Trench 8. Unit 12, on the bottom, is hash; overlying units alternate silty clays and coarse debris. The slope of the silt-rich units into the adit and opalite face, and their clear individual definition, is typical of most features with quarry debris deposits abutting bedrock faces. The silty and organic-rich appearance of the matrix in these deposits, however, also suggests that slopewash may have contributed a significant component to the fill.

Colluvial and Other Deposits Over Feature 49

Deposits covering Feature 49 include Units 1, 2, 3, 4, 5, and 6. Units 5 and 6 are silt loam slopewash deposits (cf. Figures 75 and 76). Units 4, 2, and 1 are open frameworks of coarse quarry debris probably deposited in the Feature 49 depression as a result of quarrying north or south of the feature. Unit 1 is a sparsely vegetated open framework of coarse opalite and tuff cobbles and opalite flakes that originally helped define Feature 49 from the surface. Unit 2 is similar except for having an abundant silt loam matrix. It may be related genetically to Unit 1 with the silts having infiltrated downward from the surface. Unit 4 probably also is part of Unit 2, but it has a darker matrix due to the infiltration of charcoal and ash from above. Unit 3 probably also is related to Unit 2, but it caps the overhanging bedrock face as well as filling part of the adit cavity. Unit 3 is a mixture of soil and slopewash with common opalite flakes and tuff chunks, but it contains patches of charcoal and ash; some flakes show signs of burning.

Observations of Trench 6 provide a better understanding of depositional and erosional processes at quarry features such as Features 102 and 49. Bedrock occurrence in quarried areas and the modification of bedrock morphology due to quarrying probably affected the deposition of some debris units in quarry pit fill sequences by modifying slope and therefore altering the dynamics of material transport and deposition. For example, the notable thickening of Unit 19 in Trench 3 at its western end where it passes over the quarried opalite face of Feature 102 (described below) probably was naturally thick before quarrying due to the presence of opalite bedrock. Nevertheless, additional quarrying-induced relief probably resulted in an even larger input of disturbed soil and quarry material at the break in slope.

Conclusions

Prehistoric quarrying strategies employed at Locality 36 are revealed clearly in the backhoe trench profiles described above, and the progress of quarrying is reflected in the distribution of radiocarbon dates by area (Figure 79).

The Type 2 setting so common at Tosawihi, where beds of opalite toolstone embedded in softer tuff intersect a sloping surface, offered a relatively low cost opportunity for prehistoric quarriers; it was seized upon about 4000 years ago. The earliest date from Locality 36, however, 4090±100 B.P. (Beta 42159), is enigmatic. The southern portion of Area B probably constituted a Type 2 setting, but it has been modified so extensively by quarrying that no evidence of its original morphology remains. Early quarriers may have been attracted to Area B by the presence of high quality opalite near the surface, naturally fractured by frost and the mechanical action of overlying clay paleosol; toolstone was thus extracted easily. Lying on the surface of scoured opalite bedrock below shallow, churned deposits of quarry debris, the charcoal seems unrelated to adit quarrying, and appears not to reflect an organized hearth. This date may be the only relic of an early intensive episode of bedrock quarrying in Area A, other evidence for which has been destroyed by subsequent quarrying.

Bedrock quarrying began within the next 200 years in Area C at Feature 102. Four radiocarbon dates from this feature cluster tightly between 3810 B.P. and 3890 B.P. (cf. Table 35) in the middle of the No Name Phase (Elston and Budy 1990, Figure 110). Although the youngest radiocarbon date of 3670 B.P. from Feature 102 is stratigraphically inverted, it seems not significantly younger than the other dates. A discrepancy of this magnitude *could* arise from the burning of old growth sagebrush at the commencement of quarrying and the rise of younger plants somewhat later. What perhaps *is* significant, however, is that intensive quarrying seems to have started in the least costly bedrock setting. Work at Feature 102 exploited a seam of high quality opalite intersecting the surface, and was embedded between two layers of relatively soft tuff easily removed to isolate the opalite. The presence of charcoal in the pit suggests that quarrying techniques may have involved driving adits under the opalite and setting fires to detach material, but the bedrock working face is sheer, not undercut; heavy percussion is likely to have been effective here too. The strategy was to work into the slope, and there is no sign of retrograde reexcavation through old quarry debris. The lack of churning suggests that the quarrying venture in Feature 102 was relatively short lived; radiocarbon dates span only 220 years, and the time that the feature actually was worked may have been much less.

Quarrying at Feature 102 stopped, even though it appears that exploitable toolstone remained to be quarried (cf. Figure 78). Although Middle Archaic quarriers may have ceased work for other reasons, it is possible that, compared to other localities at Tosawihi Quarries available at the time, Feature 102 became uneconomical to work further; the overburden above the opalite was about 65 cm thick, 45 cm of which was tuff. In any case, the feature subsequently was filled with and buried by slopewash and colluvium rather than quarry or processing debris. This material lay in and over Feature 102 sufficiently long to be affected by pedogenic processes, and, indeed, appears to have lain undisturbed for nearly 3,700 years. Aside from burial, the reason that Feature 102 was never reworked may owe to its position, farther down the steep slope to the west than the site of any subsequent quarrying activity. Moreover, once the blanket of quarrying debris from later intensive quarrying was established across it, the site may have masked signs of subsurface opalite that once invited early prospectors.

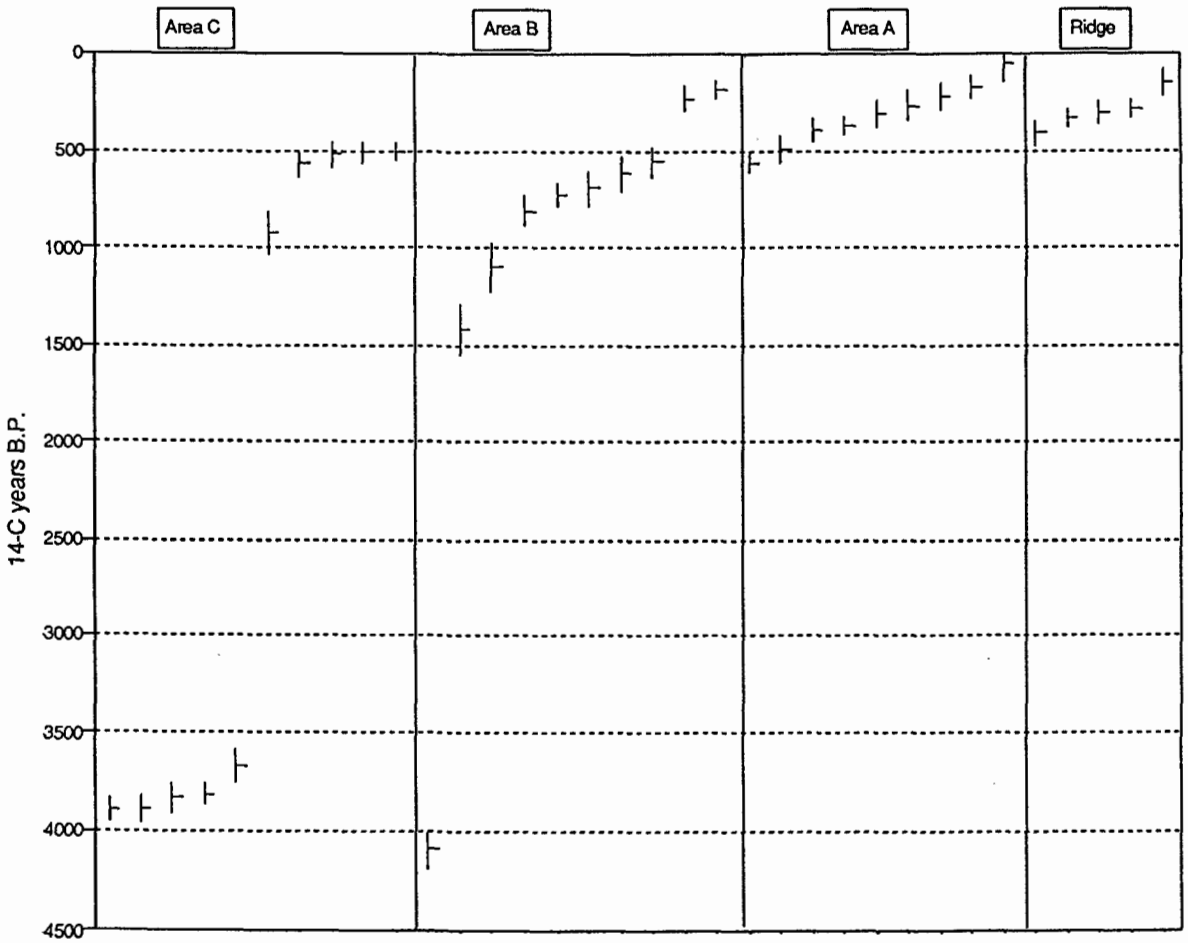


Figure 79. Radiocarbon dates, by area.

The lack of radiocarbon dates between 3,700 B.P. and about 1400 B.P. is difficult to evaluate. While this lacuna may indicate a real break in quarrying activity, previous research (Elston and Drews 1992) suggests no pause in use of the Tosawihi Quarries, but rather a steady increase in the frequency of visitation and the intensity of quarrying, culminating in the Late Prehistoric Period. It also perhaps is equally possible that later intensive quarrying destroyed evidence of earlier activity. This may account for why the earliest radiocarbon date from Locality 36 was preserved in a place where intensive quarrying had *not* occurred. Thus, even the spotty radiocarbon dates between 1420 B.P. and 810 B.P. from Feature 49 in Area C and the southern portion of Area B do not necessarily indicate a period of intermittent quarrying, but merely that radiocarbon dates are more likely to be preserved in younger deposits less prone to disturbance.

The upper opalite bed in Area C may have outcropped at the surface as a Type 1 setting. Feature 49 (and probably the other features in this group) were worked upslope and laterally into the arcuate bedrock face by driving adits along a fractured bedding plane, and by removing tuff above and below the seam. The thicker, more massive beds of opalite in Area B were worked with roughly same horizonal adit technique whenever possible, but vertical crack systems were exploited with pits and benches, producing a large, scoured bedrock depression. Lateral movement across this depression suggests a more opportunistic approach that required frequent re-excavation of older quarry debris and left thoroughly churned deposits yielding few radiocarbon dates earlier than 810 B.P. Indeed, the southern potion of Area B received a kind of persistent attention not afforded opalite elsewhere at Locality 36, reflecting its high value as toolstone.

Quarrying intensity increased during the latter part of the Eagle Rock Phase (Elston and Budy 1990, Figure 110) between 620 B.P. (A.D. 1330) and 220 B.P. (A.D. 1730). Seventeen of thirty-four radiocarbon dates from Locality 36 derive from this period (Figure 80), and four are younger than 190 B.P. (A.D. 1760). Five dates between 410 B.P. (A.D. 1540) and 150 B.P. (A.D. 1800) from hearths on the ridge crest signal late additions to the pattern of site use not previously observed.

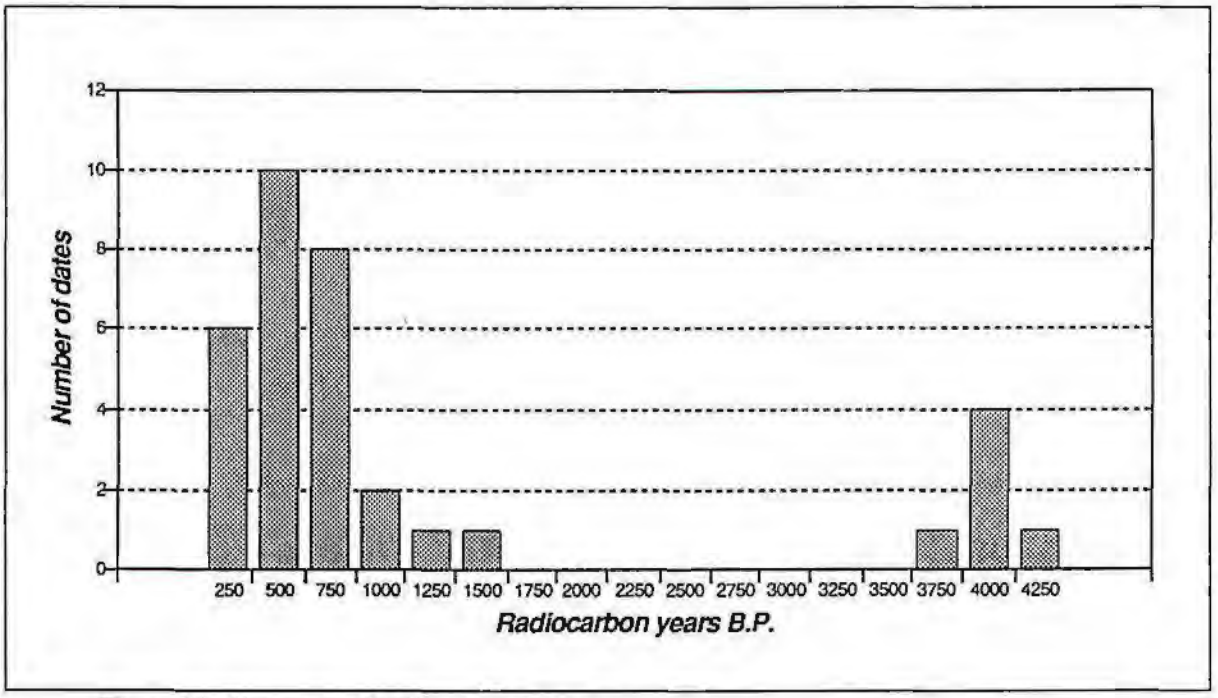


Figure 80. Histogram of radiocarbon dates.

All three quarry areas were utilized, and quarriers worked toolstone that grew more costly to extract through time.

The latest radiocarbon dates from Area C come from Feature 49; they cluster between 570 B.P. and 500 B.P. (cf. Figure 79). The creation of the adit and the abandonment of Feature 49 must have occurred somewhat later. The relatively fresh appearance of quarry debris dumped into the Feature 49 depression suggests that work continued in one or more quarry pits in Area C after Feature 49 was forsaken.

Later radiocarbon dates from Area A begin about the same time as those from Area C, but are not so clustered, extending from 560 B.P. to 170 B.P. (cf. Figure 79); one, only 50 B.P., possibly is the result of recent contamination. The dates and stratigraphy from Area A indicate progressive work into the slope with some lateral movement, but little tendency to work back through old quarry debris. Quarrying probably began in Area A in a Type 2 situation with bedrock near the surface and it terminated 6 meters to the east where the overburden was 1.5 meters or more deep.

Although no radiocarbon dates from Area B fall between 550 B.P. and 230 B.P. (cf. Figure 79), the hiatus may be due more to increased quarrying activity than to abandonment during that time. Although the stratigraphic record from the southern portion of Area B is chaotic, stratigraphy and radiocarbon data further north indicate a general tendency to work into the slope and toward the northeast after 230 B.P.

Thus, stratigraphy and radiocarbon dates reveal some generalized patterns of toolstone exploitation at Locality 36 that vary in time and space. The following chapter explores some economic constraints imposed by the topography of the bedrock and quality of available toolstone that help account for these general patterns.

Chapter 9

BEDROCK TOPOGRAPHY AND TOOLSTONE EXTRACTION

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This chapter considers how the nature of opalite bedrock constrained toolstone extraction at Locality 36. In Chapter 2 we identified several factors of strategic importance including (1) the location of bedrock, (2) the inclination of bedrock relative to ground surface (bedrock setting), (3) the structural features of bedrock, (4) the quality of toolstone and its ease of extraction, and (5) the size and form of toolstone packages which can be procured; together, these factors constitute the *bedrock topography*. We begin this discussion by describing toolstone extraction as it is represented by the ethnographic and archaeological record, and as it can be inferred from experimental quarrying. Next, we examine how bedrock topography affected toolstone extraction. Given our intention to evaluate the model proposed in Chapter 1, we conclude by formulating hypotheses relevant to the benefits and costs of toolstone extraction that can be tested with archaeological data recovered from Locality 36.

Ethnographic and Experimental Toolstone Extraction

Toolstone extraction yields toolstone packages that subsequently are transformed into useful tools. Once prospecting has located a place where lithic raw material can be obtained, overburden or poor quality stone is removed and toolstone is extracted. In order to model how bedrock topography affects toolstone extraction, we rely here on the ethnographic and the archaeological records, as well as on actualistic quarrying experiments.

Toolstone extraction commences with the successful location of places where lithic raw material can be procured. Australian Aborigines (Binford and O'Connell 1984; Jones and White 1988) interested in acquiring subsurface toolstone located such places by observing and testing (assaying) surface material as they walked over the quarry; they also paid attention to places with evidence of previous lithic reduction (Elston and Dugas 1992). Once a promising spot was located, exploration through test pitting followed.

We assume that Tosawihi quarriers followed a similar process, looking for good quality material brought to the surface by colluvial and pedogenic processes (as described in the previous chapter). However, detecting "prospecting" in the archaeological record is problematic since the debris created by prospecting at Locality 36 is likely to be obscured by the debris of toolstone extraction. Therefore, our concern is not with discovering successful prospecting, but with deciphering the location and development of quarry features relative to toolstone-quality bedrock.

How bedrock slopes relative to the surface affects the type of extraction feature likely to be created (cf. Chapter 7:Figure 54; Elston and Dugas 1992) and the technology of extraction. For example, in a Type 1 or Type 2 setting, a layer of toolstone tending toward or intersecting the ground surface presents the quarrier a vertical face of stone. Holmes' (1919) descriptions and illustrations of the Quartzite Boulder Quarries, District of Columbia, and the Mountain of Knives, Mexico, demonstrate that extraction is likely to proceed along the bed horizontal to the surface of

the bedrock. On the other hand, bedrock more or less parallel to the ground surface is likely to be extracted from vertical pits as quarriers work down into the bedrock. A good example of vertical pits excavated into a Type 3 bedrock setting is described by Fowke (1902) at Flint Ridge, Ohio (cited by Holmes [1919:176-178, Figure 58]).

The technology of toolstone extraction may be affected by bedrock setting. This appears to be the case for the application of fire and water. Akerman (1979:144) notes that fire was used to fracture the re-silicified surfaces of sandstone in the Kimberley Mountains (Western Australia) in order to access underlying toolstone beds. During actualistic quarrying experiments at Tosawihi (Carambelas and Raven 1991), fire proved useful for removing beds of tuff overlying beds of opalite. The tuff, which usually was reduced to fine powder when hammered, became "welded" and could be extracted in large chunks when fire was applied. Fire did *not* prove useful during our experiments when placed against the vertical face of a quarry pit, however. On the other hand, fires may be lit underneath a bed of toolstone in order to free packages from the parent material, or to break-up large pieces (Binford and O'Connell 1984). Fowke (1902:619-621) interprets the use of fire at Flint Ridge, Ohio, thus:

> He then sunk a pit, as large as he wished, to the surface of the flint. On this he made a fire; and when the stone was hot he threw water on it, causing it to shatter. Throwing aside the fragments, he repeated the process until he penetrated the underlying limestone to a depth which allowed him sufficient room to work conveniently. The top and freshly made face of the flint was thickly plastered with potter's clay, after which fire and water were again utilized for clearing away the limestone until a cavity was formed beneath the flint layer [Holmes 1919:177].

The tool kit used to quarry bedrock is likely to be similar from setting to setting. Pointed digging implements manufactured from antler, bone, and wood (Shepherd 1980:19-20, 28-33), and scoops made from large mammal scapulae (Ahler 1986:75-76; Schmitt 1992a) have been interpreted as tools employed to remove overburden and expose bedrock surfaces. Moreover, these tools probably functioned to loosen and remove debris created by quarrying. Hammerstones and wedges were likely to be used for breaking-up and removing weathered and poor quality stone, as well as for extracting chunks of high quality toolstone from parent material.

We suspect that the bedrock setting of Tosawihi opalite at Locality 36 affected the way in which toolstone was removed and, consequently, the type of quarry features that were formed. In settings where bedrock is more or less parallel to the surface or the slope angle intersects horizontal beds, pits should be the dominant quarry feature; where bedrock trends away from the horizontal, adits should be dominant.

As quarriers attempt to extract toolstone, they are apt to recognize structural features of the bedrock that facilitate toolstone removal. Tuman quarriers were reported to work the weak planes of a bedrock face until the planes were widened and large amount of axe stone was brought down (Burton 1984:241). Carambelas and Raven (1991) found that opalite bedrock which exhibited at least some degree of fracturing could be removed, but that massive, high quality opalite bedrock located in abandoned quarry features was impenetrable. In their experiments, small one-handed hammerstone were used to force wedges made of wood, bone, and antler into fractures of the bedrock; the same hammerstones were also used to loosen packages by light-to-moderate tapping. At Locality 36 we are interested in examining the relationship between structural features of toolstone and the location of quarry features; if appraisals from experimental quarrying are valid,

we should expect to see quarry features most developed in areas where structural features facilitate extraction, and less developed in areas where opalite beds are less structured or "massive."

Toolstone quality and ease of extraction are factors upon which toolstone extraction is dependent. Subsurface bedrock is generally higher in quality than surface material, since it has been protected from the effects of weathering (Wilke and Schroth 1989:152). However, high quality toolstone is not necessarily distributed uniformly throughout a bedrock deposit. For example, the Tuman axe makers spent upwards of one month removing stone from a bedrock face in order to expose fresh axe stone (Burton 1984:242). On the other hand, high quality stone may be so difficult to remove (as in the case of the massive opalite encountered during actualistic experiments) that usable toolstone packages may never be extracted. Thus, there appears to be a trade-off between toolstone quality and ease of extraction. For one of the quarry pits studied by Fowke ([1902:619-621] cited in Holmes [1919:177]) at Flint Ridge, Ohio, he noted: "Where the flint was well suited for the purpose intended, or was easily worked, the excavation was carried along in the form of a trench, the waste material being thrown to the rear; under less favorable conditions, the spot was abandoned." At Locality 36 we want to determine if a trade-off exists between toolstone quality and ease of extraction, and, if so, how it affected the extraction of opalite.

A final consideration in toolstone extraction is the size of extracted toolstone packages, since this variable places limits on the size and form of tools produced and on the technology used to produce them (cf. Chapters 4 and 5; K. Jones 1984). Elston (1992b) estimates that during the replication of bifaces to Stage 3 from blocks obtained during experimental quarrying, up to 95 percent of the block was reduced to lithic debris in order to manufacture the biface. This suggests that a Stage 3 biface weighing 250 gm may have been produced from a toolstone package weighing 5,000 gm, a package some 20 times the weight of the biface.

Bedrock Topography and Toolstone Extraction at Locality 36

The preceding discussion describes ways in which bedrock topography can constrain or facilitate toolstone extraction. Below, we focus our attention on the bedrock of Locality 36. Our model of the effects of bedrock topography on toolstone extraction at Locality 36 suggests that the location of toolstone-quality bedrock determined the location of quarry features, and that the bedrock setting determined the type of quarry feature that would be created. In addition, our model suggests that evidence for the use of structural features (fractures, joints, zones of weakness, etc.) in extraction will be present where toolstone was quarried. We suspect that toolstone quality and ease of extraction are associated positively, and that the size and the form of packages procured from the bedrock placed limits on the size and the morphology of useful tools produced at the site. Methods used to evaluate these propositions are included as a part of the discussion.

Location of Opalite Bedrock

As a result of the volcanic, hydrothermal, and erosional processes that created the bedrock ridge on which Locality 36 is located (Figure 81; cf. Chapter 7), toolstone-quality opalite was not distributed evenly across the locality. It seems reasonable to think that prehistoric quarriers would



Figure 81. Tuff bedrock deposit underlying Locality 36, view of southeast slope cut by road.

have located and developed quarry features in the presence of toolstone since their time and effort would have been wasted working areas where toolstone was absent. Figure 82 illustrates the spatial variation between bedrock outcrops, tuff and opalite bedrock exposed in the backhoe trenches, and quarry features as they were mapped prior to trenching. Solid areas represent trenches in which opalite bedrock was found, while dashed lines indicate trenches in which unsilicified tuff was located. Five unutilized bedrock outcrops also are symbolized on the map. Examining the map, we see that along those trenches in which opalite beds were found, quarry features are closely associated; trenches which exposed unsilicified tuff have no quarry features associated with them. Quarry features are absent near the bedrock outcrops, except at the south end where subsurface features have been excavated adjacent bedrock outcrops; this is explained by the poor quality of stone observed at these outcrops (cf. Chapter 3).

The location of opalite beds, particularly of subsurface opalite bedrock, clearly was a determining factor in the placement and development of quarry features. Thus, the decision to develop a quarry feature was calculated rather than haphazard, and information obtained during the prospecting phase of toolstone procurement influenced decisions about where to excavate.

Bedrock Setting

We have suggested that the location of opalite relative to poorly silicified tuff determined where quarry features would be located and developed. We also suspect that, once located, the bedrock setting of the opalite determined the way in which toolstone would be extracted and, consequently, the type of quarry feature that would result. As we use the term here, bedrock setting refers to the inclination of the toolstone bedrock relative to the slope of the ground surface. We employ the typology presented in Chapter 7 (Figure 54) to distinguish three types of bedrock settings (Types I, II, and III), and we note that each type appears to be more or less amenable to the formation of particular quarry features.

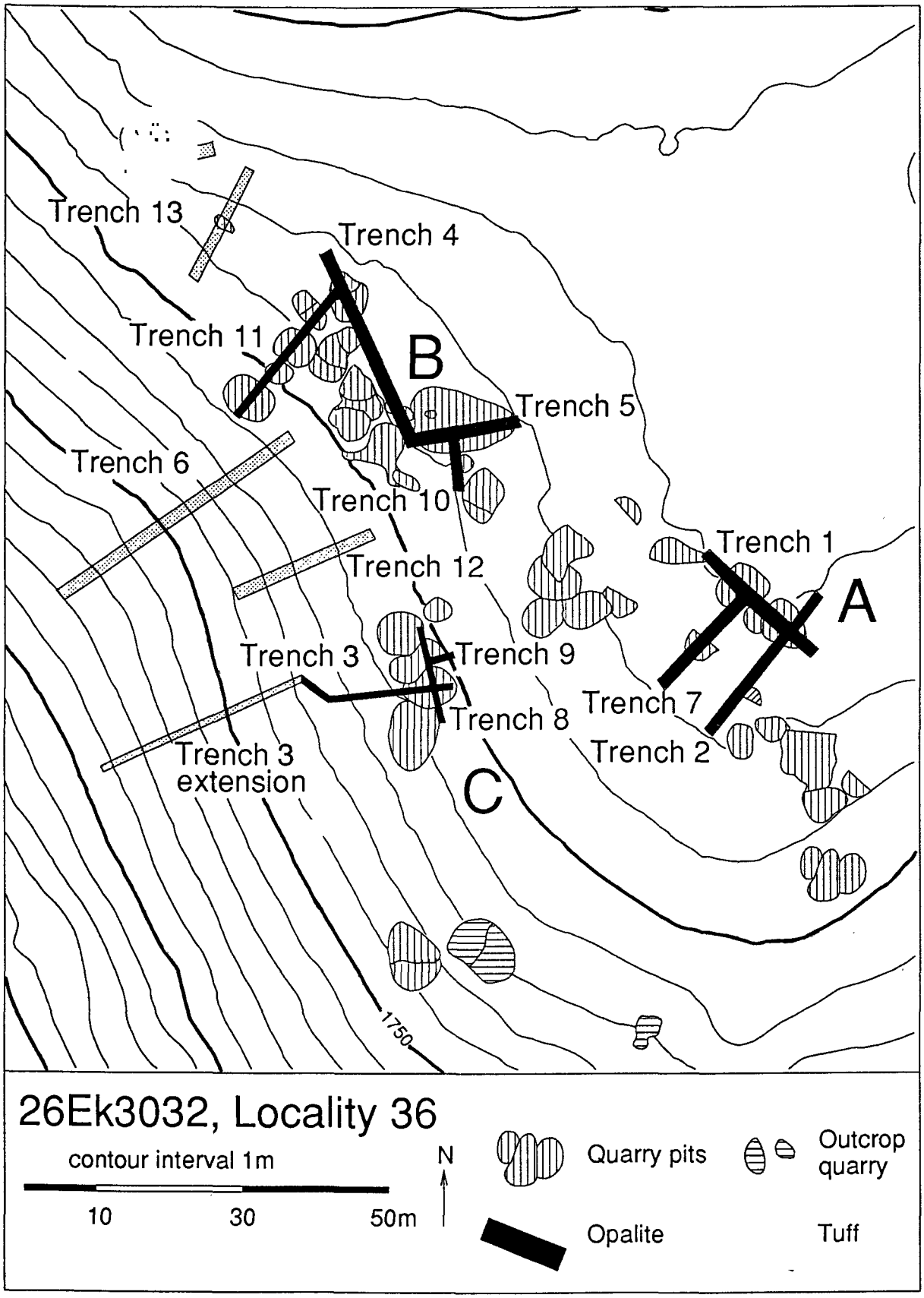


Figure 82. Topographic map of Locality 36 illustrating the relationship between outcropping bedrock, beds of tuff and opalite, and quarry features.

In a Type I setting, bedrock is positioned so that it intersects (outcrops) the ground surface. Intuitively, it seems likely that toolstone extraction would have proceeded by quarriers working back the face of the outcrop and creating adits (cf. Figures 70, 75, and 76). Similarly, adit formation might occur in a Type II setting, since toolstone bedrock inclination is tending toward an intersection with the slope of the surface. In a Type III setting, however, bedrock is more or less parallel to the slope of the surface; quarriers would have removed overlying soil and excavated vertically into the bedrock to extract toolstone (Figure 83). Such techniques result in the formation of pits, features that generally are circular with vertical to near vertical walls. A combination of pit and adit features seems to be a possibility when the bedrock setting is transitional between Types II and III, or where vertical pits penetrate sufficiently deep to create vertical faces that then can be worked laterally. To evaluate this hypothesis, we identified the different types of bedrock setting at Locality 36 (cf. Chapter 8) and the quarry features preserved in them.

Ten of 14 backhoe trenches (Areas A, B, and C) exposed opalite bedrock (cf. Figure 82). A Type III setting was observed in Area A and also in the northeastern portion of Area B (primarily Trench 4); moreover, a transition to Type II from Type III was noted in a portion of Area B (Trench 11). In one portion of Area B (Trenches 5 and 10), the topography had been so disturbed by quarrying that the type of bedrock setting could not be identified. A Type II bedrock setting was noted for Area C. The backhoe also exposed 19 quarry features in profile and plan view; of these, 15 (78.9%) were identified as quarry pits, three (15.8%) manifested characteristics of both quarry pits and adits, and one (5.3%) appeared to be an adit. Table 36 presents data relevant to the relationship between quarry feature type and bedrock setting; locational data (Area and Trench) for each feature are also presented.

Of the 15 quarry pits, 13 (86.7%) are associated with a Type III bedrock setting, and two (13.3%) are associated with a Type II setting. Of the three features that exhibit both quarry pit and adit characteristics, one is located in a Type II setting, another in a Type III setting, and one in a



Figure 83. Feature 71 quarry pit.

setting that can not be specified because it is so heavily quarried. The adit was observed in a Type II setting. These data lend support to our hypothesis that the setting in which toolstone is encountered strongly influences the methods used in its extraction and, consequently, the type of quarry feature that is created. Extraction from beds more or less horizontal to the slope of the surface from which quarries work is accomplished by the creation of pits, while extraction from beds tending toward or intersecting the surface is almost certain to create adits; extraction from bedrock intermediate between the two settings is likely to create a combination of both pit and adit features.

Table 36. Bedrock Setting and Quarry Feature Type.

Feature Number	Bedrock Setting I	II	III	Quarry Feature Type Adit	Pit	Feature Location Trench	Group
71			X		X	1	A
72			X		X	1	A
73			X		X	1	A
104			X		X	1	A
103			X		X	1	A
111			X		X	2	A
42*		?	?	X	X	5/10	B
22			X		X	4	B
25			X		X	4	B
27			X		X	4	B
112			X		X	4	B
29			X		X	4	B
31			X	X	X	4	B
32			X		X	4	B
35			X		X	4	B
30		X			X	11	B
12		X			X	11	B
102		X		X	X	3	C
49		X		X		3	C

*Large feature encompassing both trenches; bedrock setting could not be determined.

Geological Features of the Bedrock

At Locality 36, quarry features were created by the extraction of toolstone packages from bedrock. While the type of feature (pit or adit) created was due largely to the bedrock setting, other geological features including the differential emplacement of opalite and the structural features of the bedrock influenced the way in which packages were removed.

Opalite Emplacement

Opalite emplacement in the Tosawihi vicinity varied both horizontally and vertically throughout the deposit of tuff. This emplacement also affected techniques of extraction (cf. Chapter 8). For example, quarriers who encountered nearly horizontal opalite beds dug down and laterally

into the stone; joints, cracks, and tuff stringers and pockets were utilized to isolate and remove toolstone packages. If, on the other hand, an opalite bed was located above or between beds of tuff, the softer material was undermined in order to create an overhang of opalite from which usable packages could be detached.

Feature 31 (Figure 84), exposed at the junction of trenches 4 and 11 (cf. Figure 82), is a pit and adit feature that provides a good example of this latter technique. Differential silicification of tuff at this place left a lens of opalite situated between deposits of tuff (designated "a" [Figure 85]), above and below, and areas of massive opalite (designated "b" [Figure 85]), which are on either side of the opalite band. Excavations proceeded through much of the tuff in order to extract chunks of the overlying opalite band, and they terminated at places where opalite was too massive or where it did not exist.

Structural Features

While beds of tuff offered prehistoric quarriers one avenue for toolstone extraction, structural features present in opalite beds offered yet another. Fractures are the predominant structural features of opalite bedrock at Locality 36, and their development and distribution across the bedrock is variable. For example, an area of opalite exposed between Features 31 and 29 in Trench 4 (Figure 86) illustrates a typical situation in which large, angular chunks of opalite have been separated from one another by the shrink-swell action of the overlying clay paleosol in fractures. Although significant fractures occur adjacent these chunks, clays have not infiltrated and no appreciable movement has occurred. In both instances, quarriers could have removed chunks of opalite by loosening them with a hammerstone and by driving wooden or antler wedges into the fractures in order to pry the chunks from parent material. The underlying massive opalite (Figure 86, foreground) displays few fractures, and prying chunks away from the bedrock at this place would have been extremely difficult, if not impossible, as demonstrated by experimental quarrying (Carambelas and Raven 1991).

Differential development of fractures was recognized across most of the bedrock, but especially in Trench 4 where large areas of unexcavated opalite were exposed. In Figure 87, a schematic of a portion of Trench 4 produced from a number of sketch maps of quarry features, illustrates the variable distribution of fractures relative to quarry features, massive opalite, and hammerstone scars. Although quarry features obscure the continuation of fractures over stone that once was unquarried, it seems reasonable to suspect that the frequency at which fractures occurred was greater in these excavated areas. Also depicted is the observation that hammerstone scars, visible on unquarried bedrock, are more frequent near areas of greater fracturing than they are in areas where the bedrock is massive. This suggests that quarriers focused their efforts on those places where structural features facilitated toolstone removal, and that they bypassed areas where extraction was inhibited by a lack of structural features.

Toolstone Quality and Ease of Extraction

While the differential emplacement of opalite and the variable distribution and development of structural features either facilitate or impede toolstone extraction, they also contribute to the quality of the bedrock for toolstone. Other features of the bedrock, such as vugs,

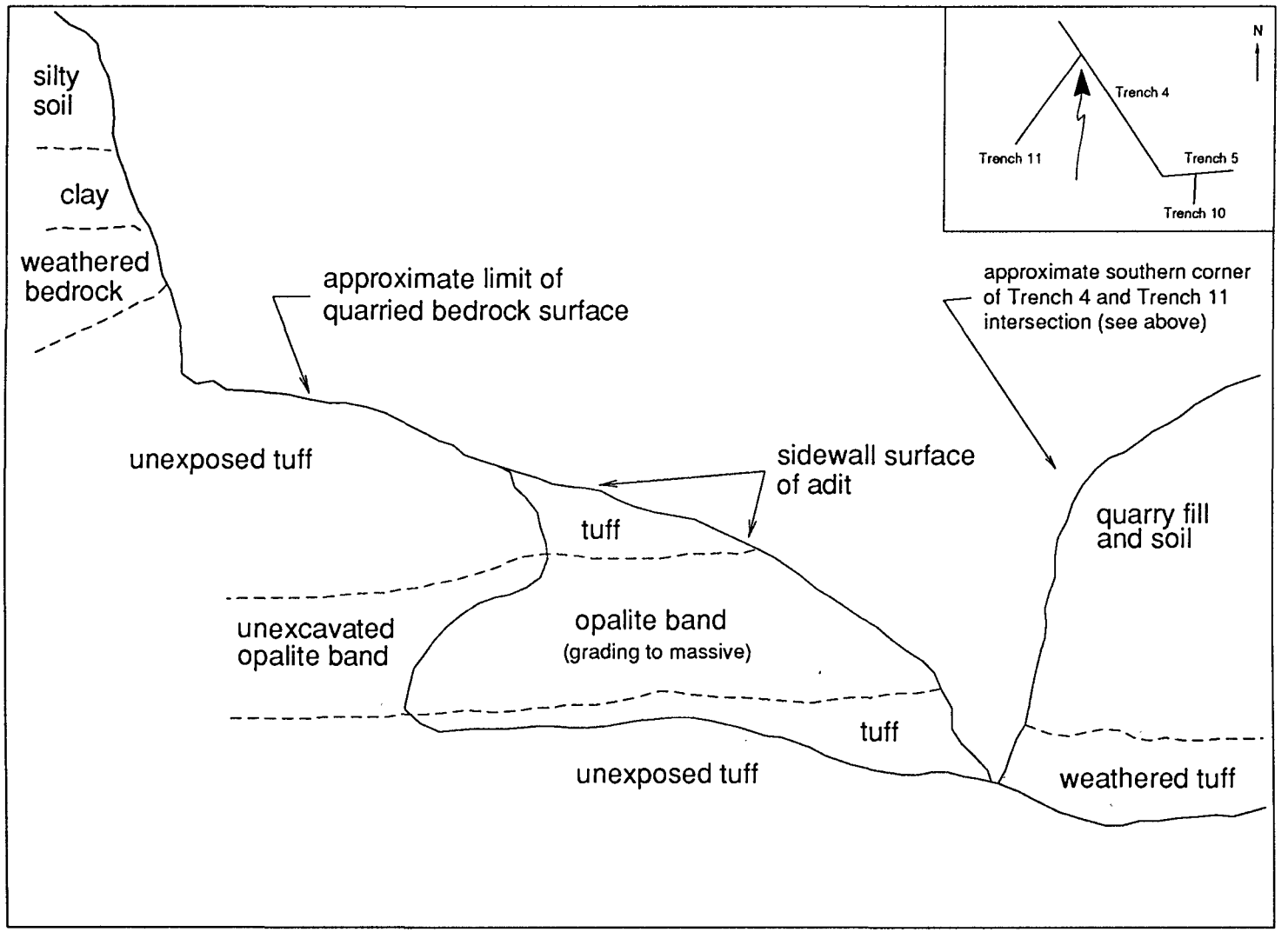


Figure 84. Profile of Feature 31 quarry pit and adit.

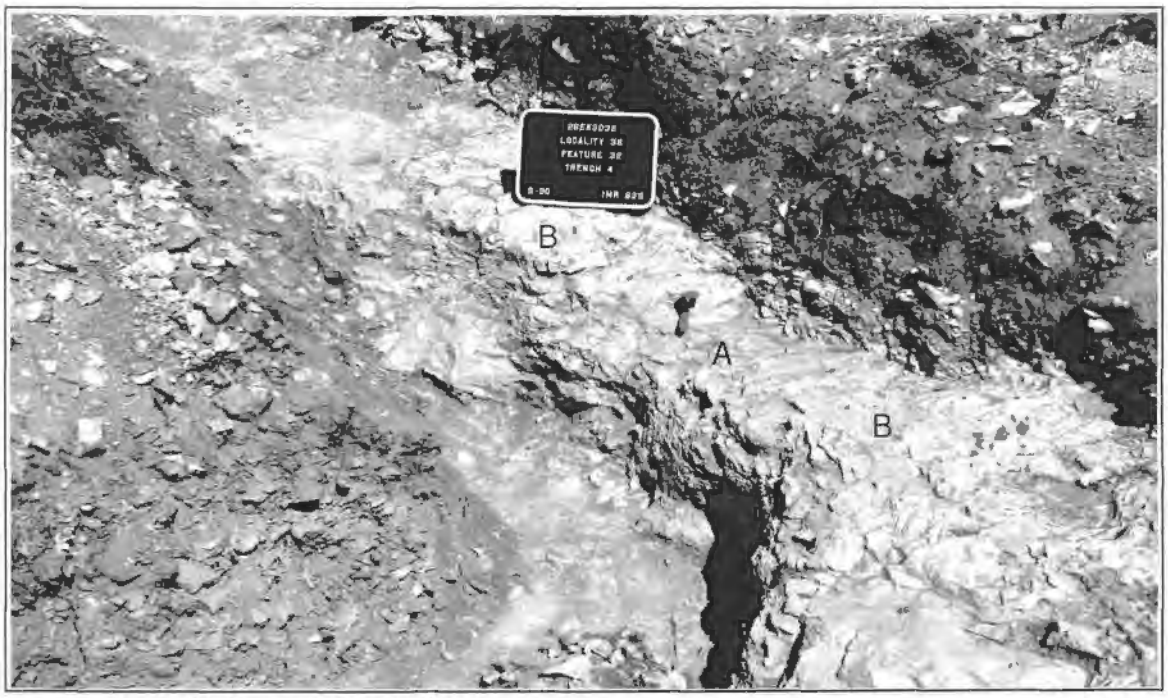


Figure 85. Quarry pit and adit, Trench 4.


Figure 86. Structural features separating opalite chunks from bedrock.

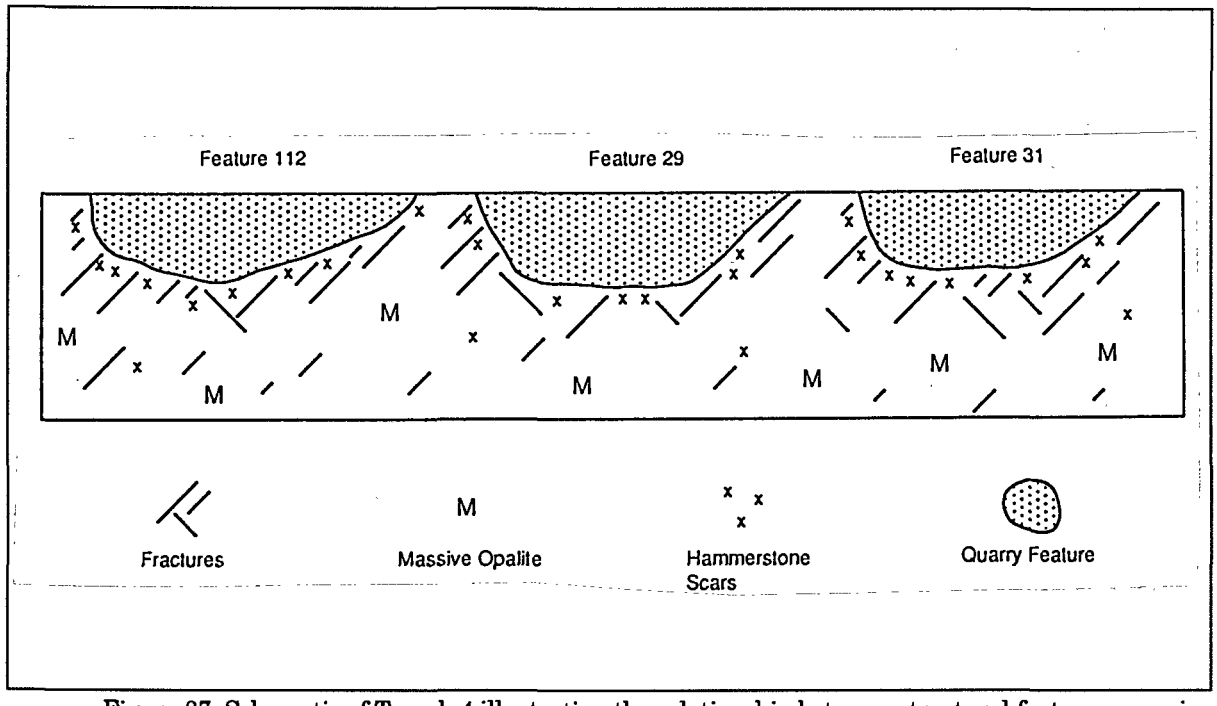


Figure 87. Schematic of Trench 4 illustrating the relationship between structural features, massive bedrock, quarry features, and hammerstone scars.

also affect quality. These observations lead us to propose that a relationship exists between the quality of opalite beds for toolstone at Locality 36 and the ease with which that toolstone can be extracted; specifically, where toolstone quality is poor, extraction is likely to be relatively easy, and where toolstone is excellent, extraction is likely to be very difficult. In order to evaluate this hypothesis, a lithic specialist assessed both quality and ease of extraction of bedrock opalite exposed in the backhoe trenches of Locality 36.

Observing opalite beds and quarry features in selected trenches (1, 2, 3, 4, 5, 7, 8, 10, and 11; cf. Table 37), the lithics specialist judged toolstone quality in terms of the observed "texture" of the bedrock, that is, the general appearance or the character of the lithic resource (Mark Moore, personal communication 1991). Areas of the bedrock then were ranked and mapped; rankings included Poor (0.0-0.9), Below Average (1.0-1.9), Average (2.0-2.9), and Above Average (>2.9). Opalite receiving the highest rank was that which exhibited the greatest amount of textural homogeneity; tuff stringers and pockets, cracks, vugs, and other inclusions were noticeably absent. Opalite receiving the lowest rank was that which manifested the greatest amounts of textural heterogeneity; or, it contained many of the features described above.

Ease of toolstone extraction was judged in a similar fashion; bedrock was ranked and mapped as Very Difficult (0.0-0.9), Difficult (1.0-1.9), and Least Difficult (>1.9). Massive opalite was considered the most difficult to extract, while opalite exhibiting well developed structural features or large pockets or stringers of tuff was considered the least difficult to extract. Figure 88 illustrates how each trench was assessed.

None of the maps produced by the lithics specialist was drawn (to scale), which precluded our use of rigorous quantitative techniques in evaluating our hypothesis. Therefore, for each of the trenches assessed, we compared, qualitatively, toolstone quality maps against the maps for ease of

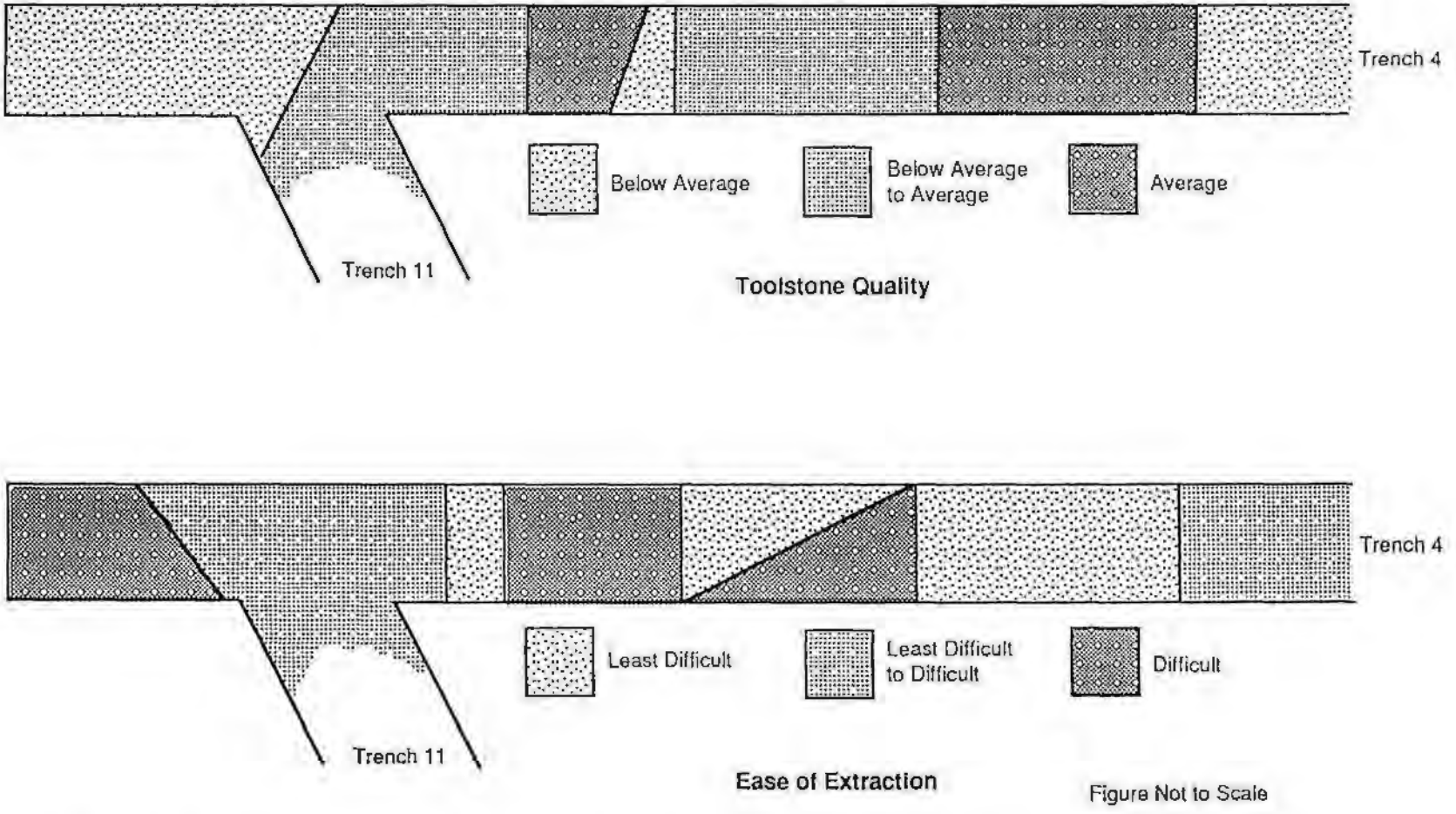


Figure 88. Characterizations of toolstone quality and ease of extraction; example from Trench 4.

extraction. That is, for each area encompassed by a particular toolstone quality ranking, we observed and tabulated the ease of extraction rankings occurring within that area. The results of this analysis, cross-tabulated in Table 37, point up results we expected: as toolstone quality grades from poor to above average, ease of extraction grades from least difficult to very difficult. We suspect that had we been able to use more rigorous quantitative methods, an even stronger relationship would have been demonstrated.

Table 37. Cross-Tabulation Between Toolstone Quality and Ease of Extraction.

	Ease of Extraction							
	Very Difficult		**Difficult**		**Least Difficult**		**Total**	
Toolstone Quality	n Col. %	Row % Cum. %	n Col. %	Row % Cum. %	n Col. %	Row % Cum. %	n Col. %	Row % Cum. %
Above Average	3	75.0	1	25.0	0	0.0	4	100.0
	33.3	5.1	2.8	1.7	0.0	0.0	6.8	6.8
Average	4	16.0	18	72.0	3	12.0	25	100.0
	44.4	6.8	50.0	30.5	21.4	5.1	42.4	42.4
Below Average	2	9.5	13	61.9	6	28.6	21	100.0
	22.2	3.4	36.1	22.2	42.9	0.2	35.6	35.6
Poor	0	0.0	4	44.4	5	55.6	9	100.0
	0.0	0.0	11.1	6.8	35.7	8.5	15.3	15.3
Totals	9	15.3	36	61.0	14	23.7	59	100.0
	100.0	15.3	100.0	61.0	100.0	23.7	100.0	100.0

Earlier in this chapter we suggested that, during toolstone extraction, quarriers are likely to be faced with a trade-off between toolstone quality and the ease with which that toolstone may be extracted. For instance, massive opalite may be the highest quality toolstone available, yet the efforts of quarriers to pursue such stone may come to naught. On the other hand, toolstone may be very easy to extract, but its poor quality may frustrate attempts to produce tools. Later, in Chapter 12, we attempt to estimate return rates for the different quality rankings we have described; using these return rates we predict which places ought to manifest the greatest amount of toolstone extraction and which places ought to be ignored.

Toolstone Packages

Bifaces of a certain size and form were the goal of tool production at Locality 36 (cf. Chapters 4 and 5). Therefore, it was incumbent upon those who extracted toolstone to recover packages of sufficient size and shape to produce the desired biface. Here, we estimate the minimum dimensions and weight of toolstone packages used to produce bifaces that were eventually transported from Locality 36. We draw from our actualistic quarrying experiments, as well as from replication experiments, in order to make our estimates.

Two of five quarrying experiments conducted at the Tosawihi Quarries were performed at Locality 36 (Carambelas and Raven 1991; Elston 1992b). One experiment estimated rates of

overburden removal from a filled-in quarry feature, while the other estimated toolstone return rates from bedrock. During the latter experiment, 61 blocks of opalite were extracted from the bedrock and subsequently were used in replication experiments. Of these, Elston (1992b) reports that 18 were rejected because they were "too small" (mean weight 577.78±264.7 g), and 14 were discarded because they were of poor quality. Twenty-nine blocks were retained for replication (mean weight 1907.14±1458.9 g); 19 either failed or could be reduced only to Stage 2 of the biface continuum, while 10 were reduced successfully to Stage 3 bifaces. The knapper was able to produce 11 Stage 3 bifaces from the remaining 10 packages, however. Our concern is with estimating the weight and dimensions of packages that produced bifaces which were likely to leave Locality 36; therefore, we focus our attention on the 10 blocks from which bifaces were replicated.

Table 38 presents dimensional and weight data for the 10 extracted toolstone packages and the 11 replicated bifaces; the amount of waste produced during replication and the percentages of waste-to-tool for each artifact is also provided. Two observations are immediately interesting. First, replicated bifaces are comparable in dimensions and weights to Stage 3 archaeological bifaces collected from Locality 36 (cf. Table 20), and second, an astonishing amount of waste is produced when replications are preformed.

Table 38. Comparison of Toolstone Package and Stage 3 Biface Produced from Package.

Specimen	Toolstone Package				Stage 3 Biface				Waste	Waste %/
Number	Wt.	L	W	T	Wt.	L	W	T	(g)	Tool %
1-1	3150	19	16.5	14	310	10.8	9.3	2.9	2840	90.2/ 9.8
1-5	3500	24.5	14.5	11	141	11.8	5.6	1.5	3359	96.0/ 4.0
1-6	1500	21.5	18	3.5	449	17.5	8.3	2.4	1051	70.1/29.9
1-7	1500	16.9	15	6	418	12.8	9.8	2.6	1082	72.1/27.9
2-2	1600	16	12	6.5	288.2	13.5	8.6	2.4	288.2	82.0/18.0
5-4	1050	13	10	8	209.1	11.5	6.9	2	840.9	80.1/19.9
6-1*	3400	16	15	14.5	307	11.9	8.8	2	2863	84.2/15.8
					230	11.4	7.4	3		
6-3	1700	16.5	10.5	9	239	11.8	7.8	1.7	1461	85.9/14.1
19-1	1350	19	16.5	5	272.6	13.8	7.5	2.6	1077.4	79.8/20.2
20-1	900	14	10	7	87.7	10.8	4.5	1.6	812.3	90.3/ 9.7
Totals	19650				2951.6				15673.8	85.0/15.0

Wt. = Weight in grams
L = Length in millimeters
W = Width in millimeters
T = Thickness in millimeters

*Two bifaces produced from one toolstone package

These observations testify to the knapper's ability to replicate archaeological bifaces given a toolstone package of a particular size and weight. More to the point, they offer a means of estimating *at least* the upper dimensional and weight limits of the smallest packages needed to produce the bifaces recovered from Locality 36. For example, bifaces probably were transported from Locality 36 at approximately middle Stage 3, and the mean weight of Locality 36 bifaces of this stage is 247 gm (±171 gm). Applying the total waste-to-tool percentages in Table 38, we estimate that a package weighing approximately 1647 gm was needed to produce a biface of that weight.

Given a range of variation in toolstone package size and weight, it seems reasonable to think that the "smallness" of packages would be more limiting on biface production than the "largeness" of packages. Nevertheless, it is tempting to speculate about the largest package. Elston

(1992b) notes that during backhoe trenching of Locality 36 a boulder weighing probably in excess of 75 kg was extracted and subsequently reduced during replication experiments. Thirteen block blanks (mean weight 4054.17, ±3742.11 gm) and 11 flake blanks (763.64, ±386.06 gm) resulted in the break-up of the large boulder. Although the package was mechanically excavated, it seems likely that parent material would have released a package of this size when sufficient crack systems and/or tuff stringers allowed ingress, particularly when the adit technique was employed.

A final note on package size concerns the windfalls of nature. Field work in the Tosawihi vicinity provided an opportunity to revisit Locality 36 in the spring of 1991, approximately eight months after the field work phase of our data recovery program had been completed. Backhoe trenches left open throughout the fall and winter months allowed opalite beds to be exposed to the effects of freezing and thawing. We noticed that where experimental extraction had failed to recover many blocks the year before, weathering had loosened the blocks sufficiently that they could be removed with only a little effort. Moreover, as we walked across the opalite beds we noticed blocks that had split away from parent material as a result of weathering. Figure 89 is an example of one such block; its material quality is excellent, and the package weighs 1527.6 gm, well within the range required to produce replication bifaces. Thus, packages of various sizes and shapes, which split away from parent material along natural fracture planes, probably were available to quarriers who simply removed the stone from a pit which had been exposed to the elements.

Conclusion

This chapter has attempted to describe how factors governing the nature of opalite bedrock constrained or facilitated toolstone extraction. We identified the factors, referring to them as compromising the bedrock topography, and described their effects on toolstone extraction elsewhere. Projecting from these descriptions, we anticipated what we might see at Locality 36 in terms of the influence of bedrock topography on toolstone extraction. Here, we offer a synopsis of what we observed. Given our understanding of toolstone extraction at Locality 36, and the way in which it was affected by the bedrock topography, we formulate hypotheses that are relevant to cost minimizing/rate maximizing toolstone extraction behavior; these are evaluated in Chapter 12.

The location of opalite beds at Locality 36 determined the placement and the development of quarry features. While this may seem trivial, it is important to recall that opalite beds at the locality are buried, for the most part, which leads us to conclude that prospecting played a significant role in the location of usable toolstone at the locality. Whether quarriers divined toolstone locations, or whether they probed the ground prior to toolstone extraction is difficult to determine, since the abundance of material produced during extraction masks these activities.

Second, depending upon the bedrock setting, toolstone extraction at Locality 36 proceeded in different directions and formed different quarry features. If opalite beds tended toward or intersected the surface from which quarriers worked, then the exposed vertical face was worked back forming an adit. This contrasts somewhat with similar bedrock settings at 26Ek3084 and 26Ek3208, where not only the face was worked back but pits were excavated into the outcrops as well (Elston and Dugas 1992; Leach, Dugas, and Elston 1993). If opalite beds at Locality 36 were nearly horizontal to the working surface, then extraction proceeded downward and pits were formed. In addition, beds of tuff underlying beds of opalite often were undermined in order to isolate ledges of stone from which packages could be extracted. A combination of these activities, applied for a long period in the southern portion of Area B, produced a large depression in the opalite bedrock. During



Figure 89. Opalite chunk separated from bedrock by natural processes.

extraction, structural features almost certainly facilitated the removal of toolstone while massive opalite inhibited extraction efforts. Too, it is likely that the size and shape of packages procured from the beds determined the size and shaped of bifaces that eventually were transported from the locality.

We demonstrated that toolstone quality and ease of extraction are associated positively. Based upon the observations of a lithics specialist, massive, high quality toolstone beds are the most difficult places to undertake extraction; tufaceous beds, or beds exhibiting well developed fractures contained the poorest quality of toolstone packages, yet these packages are least difficult to extract. Thus, quarriers faced a trade-off between toolstone quality and ease of extraction.

One goal of this report is to evaluate the lithic procurement model outlined in Chapter 1. We assume that toolstone extraction, as a component of the lithic production system, involves some of the highest costs of lithic procurement. Therefore, it is reasonable to expect that this component of the system should evidence some of the most cost-effective and rate-maximizing behaviors; two of these are likely to include the selection of toolstone beds, based upon the amount and kind of overburden overlying them, and the selection of toolstone from places in the bedrock according the return rate which that place yields.

Locality 36 is covered by colluvium and soils of various depth and consistence (cf. Chapter 7). Moreover, with the possible exception of one of the bedrock settings at the locale (cf. Chapter 8, Area C), toolstone beds were all subsurface. Analysis of radiocarbon dates and stratigraphy presented in the previous chapter suggested that toolstone extraction commenced where toolstone beds could be accessed with the least effort, and proceeded thereafter to beds where extraction required more time and effort. In Chapter 12, we examine this hypothesis in terms of another line of evidence: regarding the nature of deposits overlying toolstone, we calculate which of them could have been removed quickest, and determine those places where toolstone extraction most likely commenced.

Once beds are exposed, a second way in which quarriers could have maximized toolstone extraction rates would have been to focus on those area of the bedrock that returned to them the greatest amount of usable toolstone packages per unit of time. Therefore, we propose that quarriers may have compromised toolstone quality for ease of extraction, but only to the point where usable stone remained obtainable. In Chapter 12, we calculate rates of extraction among quality rankings of stone and evaluate which of those places across the bedrock was quarried most intensively.

Chapter 10

DISTRIBUTION STUDIES

Eric E. Ingbar

This chapter examines the spatial distribution of artifacts and features at Locality 36. Our purpose is to elucidate *site structure*: patterns in the spatial occurrence and covariation of artifacts and features.

Several different sets of data are used here to examine spatial patterning. First, feature distributions are examined. Features, especially ones as large as quarry pits, serve as fixed points which constrain how space can be used by site occupants (Binford 1983). Second, the distribution of debitage is studied. Since debitage is the most frequent artifact class, its distribution constitutes a spatial "signature" of the site. As well, the spatial occurrence of debitage attributes yields several patterns interpretable in terms of where different technological acts most often took place. Third, the distribution of a single distinctive variety of local opalite is examined. The purpose of this examination is two-fold: to see how far material from a specific source was transported and to determine whether its use can be considered a chronological marker. Fourth, the spatial distribution of tools is discussed. The occurrence of the two most frequent tool classes—bifaces and hammerstones—is studied and some of their attributes are discussed. Fifth, spatial variation in assemblage contents from three quarry pit complexes (cf. Chapter 9) is used to delineate how areas that probably had similar functions differ from each other. Linking the patterns found in the preceding studies is the subject of the concluding discussion, which considers both how Locality 36 was used by its prehistoric occupants and the spatial structure of quarry/workshop locales in general.

Feature Distribution

Pre-existing features and other non-portable artifacts of human action often determine how site space is used (Bartram, Kroll, and Bunn 1991; Binford 1978, 1983; O'Connell, Hawkes, and Blurton-Jones 1991; Gregg, Kintigh, and Whallon 1991). In this light, Locality 36 features are examined in relationship to each other and to local topography.

Surface Features

The distribution of quarry features at Locality 36 is conditioned by accessible opalite deposits in the western portion of the site (Figure 90). Most quarry pits occur in clusters or complexes of many adjacent pits. Debitage aprons (cf. Chapter 3) surround the pit clusters.

Reduction features/lithic scatters dominate the central flat ridge top where six of the largest lithic scatters are located. Smaller lithic scatters occur in almost every other topographic setting in the site. The debitage aprons undoubtedly contain reduction features/lithic scatters comparable to those we were able to recognize as discrete, so that, in a sense, debitage aprons can be considered high density rings of reduction features around and within quarry pit complexes.

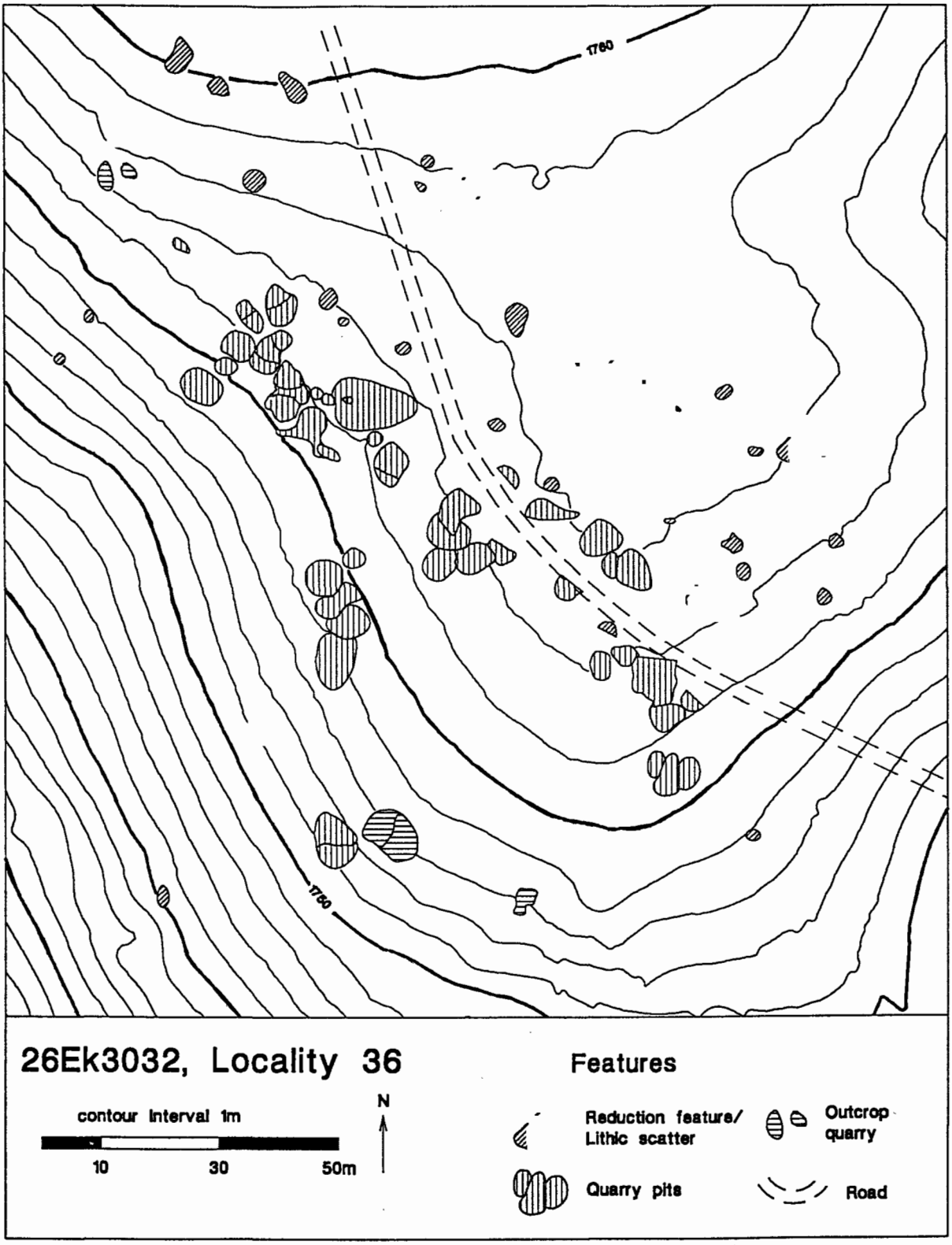


Figure 90. Feature distributions.

The ethnographic literature on quarrying suggests that toolstone extraction localities should exhibit associated reduction areas (Burton 1984; Jones and White 1988; cf. Elston and Dugas 1992). During use of a particular toolstone source, "satellite" reduction features/lithic scatters are created by the work party as they find suitable locations for reducing toolstone blocks. At Locality 36, reduction features/lithic scatters are visible only outside the debitage apron areas, but their distribution relative to quarry pits still can be examined. Figure 91 records the distance from each reduction feature margin to the nearest quarry pit margin. Two distributions of distance to nearest quarry pit are apparent, one consisting of features 2 to 10 meters from nearest quarry pits and a second of features 10 to 30 m distant. Were individual reduction features distinguishable within debitage aprons, a much higher frequency of near neighbors doubtless would emerge. The two modes may indicate a generally organized use of space within the site. Reduction features/lithic scatters within 10m of quarry pits may have resulted from reduction immediately associated with quarrying, perhaps occurring simultaneously. More distant scatters also may have been associated with quarrying, but could represent later reduction, as knappers chose comfortable spots in which to continue work outside quarrying locales.

Topographic relationships include the coincidence of quarry pits and debitage aprons with the western ridge slope (where exploitable opalite is located) and the extensive use of the broad, flat ridgetop for lithic reduction following toolstone extraction. As discussed above, the two relationships are mutually conditional. That is, reduction features/lithic scatters may be more evident east of the quarry pits because debitage aprons are more common west of them.

The distribution of surface features at Locality 36 may constitute a useful comparative case for the study of other sites. The debitage aprons make it impossible to see spatial distributions akin to ethnoarchaeologically described discrete quarrying episodes, but there is structure to their distribution. Quarry features appear embedded in a high density of debitage, and small "islands" of debitage occur further away. This spatial arrangement may well be a signature of long-term or

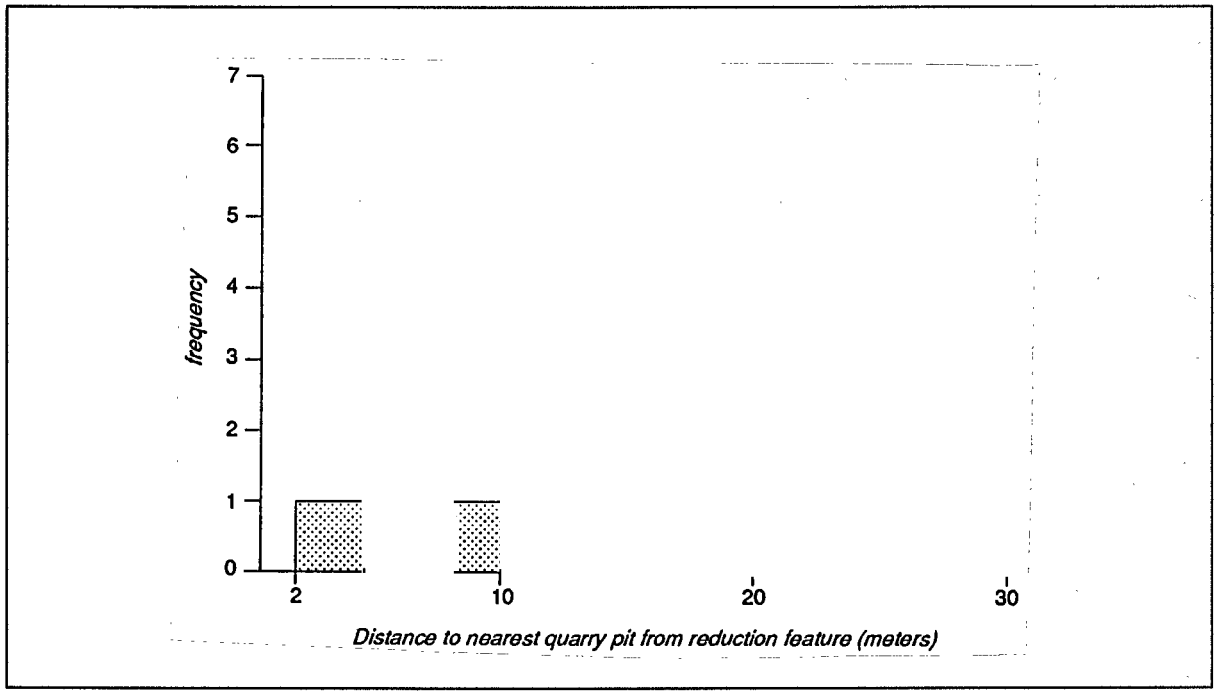


Figure 91. Histogram of distances from reduction feature margins to nearest quarry pits.

intense quarry use, and therefore may produce an index useful in studying other quarry areas through intensive surface recording.

Subsurface Features

The recognized distribution of subsurface features is conditioned, of course, by where we dug, and we found buried features only with mechanized equipment. Because we placed backhoe trenches purposefully, the buried quarry pits and adits found in or near surface quarry pits are not very useful for distributional studies; their distribution simply confirms that where there is one quarry feature there likely are more (cf. Chapter 9). However, we also used a road grader to remove surface sediment from the ridge, and this revealed a set of subsurface features useful for spatial studies because the area scraped was extensive. One surface reduction feature (Feature 70) was found to be a buried quarry pit and six hearths, the only ones found at the locality, were discovered.

The depth of sediment overlying the features was variable; Features 105, 106, 107, and 109 (Figure 92) were discovered between 10 and 20 cm below the modern surface, while Features 108 and 110 were found at 5 to 10 cm (cf. Figure 23). Since the stratigraphic levels of origin were destroyed by grading, assessment of the association between hearths and surface lithic scatter features is difficult. Two hearths (Features 106 and 109) fall within the boundaries of reduction features defined on the original ground surface. Neither surface feature (Features 65 and 69) was explored with excavation units, so the depth of debitage distributions in them is unknown. However, since the surface reduction features/lithic scatters tested on the ridge top proved to contain artifacts to at least 10 cm below surface, it is possible that Features 106 and 109 are associated with surface lithic scatters.

Radiocarbon assay yielded dates of 410±60 B.P. from Feature 106 (Beta-42488), 330±50 B.P. from Feature 105 (Beta-42487), 310±60 B.P. from Feature 109 (Beta-42490), 280±50 B.P. from Feature 107 (Beta-42489), and 150±70 B.P. from Feature 110, the possible hearth (Beta-42491). Depth correlates roughly with age (cf. Figure 23); the three most deeply buried features are the oldest, and the shallowly buried feature is the youngest. Feature 108 was not assayed, but, since it was shallow, we suspect it to be quite young.

A quarry pit adjacent surface Feature 70 (a reduction feature/lithic scatter) also was uncovered by grading. The quarry pit apparently was covered by approximately 10 to 20 cm of surface sediment. No further investigation of this feature was undertaken. Since no data are available on it, it has been omitted from analysis and Feature 70 is still considered a reduction feature for analytical purposes.

Debitage Distribution

We examine two aspects of the Locality 36 debitage assemblage. The distributions of flakes (regardless of technological characterization), flake attributes and angular debris are described. Second, we describe technological characterizations (cf. Chapter 4) in different parts of the site. For the sake of clarity, we briefly restate the conditions under which a sample set was collected; greater detail on particular debitage collection strategies are present in Chapters 3 and 4.

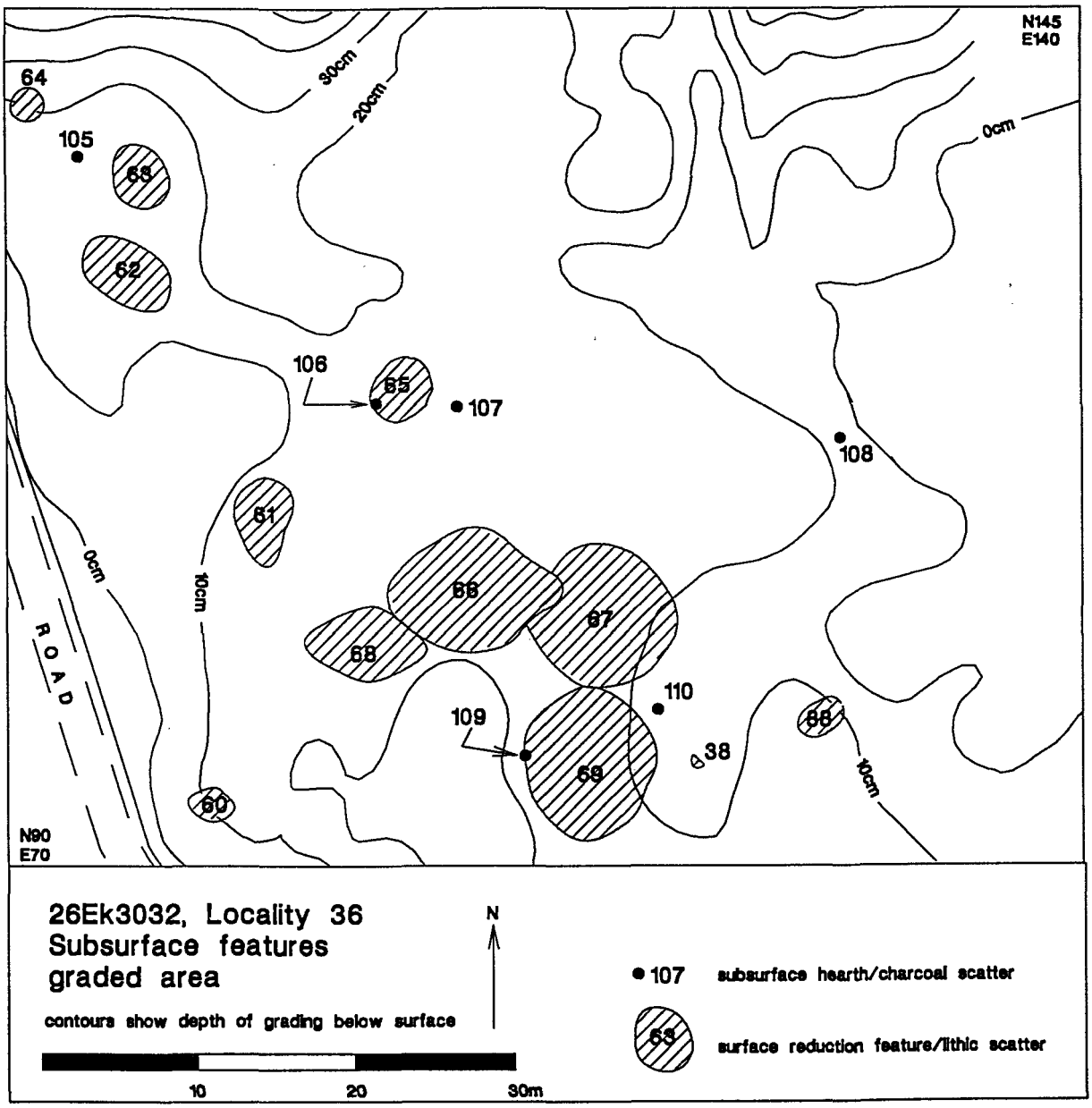


Figure 92. Distribution of subsurface hearth features.

Debitage Size and Frequency Variation

The general distribution of debitage is interesting because it is a major constituent of overall artifact distribution and provides an indirect measure of the frequency with which lithic reduction occurred in different parts of the site over time. For example, if there is a general pattern of reduction within 20 m of quarry pits (creating debitage aprons), a zone of relatively little use 10 to 20 m away from the quarry pits, and sporadic reduction features/lithic scatters greater than 20 m from them, as we have suggested, then this pattern should be apparent in the overall distribution of debitage.

The most appropriate sample set is the locality-wide coverage of 25x25 cm surface scrapes, comprising a systematic random sample of 522 units. Two samples were drawn from random locations within each ten meter block of the site. Sample in roadways were excluded from collection. Each sample was passed through 1/4 in. mesh. Initial analysis consisted of counting and weighing flakes, counting and weighing angular debris greater than 2 in. in maximum dimension, and weighing angular debris smaller than 2 in. in maximum dimension. The sample reflects slightly more than one percent of the surface area of the locality.

The values for each scrape were used to generate contour maps of assemblage attributes. Counts and weights of flakes and angular debris, along with their coordinates in the site grid, became the input data set for isoline map generation. Unlike plotting topographic contours, plotting data values often generates very complicated isoline patterns, a problem exacerbated when variate value distributions are non-normal. To alleviate this while conveying something of the distribution of variate values, all isoline plots of debitage values presented here follow a simple convention whereby contour intervals are based on the quartiles of the distribution. The lowest isoline is the first quartile, the second isoline is the median, the third is the third quartile, and the fourth is the outer fence (the third quartile plus 1.5 times the difference between the first and third quartiles; cf. Fox 1990). The isoline plots of variates convey the spatial distribution of a particular variable's frequency and its distribution. To render differences in values more graphically, wire-mesh plots were generated for some variables.

Flake frequency (extrapolated per square meter; Figure 93) is highest near quarry pits. High flake frequencies are common southwest (downslope) of the quarry pits. Most areas of flake frequency higher than the median value of 420 flakes per square meter are debitage aprons associated with quarry pit complexes. Small higher frequency areas in the center of the northeastern quadrant of the site do not correspond with known feature locations. Since eolian silt tends to accumulate on this ridge top, these may be shallowly buried reduction features/lithic scatters.

The total weight of flakes (extrapolated per square meter; Figure 94) generally reflects their frequency. Again, the highest weights per square meter are associated with quarry features. Figure 95 compares standardized scores (z-scores) for total flake weight subtracted from standardized scores for flake frequency, comparing the two distributions directly by showing differences in both frequency and weight. Negative values indicate areas having heavier than average total flake weights relative to flake frequency, positive values the reverse. Three areas have very high total flake weights relative to flake frequency: around Features 51 and 52, near Feature 9, and an area not associated with any known features in the west central part of the site.

High total flake weight relative to flake count in a sample indicates high *average* flake weight within the sample. When average flake weight is plotted (Figure 96), highest average flake weights correspond to the same three areas mentioned above. Average flake weight is also high in

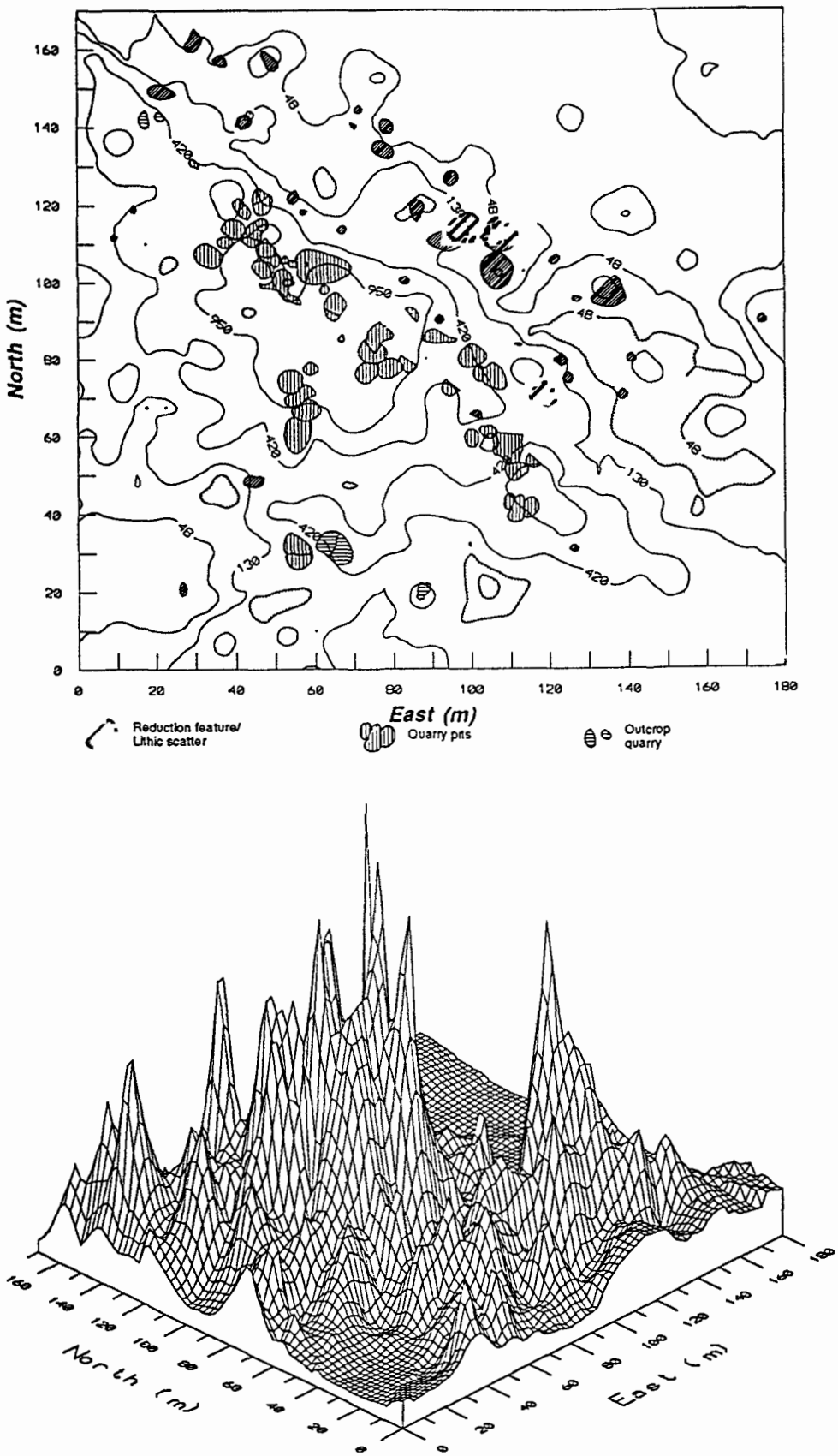


Figure 93. Isoline and wire-mesh plots of total flake frequency per square meter, based on 25 cm by 25 cm surface scrape data.

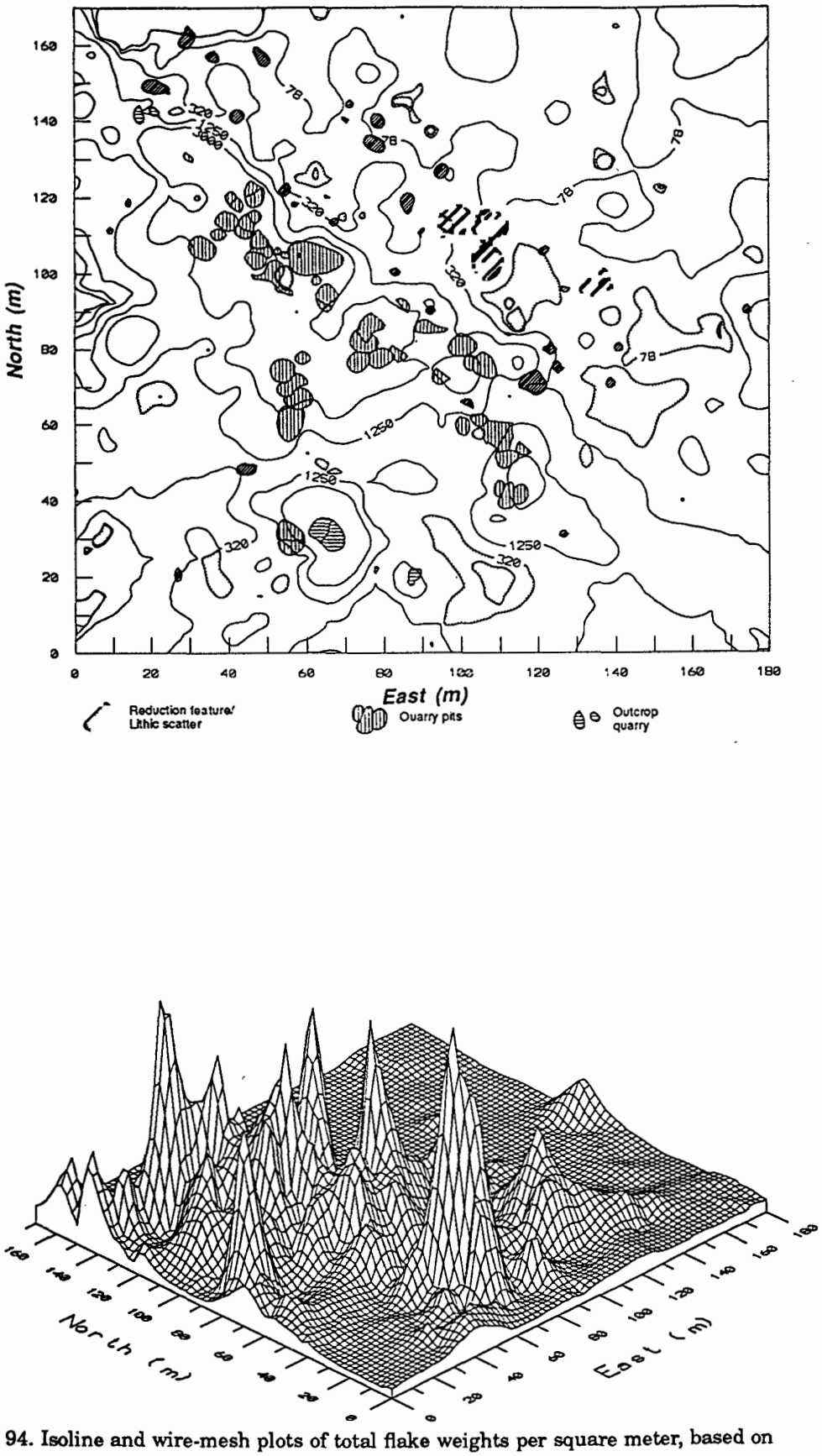
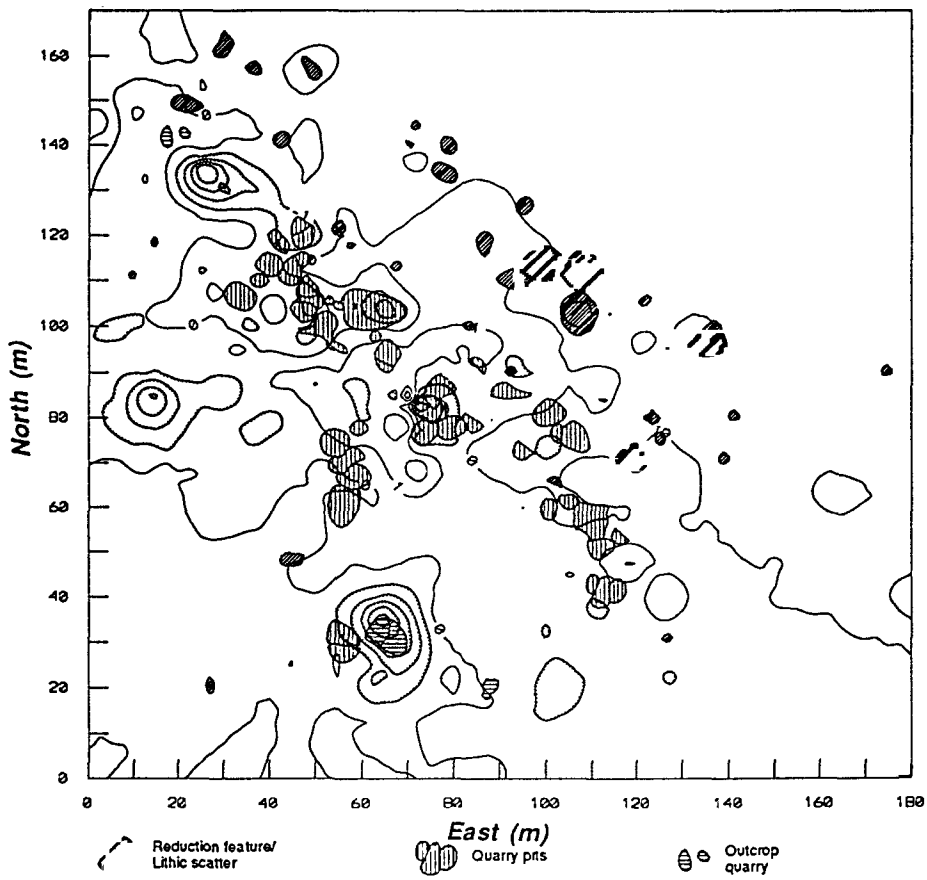


Figure 94. Isoline and wire-mesh plots of total flake weights per square meter, based on 25 cm by 25 cm surface scrape data.



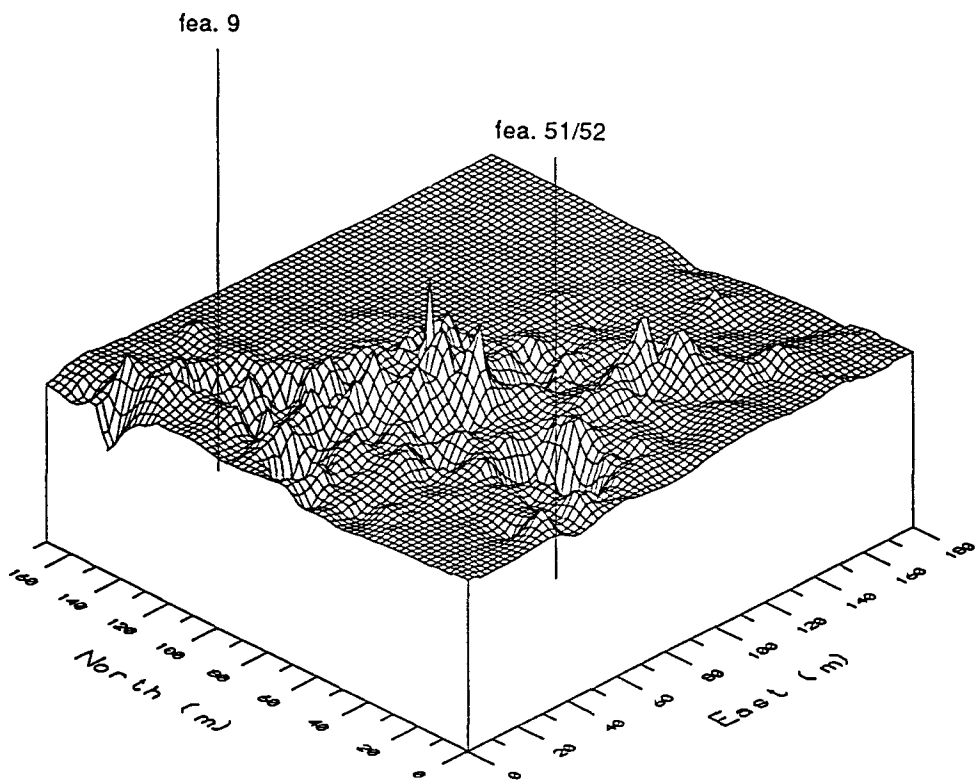
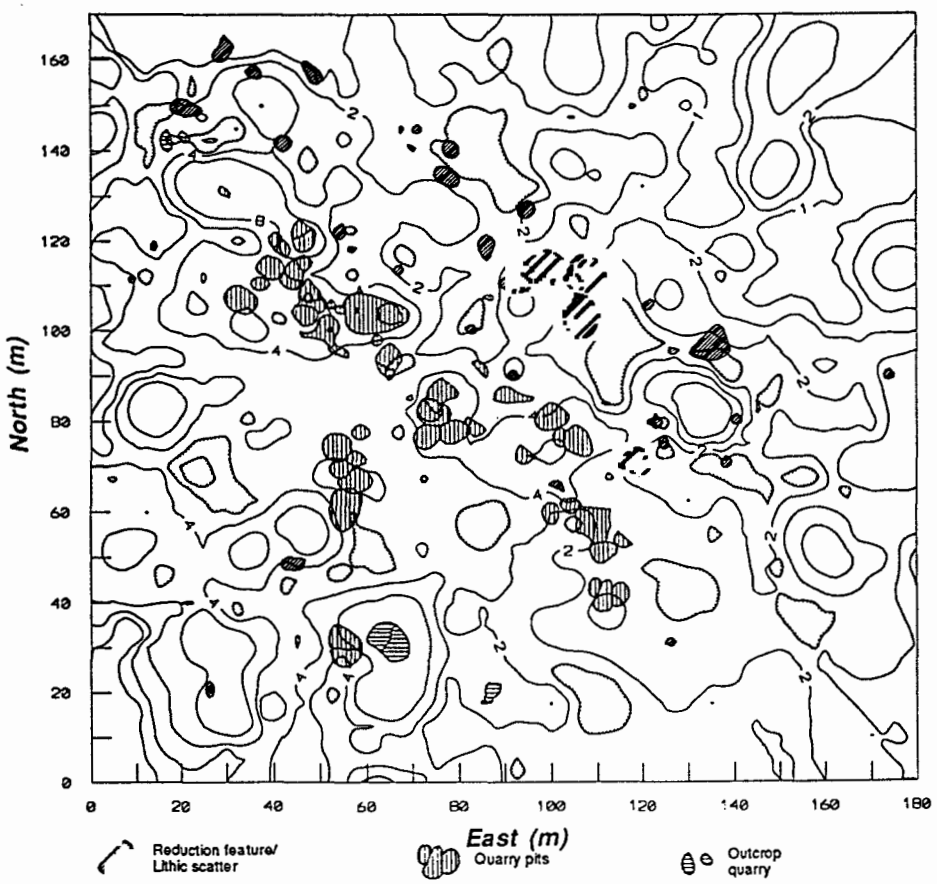


Figure 95. Isoline and wire-mesh plots of z-score values for total flake frequency minus z-score values for total flake weight, based on 25 cm by 25 cm surface scrape data.



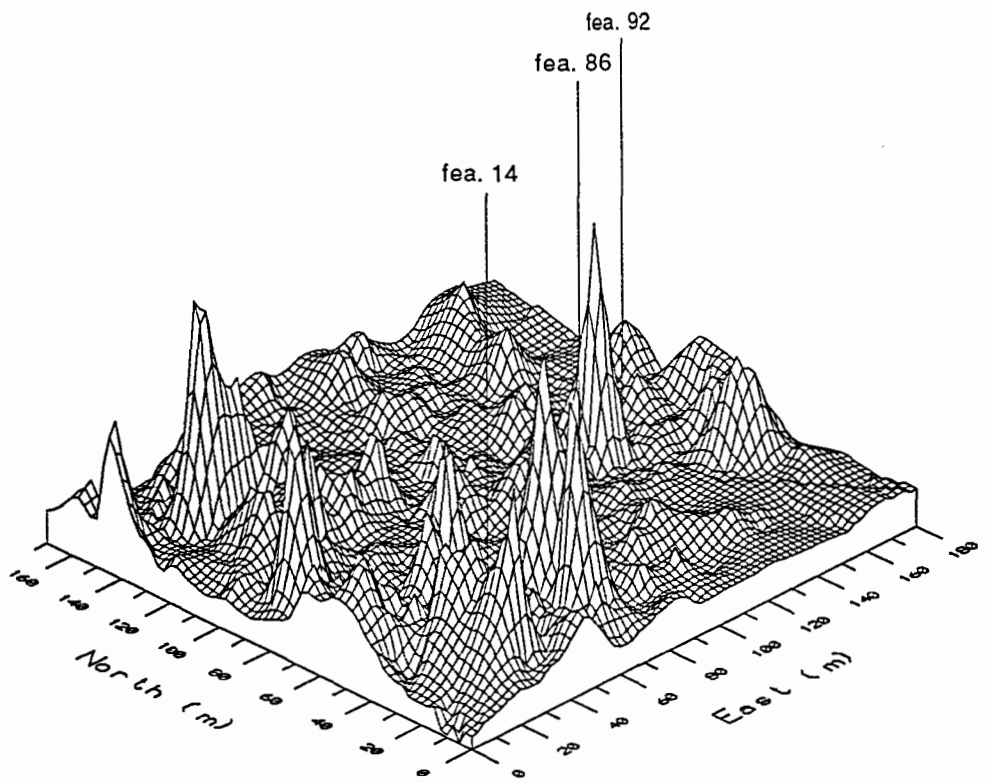


Figure 96. Isoline and wire-mesh plots of average flake weight, based on 25 cm by 25 cm surface scrape data.

several other parts of the site, notably around the main complexes of quarry pits (although not around Features 71 through 74), and near three reduction features/lithic scatters (Feature 14 in the southwest part of the site, and near Features 86 and 92 in the central eastern part of the site).

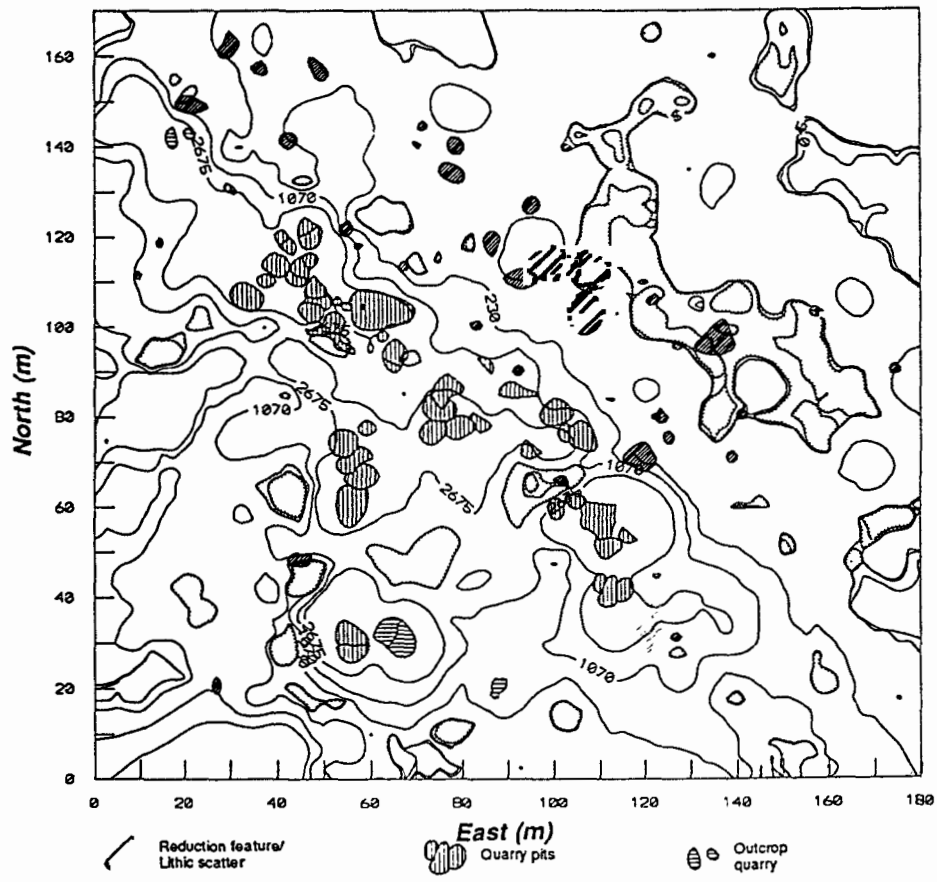
The utility of examining average flake weight extends beyond elucidating patterns. In principle, average flake weight should be greatest at the initiation of lithic reduction when large flakes are driven from cores. Average flake weight then should diminish through the reduction sequence, as ever thinner or smaller flakes are struck to shape a core or tool (Ingbar, Larson, and Bradley 1989). In practice, it is fairly easy to forecast some exceptions to this general proposition: intensive trampling of a debitage assemblage will increase the breakage frequency, causing average flake weight to decrease (Prentiss and Romanski 1989); so too, differential friability of raw material may cause flakes of one material to break more often than those of another, and cores of different sizes may produce flake assemblages of different average flake weights within the same reduction stages (cf. Chapter 4). Thus, the observed pattern may well reflect not only reduction, but numerous other factors. Sorting variation in flake size caused by lithic reduction actions from such other factors requires consideration of additional attributes of the debitage assemblage.

Areas of high average flake weights resulting from initial reduction of toolstone also should have high angular debris weights (Figure 97), since initial reduction produces primarily angular debris and large flakes. High average flake weight areas around Features 51 and 52, at the northern end of the main quarry pit complex, and in an area unassociated with known features centered on N80/E10, meet these criteria. Since Features 51 and 52 are opalite outcrops with associated lithic scatters, production of large flakes and much angular debris may reflect the extraction techniques used there (cf. Chapter 9). More generally, extraction and initial reduction of large pieces of stone (whether from pits or outcrops) may result in such values; perhaps this is the case for the area at the northern end of the main quarry pit complex around Feature 9. The area centered on N80/E10, on the other hand, lies in a swale downslope from the main quarry pit complexes. The high values for average flake weight and angular debris weight could be due to colluvial movement of material from above, if the debitage in this area is not in its original depositional locus. If it is in its original place of deposition, then perhaps smaller items were washed from it, leaving a lag deposit of large flakes and angular debris.

There also are areas having low to median values for mean flake weight and high weights of angular debris—around Features 78, 79, and 80, and west of Features 2 and 3 in the northwestern corner of the locality. These may be places where extraction debris or initial reduction of extracted blocks occurred without much further reduction; alternately, the toolstone extracted may not have been amenable to production of large flakes.

The converse pattern (high average flake weights and low to median total weights of angular debris) occurs as well. The area between Features 84 and 92, as well as the eastern margin of the site, exhibit this pattern. These may be areas in which little initial toolstone reduction took place. High average flake sizes may indicate later reduction of large pieces of opalite, or less post-depositional trampling. Insofar as angular debris weight reflects extraction or initial processing of toolstone, Figure 97 also shows that such actions have a close spatial association with toolstone sources.

Isoline plots for average flake weight and angular debris weight suggest that initial reduction of toolstone is spatially limited to areas close to quarry features. The ratio of total flake weight to total angular debris weight (Figure 98) exposes the relative proportions of each kind of debitage. In general, the western third of the site (west of almost all the quarry pits) has very little angular debris (cf. Figure 97); flakes (usually at least 25 times the weight of angular debris) dominate debitage aprons downslope of quarry pits. Near the major quarry pit complexes, and downslope (southwest) from them,



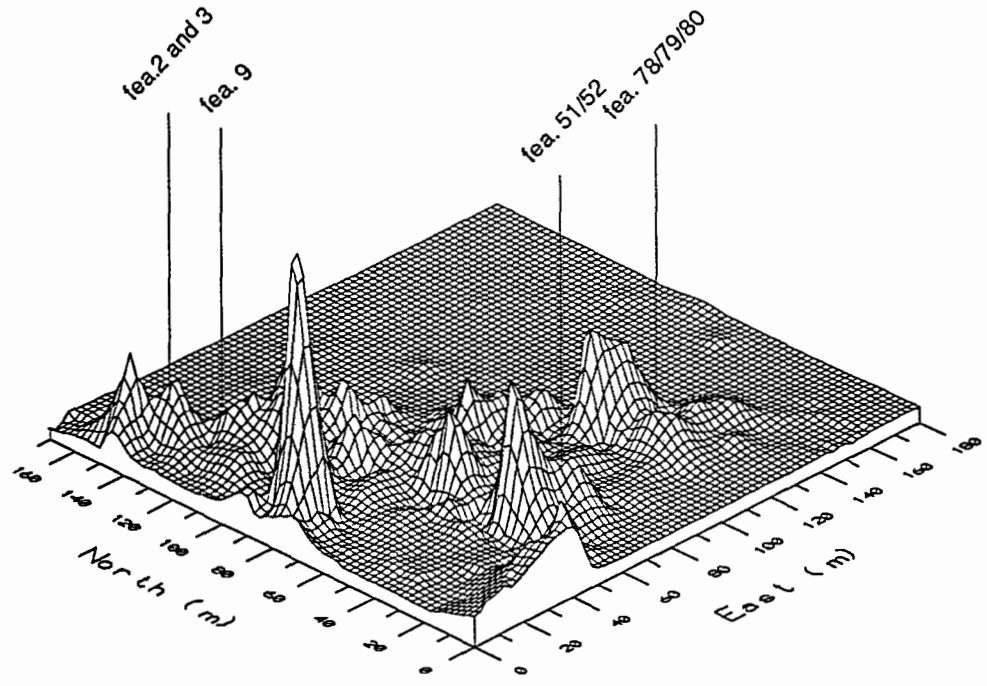
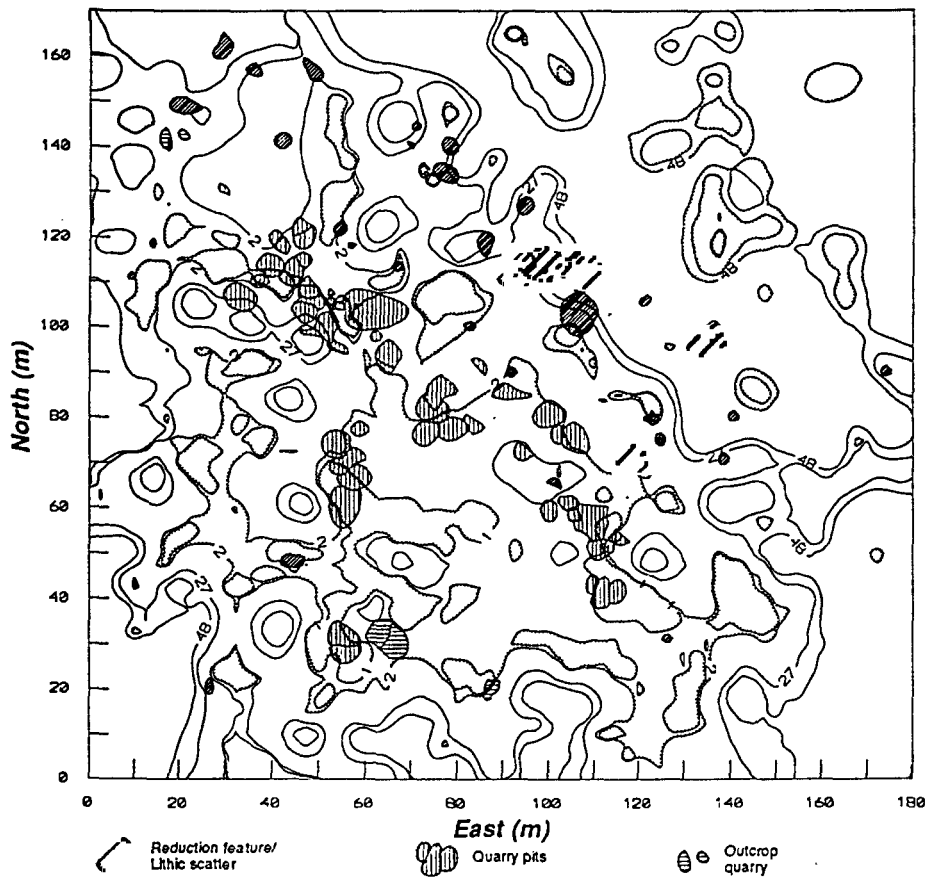


Figure 97. Isoline and wire-mesh plots of total angular debris weight per 25 cm by 25 cm area, based on 25 cm by 25 cm surface scrape data.



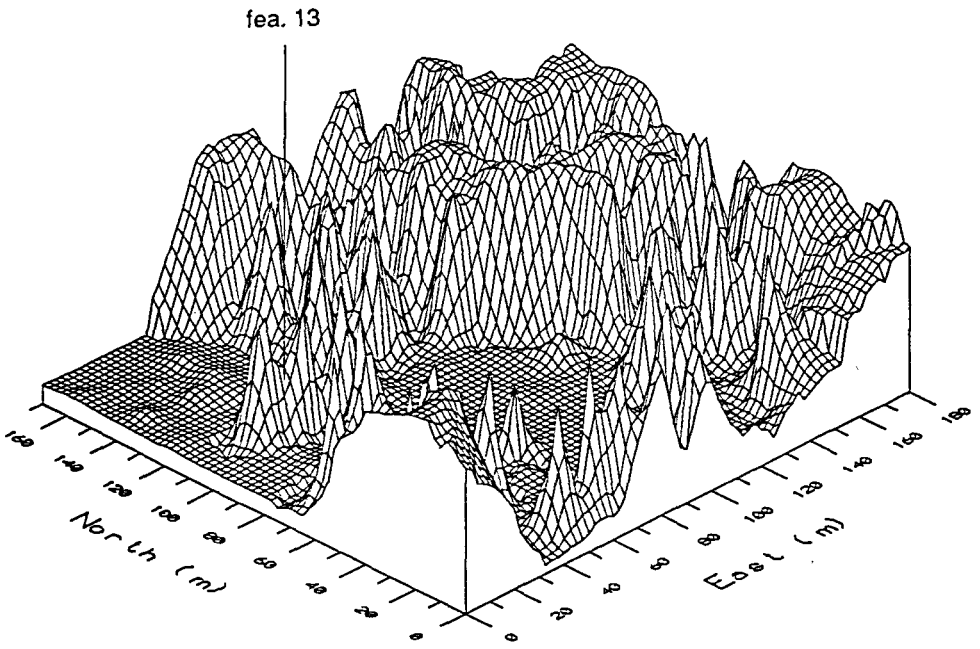


Figure 98. Isoline and wire-mesh plots of total flake weight divided by total angular debris weight, based on 25 cm by 25 cm surface scrape data.

the pattern is reversed: angular debris dominates. An interesting exception to this overall pattern is seen near Feature 13 in the west central part of the site, where an area of low angular debris weight (cf. Figure 97) contains a relatively high weight of flakes. This, perhaps, was an area where later reduction of toolstone occurred exclusively, but it is uncharacteristically close to the quarries.

This initial examination of debitage distribution, using several gross attributes of the samples, shows several interesting patterns. First, the spatial signature of debitage frequency clearly is tethered to quarry pit locations: debitage aprons appear as distinct, high frequency, high weight scatters of flakes and angular debris. Second, generalizations about the kind of reduction represented in debitage aprons may be risky: there are areas with little angular debris and many flakes, the converse, and broad scatters of flakes of different sizes. Third, the debitage attributes of areas away from the quarry and the quarry associated debitage aprons are not simple, although there is virtually no angular debris more than 10m east (upslope, in general) from quarry pits. For example, the area of larger flakes found in surface scrape units between Features 84 and 92 is unique away from the quarry pit. Thus, it is difficult to support a model of uniformity amongst reduction settings.

These results lead to further inquiry: is there a systematic relationship between the attributes used above and technological characterizations (cf. Chapter 4)? This was examined by undertaking technological analysis of 64 surface scrape unit debitage samples. Sample selection was entirely purposive, predicated on total flake weight and total flake count (Figure 99). A total flake weight of 420 g was used to divide the debitage assemblage into two groups of high and low weight. Samples then were selected from each of the two weight groups. Similarly, a count of 100 items (per 25x25 cm surface scrape unit) discriminated high and low count samples. The samples then were analyzed technologically using techniques discussed in Chapter 4.

Figure 100 shows the sample distribution across the locality on the isoline plot used to compare total counts and weights. The overall frequency of individual technological characterizations (Table 39) is similar to that found in the other technologically analyzed samples (cf. Table 9). However, when frequencies of individual technological characterizations are cross-tabulated by count and weight classes (Table 40) some simple patterns become evident. All samples contain quarrying and mass reduction debitage. Later stages of reduction, particularly blank preparation and early biface thinning, are more common in high count samples. Because the high count-high weight group contains only two samples, it probably should be excluded from consideration. Thus, later stages of reduction are most common in the high count-low weight group. High count-low weight samples are, of course, those with the lowest average flake weights. Therefore, the analytical results support the model posed above in which lower average flake weights were posited to indicate later stages of reduction. This analysis cannot be extended to numerous surface scrape samples due to the small numbers of flakes recovered from them.

Table 39. Frequency of Single Characterizations, 25x25 cm Surface Scrape Debitage Samples (n=64).

Category	n	% of total
Q	53	82.8
M	63	98.4
B	30	46.9
E	17	26.6
L	6	9.4

Key: Q = quarrying; M = mass reduction; B = blank preparation; E = early biface thinning; L = late biface thinning

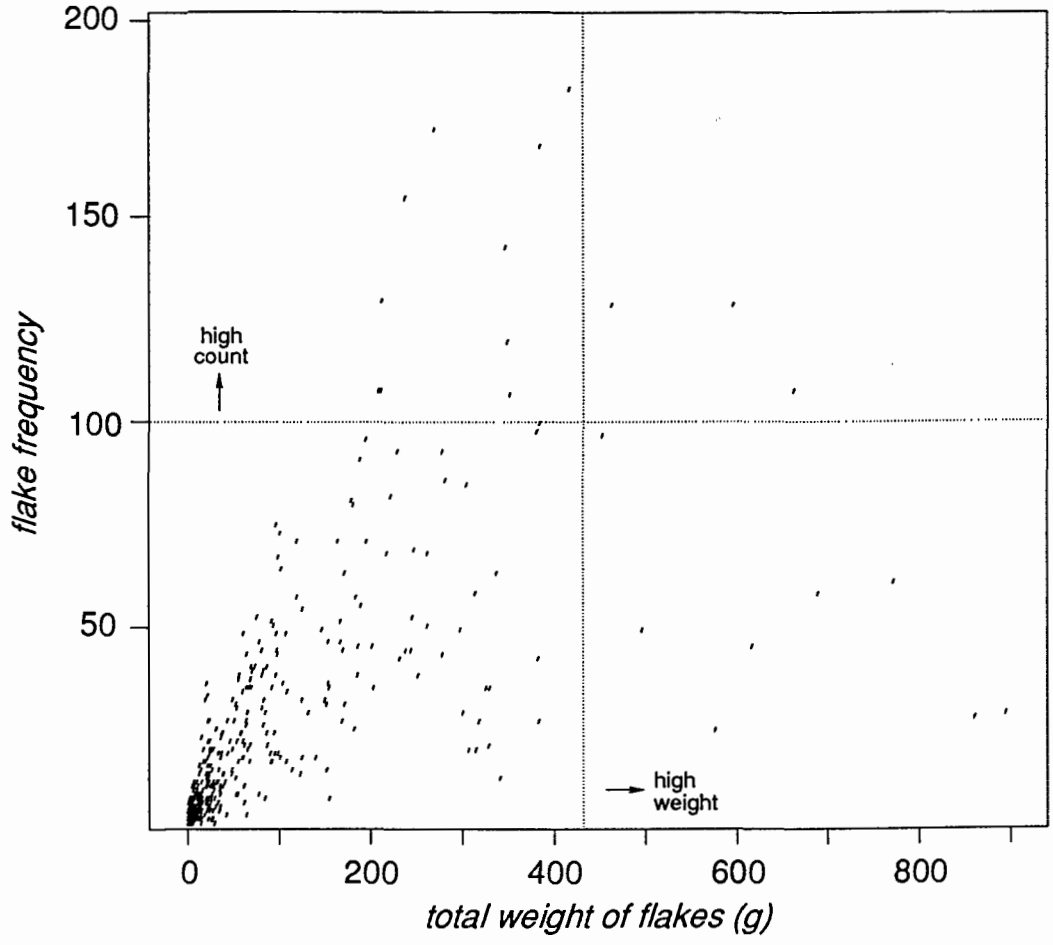


Figure 99. Scatter plot of flake frequency vs. flake weight for all 25 cm by 25 cm surface scrape debitage samples.

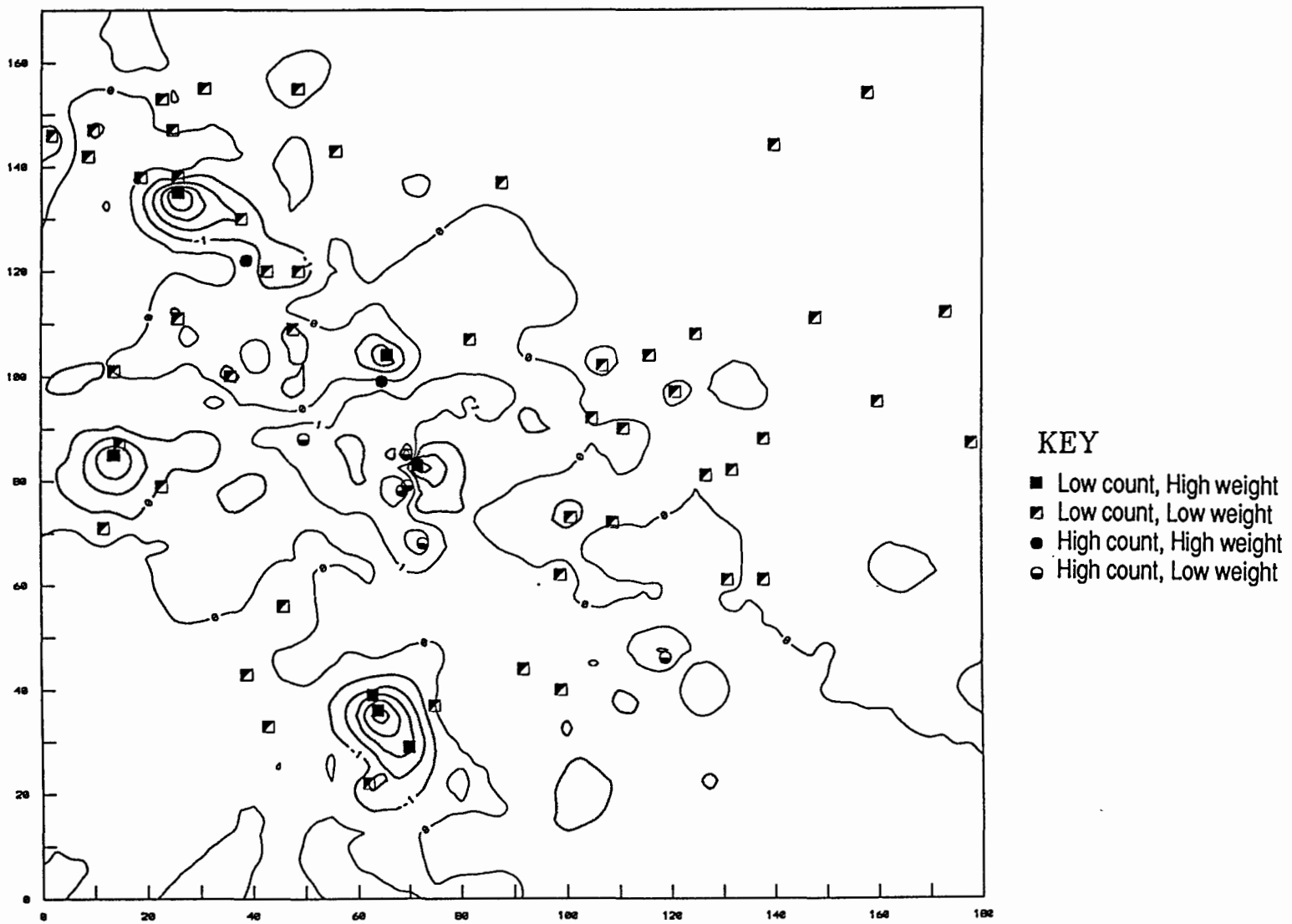


Figure 100. Distribution of technologically analyzed 25 cm by 25 cm surface scrape samples.

Table 40. Frequency of Single Characterizations Cross-tabulated by Count and Weight Groupings, 25x25 cm Surface Scrape Debitage Samples.

	HIGH COUNT				LOW COUNT			
	High Weight (n=2)		Low Weight (n=6)		High Weight (n=7)		Low Weight (n=49)	
Category	n	%	n	%	n	%	n	%
Q	2	100.0	6	100.0	7	100.0	38	77.6
M	2	100.0	6	100.0	7	100.0	48	98.0
B	2	100.0	5	83.3	4	57.1	19	38.8
E	2	100.0	4	66.7	1	14.3	10	20.4
L	1	50.0	1	16.7	0	0.0	4	8.2

Key: Q = quarrying; M = mass reduction; B = blank preparation; E = early biface thinning; L = late biface thinning

Technological Variation in Debitage

Here we compare the debitage from different feature settings to determine whether there is an association between lithic reduction actions and any particular feature classes. This was discussed in passing in Chapter 4, where the technological analysis of quarry pit debitage samples was contrasted with results from other Tosawihi quarry sites. Results of technological analyses from different feature contexts *within* the locality are compared here.

The samples used for this analysis are the 319 samples discussed in Chapter 4. The frequencies of individual technological characterizations, following the conventions used already, were tabulated for each feature context. However, trace amounts of a particular characterization were grouped with absent, and the dominant and frequent characterizations were summed (Table 41). For each contrast, a contingency table was made, comparing the frequencies of characterizations between the two feature contexts (e.g., quarry pits vs. reduction features, quarry pits vs. all non-quarry settings). Chi-square then was calculated. If this was statistically significant at a confidence level of p=0.05, adjusted standardized residuals (Everitt 1977, Grayson 1984) were derived to explore the direction of difference and permit interpretation. This use of chi-square is not intended to serve as a test of hypotheses; rather, it is a technique for elucidating pattern. Results are presented in Table 42.

Table 41. Frequencies of Technological Analysis Single Categorizations by Context.

Technological Characterization	Quarry Pit/ Quarry Area	Reduction Feature	Hearth/ Possible Hearth	Non-Feature	Feature 102[1]
Q* or Q	103	2	0	54	30
q or none	19	112	18	11	5
M* or M	107	49	7	64	32
m or none	15	65	11	1	3
B* or B	59	90	14	31	17
b or none	63	24	4	34	18
E* or E	61	85	14	17	14
e or none	61	29	4	48	21
L* or L	3	13	0	6	0
l or none	119	101	18	59	35

[1]Already included in frequencies listed for quarry pit/quarry area samples.

Key:
Q = quarrying
M = mass reduction
B = blank preparation
E = early biface thinning
L = late biface thinning

Lower case: Trace Quantity
Upper case: Frequent
Upper case w/asterisk: Dominant

Table 42. Summary of Results for Contingency Table Contrasts of Individual Technological Analysis Characterizations by Feature Contexts.

Presence/Absence of Technological Characterization	Quarry Pit/ Quarry Area to Reduction Features	Quarry Pit/ Quarry Area to Non-Feature Area	Reduction Features to Non-Feature Area	Reduction Features to Hearths and Possible Hearths	Quarry Pit/ Quarry Area to Feature 102
Quarry debris	more in quarry areas	no significant difference	more in non-feature area	no significant difference	no significant difference
Mass reduction	more in quarry areas	more in non-feature areas	more in non-feature areas	no significant difference	no significant difference
Blank preparation	more in reduction features	no significant difference	more in reduction features	no significant difference	no significant difference
Early biface thinning	more in reduction features	more in quarry areas	more in reduction features	no significant difference	no significant difference
Late biface thinning	more in reduction features	more in non-feature areas	no significant difference	more in hearth areas	no significant difference

Compared to reduction features, quarry pit and quarry area debitage samples have more early reduction (quarrying debris from extraction of opalite and mass reduction flakes struck to shape a core; cf. Chapter 4) and less later reduction (blank preparation, early and late biface thinning). When quarry pit and quarry area debitage samples are compared to those from non-feature contexts (collections made from excavation units having no feature associations), non-feature settings have more mass reduction and late biface thinning debitage (although we observed few specimens of the latter). Quarry pit and quarry area samples have more early biface thinning than do non-feature samples. Relative to reduction features, however, the non-feature samples are technologically earlier. In sum, samples from three general contexts (quarry pit, reduction feature, and non-feature area) show that quarry features exhibit earlier stage reduction than reduction features, non-feature samples are technologically intermediate between the two other settings, and the major differences between quarry debitage samples and non-feature debitage samples are that the latter have disproportionately high frequencies of mass reduction and low frequencies of early biface thinning. This suggests that the non-feature debitage samples reflect an entirely different suite of technological behaviors: they seem both later (having more mass reduction) and earlier (having significantly less early biface thinning) than quarry samples.

The results may indicate the spatial extent of different technological actions. Quarrying debris clearly is limited to the surroundings of bedrock sources, as both this analysis and the general debitage distribution analyses demonstrate. Blank preparation and early biface thinning also are somewhat spatially restricted, evident mostly in accumulations of debitage. We defined such accumulations as features (either reduction feature/lithic scatters or quarry pits). Once the activities forming such features began, or had occurred in a place before, they tended to recur in the same portion of site space. Mass reduction debitage, the hallmark of non-feature samples, is not so restricted in its spatial occurrence; in fact, it occurs most frequently outside organized reduction or quarry features. So, different technological actions may have similar spatial extents. Early biface thinning may be restricted spatially, depositing debris in only a small radius. Quarrying is more spatially extensive, and mass reduction more extensive still. These spatial extents can overlap, and only through analysis of technological attributes can they be isolated.

We undertook comparison of the debitage assemblages from hearths and possible hearths with those from reduction features/lithic scatters, although the number of interpretable samples

from hearth settings is low (cf. Table 41). The sole difference between these two contexts, technologically, is a higher than expected frequency of late stage thinning in hearths.

We made another technological comparison, between Feature 102, a buried quarry feature dating to approximately 4000 yrs. B.P. (cf. Chapter 8), and all other quarry pit debitage assemblages. Feature 102 debitage samples had a higher frequency of early biface thinning than any other quarry pit samples. However, in terms of single occurrences of technological categories, the two sample sets do not differ. This does not contradict the observation made during the debitage analysis, but it does indicate that the simple comparison of category *incidence* does not reflect frequency variation within a category.

Distribution of Distinctive Raw Materials

Most opalite from Locality 36 bedrock is indistinguishable, but one distinctive variety with swirled bands was the target of quarrying at Feature 102, a buried quarry pit. (Other distinctive raw material characteristics, such as variations in trace element composition, may occur at Locality 36, but we made no special effort to identify them.) This feature provided the oldest radiocarbon age from the locality and, since its raw material was distinguishable, we tallied its presence in all debitage samples and bifaces. Figure 101 shows the distribution of "swirled" opalite debitage, Figure 102, the distribution of "swirled" opalite bifaces.

Swirled opalite debitage is infrequent, being present in low quantities (5 to 10 pieces of debitage per occurrence) in four of the six features where it appears (reduction features/lithic scatter Features 63, 87, 92, and hearth feature Feature 105). It is very common, however, in Features 49 and 102, which are at the source of the material. Swirled opalite bifaces also are most frequent in the two features at the material source. They are present in low frequencies (1 or 2 bifaces per feature) in Features 18, 19, 28, 48, 50, 63.

Swirled opalite may have been used only while Feature 102 was an active quarry (cf. Chapter 9). However, a few flakes of swirled opalite are associated with Feature 105, which was radiocarbon dated to 330±50. The later use of swirled opalite may owe to scavenging of previously quarried stone or from additional exposures of the stone in Feature 49, which is younger than Feature 102.

Stone Tool Distributions

The most frequent classes of stone tools at Locality 36 are bifaces and hammerstones. Distributional analyses of these are discussed below. Ground stone, projectile points, and flake tools are so infrequent that their distributions are uninformative and are not discussed. Modified chunks are frequent and are found predominantly in quarry pits (cf. Chapter 5).

The distributions of hammerstones and bifaces were examined in a fashion similar to that used in analysis of debitage distributions. Hammerstones (cf. Chapter 6) are useful for distributional analysis not only because they are relatively common, but also because they are related directly to opalite extraction and subsequent reduction into transportable forms. The distribution of bifaces was investigated because bifaces were the major product derived from Locality 36 by prehistoric flintknappers (cf. Chapter 5).

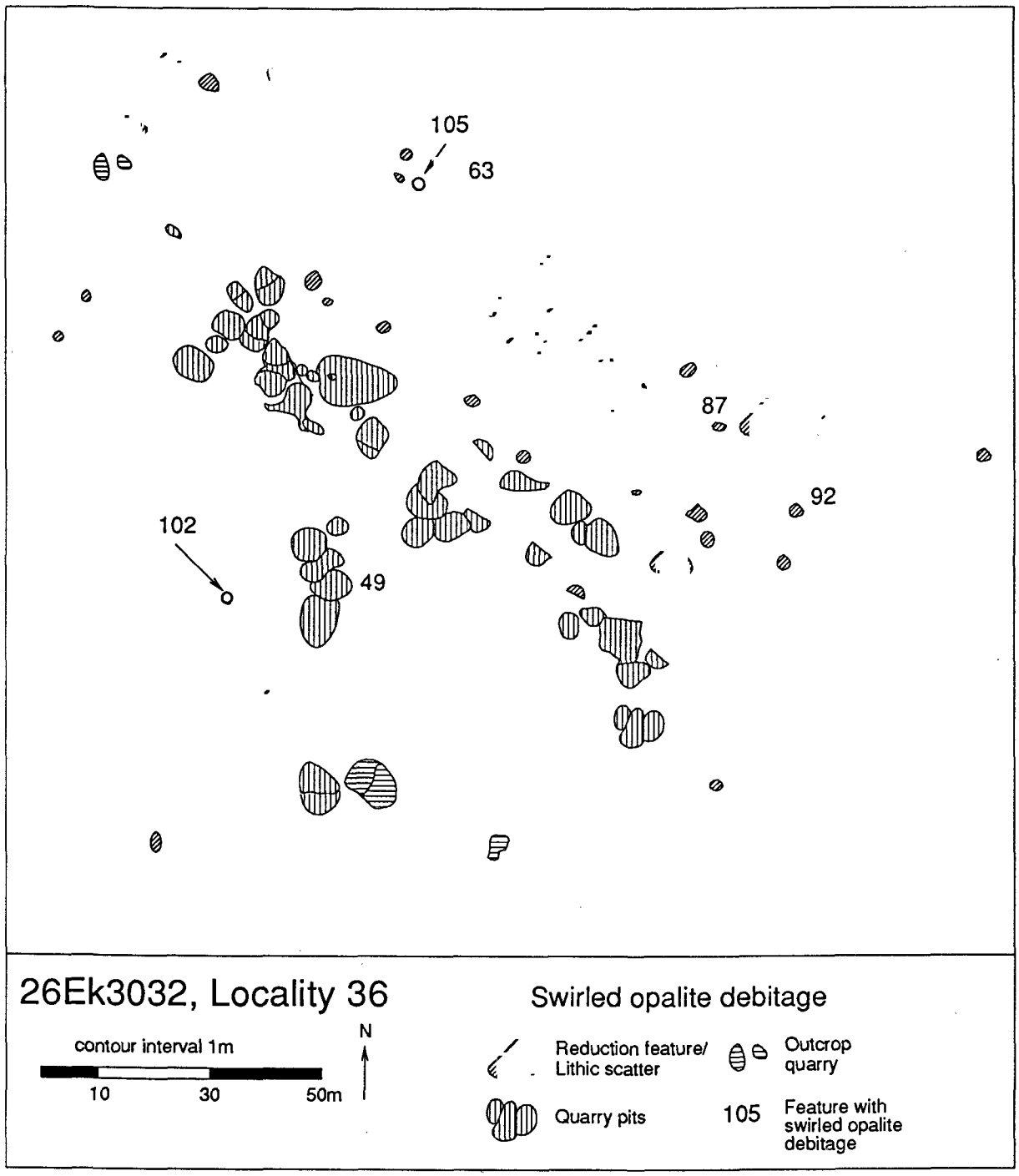


Figure 101. Distribution of "swirled" opalite debitage.

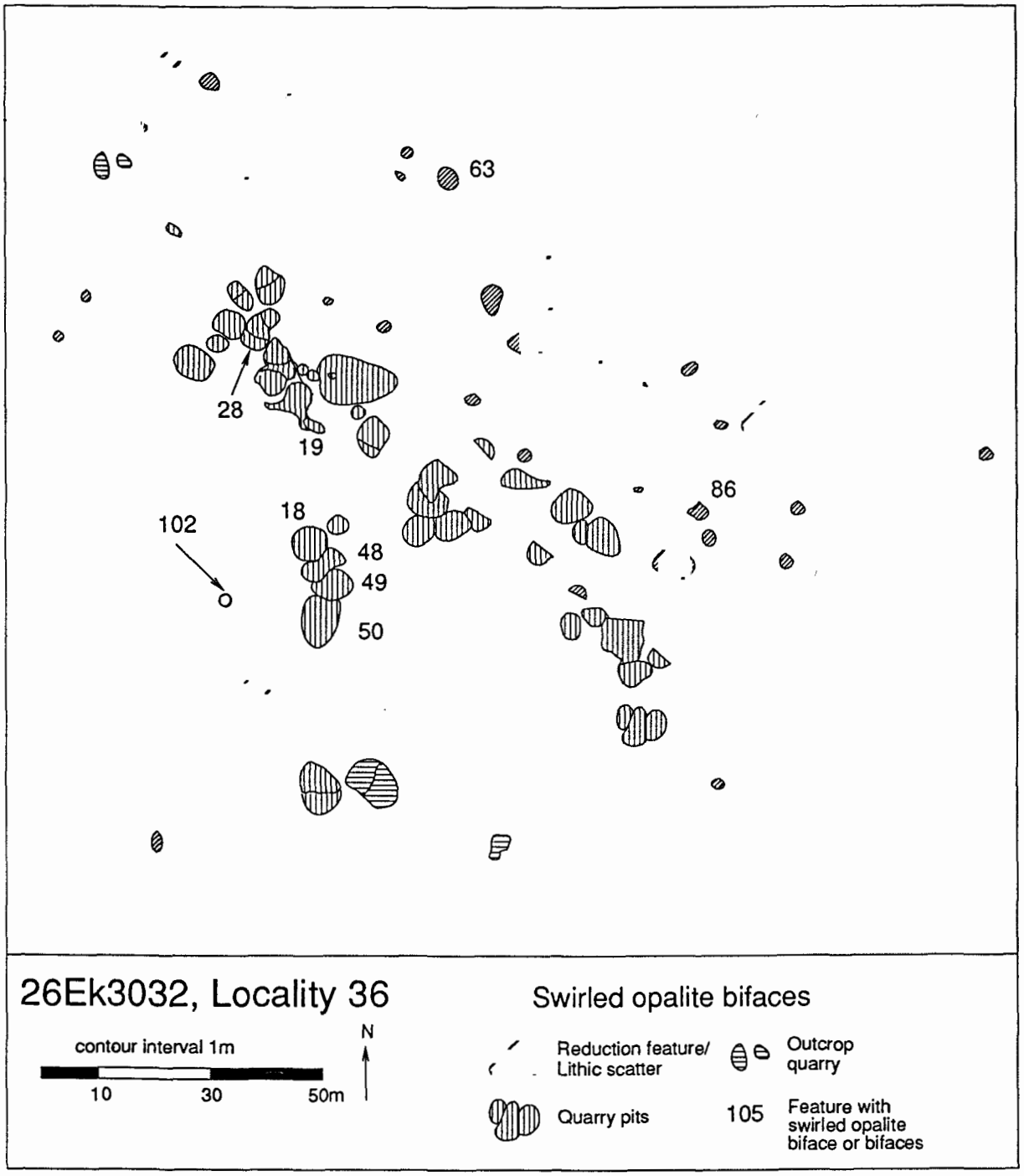


Figure 102. Distribution of "swirled" opalite bifaces.

Hammerstone Distributions

Three attributes of the hammerstone assemblage were examined: hammerstone weight (i.e., size, since most raw materials are of similar density), raw material source, and completeness. Data used for the analysis are derived from those in Chapter 6.

If quarrying required the heaviest hammerstones, then unbroken hammerstones from quarry pits should have weights significantly higher than those from other settings. A t-test of the 78 complete hammerstone weights, grouped by quarry pit vs. all other contexts, shows that this was not the case (t=0.148, p=0.88; $n_{\text{quarry pit}}$=67, mean=965.5 g, std. dev.=852.0 g; $n_{\text{non-quarry pit}}$=11, mean=1005.4 g, std. dev.=822.8 g).

If raw material properties differ in their suitability for hammers, we might expect the toughest to have been used for quarrying since that is the heaviest work. In general, the local raw material used for hammerstones (opalite and tuff) is less durable (being only as hard as the opalite itself) than non-local raw materials (especially quartzite, but also basalt, rhyolite, and other stone). So, comparing local and non-local raw materials contrasts hammerstone durability, as well as raw material selectivity. Raw material and feature context were found to be dependent (Table 43). The hammerstone assemblage from quarry pits exhibits a higher than expected frequency of local raw materials and lower than expected frequency of non-local raw materials. The converse is true for the non-quarry pit hammerstone assemblage. The extensive use of local, perhaps less durable, material within quarry pits may owe to its proximity, since virtually every quarry pit has an endless supply of opalite or tuff hammers. Given their ready availability, opalite and tuff hammerstones simply may have been discarded when no longer needed. Hammerstones of non-local material also were used within quarry pits; a few basalt or quartzite hammerstone flakes usually occur in every quarry pit debitage sample, but being both more durable and less available, hammers of these materials were used in actions outside the quarry pits too. Discard may have occurred at their place of use, as well.

Table 43. Contingency Table of Hammerstone Raw Material (local vs. nonlocal) by Feature Context (quarry pit vs. non-quarry pit).

	RAW MATERIAL SOURCE	
Feature Context	Local	Nonlocal
Quarry pits	31	89
	(2.39*)	(-2.39*)
Not quarry pits	1	24
	(-2.39*)	(2.39*)

chi-square = 5.73; df=1, p<0.05
(adjusted standardized residual, asterisk indicates p<0.05)

If hammerstones had different durations of use, as suggested above, then one might expect that local and nonlocal hammerstones would have been discarded in different states of completeness. Table 44 shows this expectation to be correct. Hammerstones of local raw material are more often complete (and less often broken) than non-local ones. Despite the association of complete hammerstones made of local raw material with quarry pits, there is no statistically significant association between feature context and frequency of complete hammerstones.

Table 44. Contingency Table of Hammerstone Raw Material (local vs. nonlocal) by Hammerstone Completeness.

Completeness	RAW MATERIAL SOURCE Local	Nonlocal
Complete	28 (4.33*)	50 (-4.33*)
Incomplete	4 (-4.33*)	63 (4.33*)

chi-square = 5.73; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

The distribution of hammerstones suggests that local raw materials may have been used for quarrying and only slightly for later reduction. Opalite and tuff hammerstones probably were used expediently and discarded. Hammerstones of nonlocal materials *may* have been used in quarrying, but their ultimate discard location was determined more by their utility in later stages of opalite reduction. Hence, they tend to be found broken in non-quarry pit contexts.

Biface Distributions

Bifaces are the dominant stone tool class in the flaked stone assemblage. There can be little doubt that biface production was an important aspect of prehistoric use of the opalite sources at Locality 36. As previously discussed, the Locality 36 biface is highly patterned: heat-treatment is significantly more common among mid-Stage 3 and later specimens, and early stage (Stages 1 and 2) bifaces are broken less often than those in or later than mid-Stage 3 (cf. Chapter 5). The distribution of bifaces provides information on where bifaces were discarded (and probably manufactured). Such information reflects the spatial organization of biface production.

Bifaces are most common in quarry pits followed by non-feature settings, then reduction features/lithic scatters (Table 45). In general, discard of bifaces occurred twice as often in quarry pit contexts than in all other feature types. If bifaces always were discarded at the locus of their failure in manufacture, then biface failure was more frequent in the quarry area than elsewhere. Sizes and failure causes of bifaces from the quarry area (cf. Chapter 5) support this. The pattern of robust association between reduction features and biface reduction debitage is due to the dominance of biface reduction in reduction features, whereas quarry pits have more technologically heterogeneous debitage assemblages. Considered together, the two results suggest that many bifaces failed in the quarry area, and some undetermined number were reduced successfully away from the quarry pits, leaving behind a lithic scatter dominated by biface reduction debris.

Table 45. Overall Frequency, Proportions, and Average Number of Bifaces per Feature Type.

Feature Type	Feature Frequency	Biface Frequency	Percent of Biface Assemblage	Average No. of Bifaces per Feature
Quarry pits	60*	381	60.0	6.4
Reduction features	37	102	16.1	2.8
Hearths/possible hearths	5	8	1.3	1.6
Outcrop quarries	5	12	1.9	2.4
Non-feature area	--	132	20.8	--

* includes subsurface quarry features

Further elucidation of spatial patterns of biface discard can be found in the relationship between biface reduction stage and feature type (Table 46). Table 47 summarizes chi-square contrasts (at p=0.05) and analysis of adjusted standardized residuals of various attributes of the biface assemblage vs. spatial contexts. Since all the analyses summarized in Table 47 can be derived from the data presented in Table 46, intervening contingency tables are not presented.

Table 46. Cross-tabulation of Frequency of Biface Reduction Stage by Feature Type.

Biface Reduction Stage	FEATURE CONTEXT				
	Quarry Pit	Reduction Feature	Hearth/ Possible Hearth	Outcrop Quarry	Non-feature
Stage 1	2	1	0	0	0
Early Stage 2	25	5	0	0	1
Mid-Stage 2	73	15	1	0	10
Early Stage 3	220	51	4	5	63
Mid-Stage 3	47	20	2	5	33
Late Stage 3	4	3	0	1	17
Stage 4	1	2	0	1	2
Stage 5	0	0	0	0	2
Indeterminate	9	5	1	0	4

Table 47. Summary of Contingency Table Comparisons Between Biface Stages and Different Feature Contexts.

Biface Stages Contrasted	**Quarry Pits to Reduction Features**	**Quarry Pits to All Non-quarry Pit Contexts**	**Non-feature Area to Reduction Features**	**Non-feature Area to Quarry pits**
Early (Stages 1 to mid-Stage 2) to Late (mid-Stage 3 to Stage 5)	Quarry pits associated with early, reduction features with late	Quarry pits associated with early, non-quarry contexts with late	Non-feature area associated with late, reduction features with early	Non-feature area associated with late, quarry pits with early
Stage 2 to early Stage 3	No association	No association	Non-feature area associated with Stage 3, reduction features with Stage 2	Non-feature associated with Stage 3, quarry pits with Stage 2

The distribution of early stage (up to but not including Stage 3) vs. late stage (mid-Stage 3 and later) bifaces across feature contexts is not random (Table 47). Early stage bifaces are associated strongly with quarry pits, later stage bifaces with reduction features/lithic scatters and non-quarry pit settings generally. Early Stage 3 bifaces, in the middle of the reduction continuum, do not differ in association from Stage 2 bifaces (Table 47) between quarry pits and all other contexts.

Bifaces not associated with features are generally later in stage than those from quarry pits and reduction features/lithic scatters (Table 47). Bifaces from feature and non-feature settings also differ in the Stage 2 to early Stage 3 comparison, where once again non-feature bifaces are later in reduction stage than bifaces from reduction feature/lithic scatters. Debitage contrasts

between reduction feature/lithic scatters and the non-feature areas exhibit a different pattern, with earlier (mass reduction) debitage associated with non-feature contexts and later (biface reduction) debitage associated with reduction feature/lithic scatters.

Heat-treatment and brokenness are associated strongly with the later stages of biface reduction within the overall assemblage (cf. Chapter 5). These attributes have significant associations with feature contexts (Tables 48 to 51). Bifaces in quarry pits are more often complete and not heat-treated than those from non-quarry pit contexts or reduction features only. Thus, early and late biface reduction and associated attributes of heat-treatment and completeness all pattern across feature contexts.

Table 48. Contingency Table of Feature Context (quarry pit vs. reduction feature) by Heat-treatment, Biface Assemblage.

	FEATURE CONTEXT	
Heat-Treatment	Quarry Pits	Reduction Features
Heat-treated	5 (-2.32*)	5 (2.32*)
Not heat-treated	376 (2.32*)	94 (-2.32*)

chi-square = 5.38; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 49. Contingency Table of Feature Context (quarry pit vs. non-quarry pit) by Heat-treatment, Biface Assemblage.

	FEATURE CONTEXT	
Heat-Treatment	Quarry Pits	Not Quarry Pits
Heat-treated	5 (-5.40*)	28 (5.40*)
Not heat-treated	376 (5.40*)	226 (-5.40*)

chi-square = 29.17; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 50. Contingency Table of Feature Context (quarry pit vs. reduction feature) by Completeness, Biface Assemblage.

	FEATURE CONTEXT	
Completeness	Quarry Pits	Reduction Features
Complete	202 (3.18*)	36 (-3.18*)
Incomplete	179 (-3.18*)	66 (3.18*)

chi-square = 10.11; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 51. Contingency Table of Feature Context (quarry pit vs. non-quarry pit) by Completeness, Biface Assemblage.

	FEATURE CONTEXT	
Completeness	Quarry Pits	Not Quarry Pits
Complete	202 (3.28*)	101 (-3.28*)
Incomplete	179 (-3.28*)	153 (3.28*)

chi-square = 10.73; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Two attributes indicative of biface production technique merit consideration (cf. Chapters 4 and 5): initial core form (block or flake blank) and use of specialized techniques (end-thinning, thinning from square edges). As discussed in Chapter 5, initial core form usually can be identified only on early stage bifaces. Hence, Tables 52 and 53 tabulate the presence of one form vs. presence of another, rather than presence and absence. Block cores are more common than expected in quarry pits, flake blanks more common in reduction feature/lithic scatter and non-quarry pit contexts (Table 52, Table 53). Thinning from square edges and end-thinning are not associated with any particular feature context (Table 54, Table 55).

Table 52. Contingency Table of Feature Context (quarry pit vs. reduction feature) by Biface Blank Type, Biface Assemblage.

	FEATURE CONTEXT	
Blank Type	Quarry Pits	Reduction Features
Flake blank	55 (-1.98*)	17 (1.98*)
Block blank	34 (1.98*)	3 (-1.98*)

chi-square = 3.92; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 53. Contingency Table of Feature Context (quarry pit vs. non-quarry pit) by Biface Blank Type, Biface Assemblage.

	FEATURE CONTEXT	
Blank Type	Quarry Pits	Not Quarry Pits
Flake blank	55 (-1.98*)	34 (1.98*)
Block blank	34 (1.98*)	9 (-1.98*)

chi-square = 3.94; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 54. Contingency Table of Feature Context (quarry pit vs. reduction feature) by Specialized Thinning Techniques, Biface Assemblage.

	FEATURE CONTEXT	
Thinning Technique	Quarry Pits	Reduction Features
Square edge thinning	61	16
	(0.37)	(-0.37)
End thinning	22	7
	(-0.37)	(0.37)

chi-square = 0.14; df=1, $p>0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 55. Contingency Table of Feature Context (quarry pit vs. non-quarry pit) by Specialized Thinning Techniques, Biface Assemblage.

	FEATURE CONTEXT	
Thinning Technique	Quarry Pits	Not Quarry Pits
Square edge thinning	61	37
	(0.63)	(-0.63)
End thinning	22	17
	(-0.63)	(0.63)

chi-square = 0.40; df=1, $p>0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Feature 102, the oldest quarry feature known at Locality 36, has a higher frequency of late stage bifaces than other quarry pits (Table 56). In fact, there is no significant difference in biface stage frequency when the Feature 102 biface assemblage is compared to that from reduction features/lithic scatters (Table 57). No other quarry pit feature exhibits this pattern. In terms of early and late stage biface presence, Feature 102 is therefore more similar to reduction feature/lithic scatter biface assemblages than to other quarry pits.

Table 56. Contingency Table of Feature Context (Feature 102 vs. all other quarry pits) by Early and Late Stage Biface Stage Frequency.

	FEATURE CONTEXT	
Biface Reduction Stage	Feature 102	Other Quarry Pits
Early (Stages 1 to mid-2)	9	91
	(-2.93*)	(2.93*)
Late (mid-Stage 3 to 5)	14	38
	(2.93*)	(-2.93*)

chi-square = 8.56; df=1, $p<0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Table 57. Contingency Table of Feature Context (Feature 102 vs. reduction features) by Early and Late Stage Biface Stage Frequency.

	FEATURE CONTEXT	
Biface Reduction Stage	Feature 102	Reduction Features
Early (Stages 1 to mid-2)	9	21
	(-0.52)	(0.52)
Late (mid-Stage 3 to 5)	14	25
	(0.52)	(-0.52)

chi-square = 0.27; df=1, $p>0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

The distribution of bifaces centers on quarry pit complexes (Figure 103). The distance from each staged biface outside quarry pits to the nearest quarry pit is one way to measure biface distribution. The means and standard deviations of these distances, by reduction stage, are plotted in Figure 104. Stage 4 bifaces are somewhat farther from quarry pits than earlier stages, but there is no significant difference among the distances to quarry pits for reduction stages.

Summarizing the distribution of bifaces is relatively simple because the patterns are so strong. Bifaces from reduction feature/lithic scatters are generally later in reduction stage than those from quarry pits, with the exception of Feature 102. Bifaces from non-feature contexts are later still. Heat-treatment and completeness share these associations, as expected given their mutual dependence on reduction stage (cf. Chapter 5). The difference found in flake blank-based bifaces (generally more frequent in non-quarry pit settings) and block-based bifaces (more frequent in quarry pits) probably reflects a real difference in reduction technique. The spatial distribution of bifaces, like that of debitage, is centered on quarry features.

Spatial segregation of biface discard, and thus perhaps of biface production, is not apparent at Locality 36. Yet, the absence or invisibility of discrete work areas near the quarry pits cannot be taken to mean that biface production was not organized into discrete spatial areas. The observed distribution of bifaces is the result of over 4000 years of biface production, whether continuous or not. During any *single* use of the locality, biface production may have been removed spatially from active quarry features. Over time, with re-use of the site surface, these differences became indistinguishable as quarrying shifted from one feature to another.

Spatial Variation in Assemblage Contents

Earlier a distinction was drawn between three complexes of quarry pits: Area A, centered around Feature 71, Area B, centered around Feature 42, and Area C, centered around Feature 49 (cf. Chapter 8). Each area was defined using the boundaries shown in Figure 105 to evaluate differences in their content. Attributes of the bifaces and hammerstones from each feature group were tallied, as were the frequencies of single technological characterizations of debitage samples from them. These data then were used to look for differences between areas.

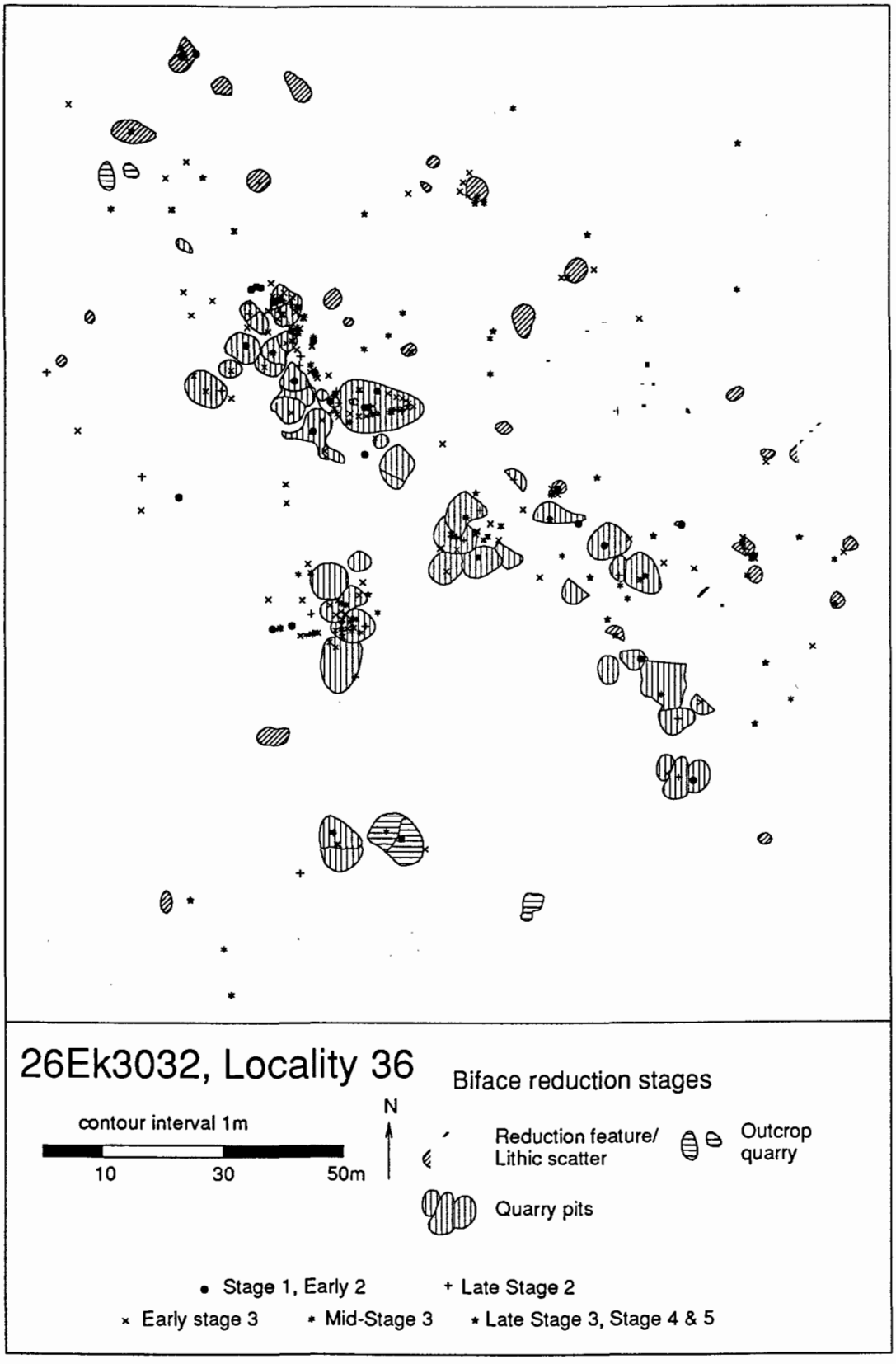


Figure 103. Distribution of bifaces by reduction stage.

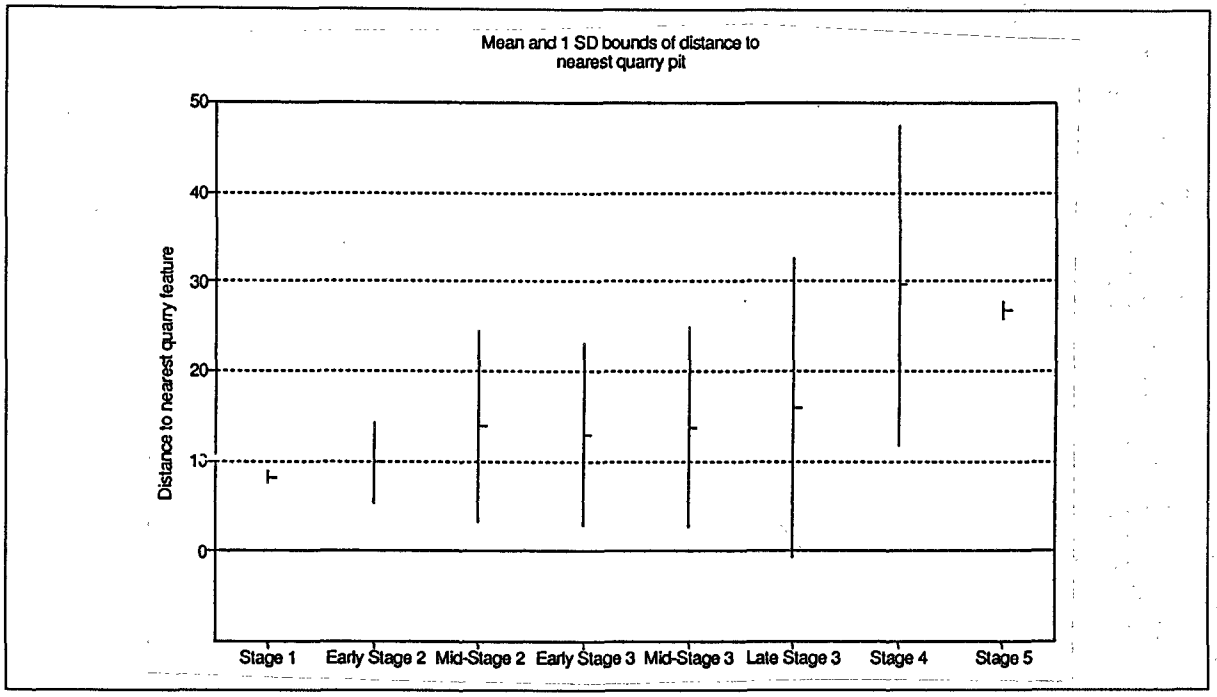


Figure 104. Mean and one standard deviation boundaries of distance from non-quarry pit bifaces to nearest quarry pit, by stage.

The 66 technologically analyzed samples were tallied using the techniques already described here and in Chapter 4 (Table 58). To compare the areas, we calculated the proportions of debitage samples within each area having a single characterization. Figure 106 compares these proportions. Area B and Area C are quite similar. Most samples from these areas have quarrying debris, mass reduction debris, and lower frequencies of blank preparation and early biface thinning. Late biface thinning is rare or absent. Area A differs from Areas B and C. Quarry debris is rare, and while mass reduction debitage is frequent as in Areas B and C, so are blank preparation and early biface thinning flakes. Area A, then, appears to have more biface production and less frequent quarry debris than the other quarry pit groups.

Table 58. Assemblage Summaries (frequencies) for Three Quarry Pit Complex Areas.

	QUARRY PIT COMPLEX		
Debitage	Area A	Area B	Area C
Q* or Q	5	11	19
q or none	25	1	5
M* or M	21	12	21
m or none	9	0	3
B* or B	23	6	14
b or none	7	6	10
E* or E	26	4	14
e or none	4	8	10
L* or L	0	0	1
l or none	30	12	23
BIFACES			
Early (Stage 1 to mid-2)	16	61	14
Late (mid-Stage 3 to 5)	22	16	30

Key:

Q = quarrying
M = mass reduction
B = blank preparation
E = early biface thinning
L = late biface thinning

Lower case: Trace Quantity
Upper case: Frequent
Upper case w/asterisk: Dominant

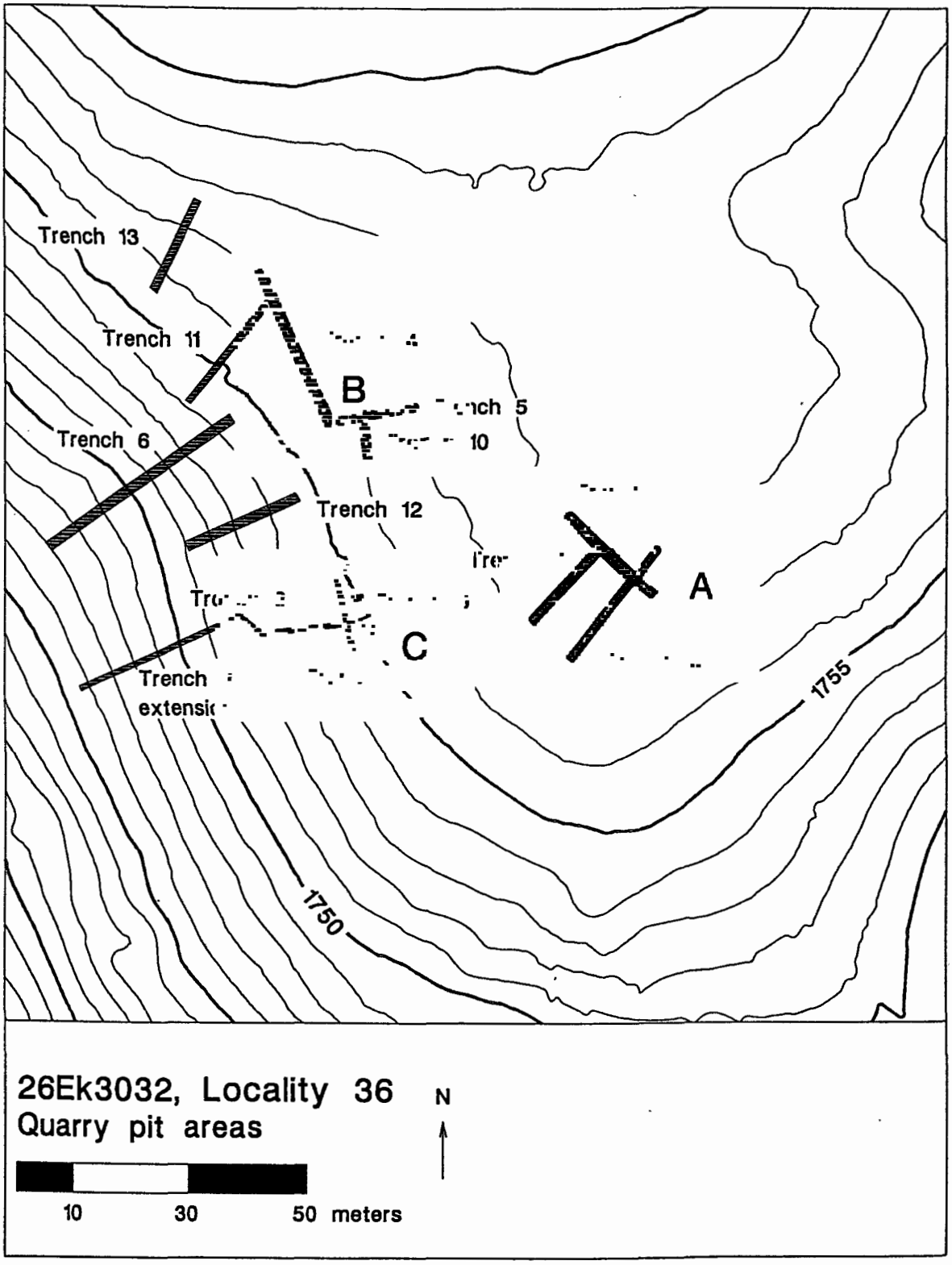


Figure 105. Quarry pit complex areas.

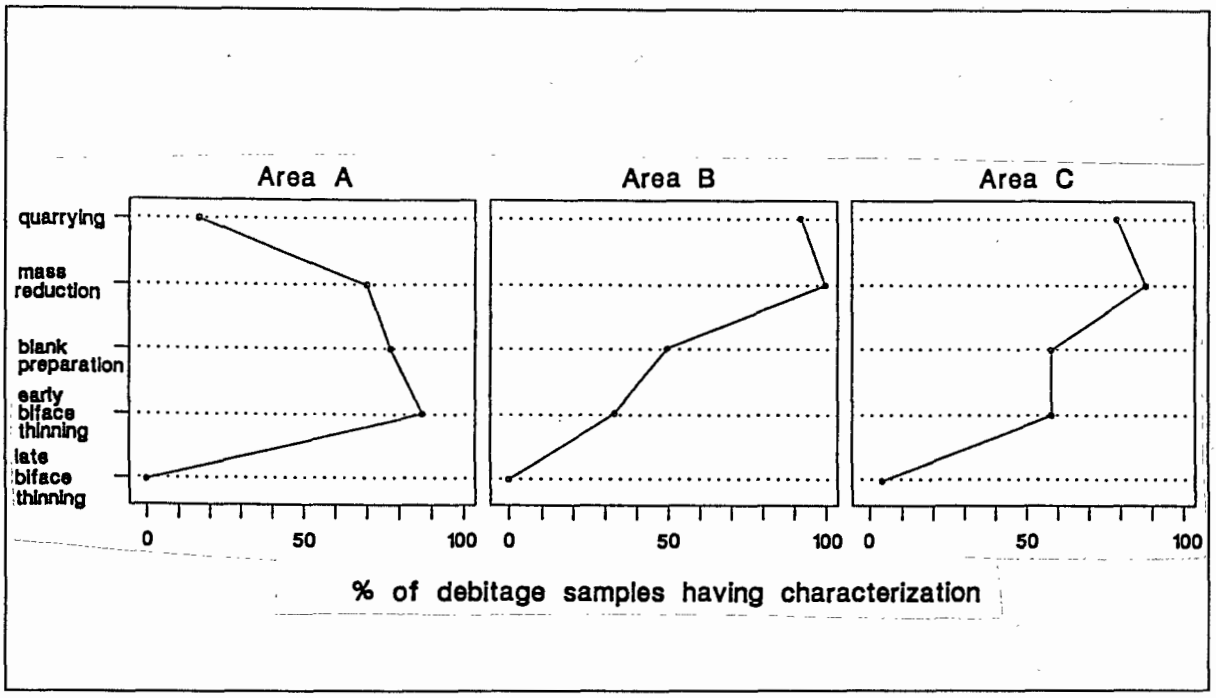


Figure 106. Dot plot of proportional frequency of individual technological characterizations of debitage samples, quarry pit Areas A, B, and C.

Another pattern emerges from examination of the reduction stages of bifaces recovered from each area. The bifaces from each subarea were grouped into early stage (Stage 1 to mid-Stage 2) and late stage (mid-Stage 3 to Stage 5) classes. They then were compared in a 2 by 3 cross-tabulation. The resulting chi-square value indicates that there is an association between early/late stage classes and quarry pit areas (Table 59). Adjusted standardized residuals (Table 59) indicate that in Areas A and C, late stage bifaces are more common than would be expected under a chi-square model of independence. In Area B, early stage bifaces are more common than expected.

Table 59. Contingency Table of Feature Context (Feature 102 vs. reduction features) by Early and Late Stage Biface Stage Frequency.

	FEATURE CONTEXT		
Biface Reduction Stage	Area A	Area B	Area C
Early (Stages 1 to mid-2)	16 (-2.16*)	61 (5.43*)	14 (-4.01*)
Late (mid-Stage 3 to 5)	22 (2.16*)	16 (-5.43*)	30 (4.01*)

chi-square = 30.37; df=2, $p>0.05$
(adjusted standardized residual, asterisk indicates $p<0.05$)

Hammerstone attributes (completeness, local vs. nonlocal material, frequency of basalt and quartzite hammerstones, and hammerstone weights) were tallied for each area. No differences in the attributes of the hammerstone assemblages were found among quarry pit areas.

Discussion

Distributional studies at Locality 36 show a variety of patterns; the purpose of this discussion is to consider how best to interpret them. Patterns appear at numerous levels in Locality 36, both within artifact classes and among them. Since spatial patterns are rarely direct testimony of individual activities in the past (Bartram, Kroll, and Bunn 1991; O'Connell, Hawkes, and Blurton-Jones 1991; Gregg, Kintigh, and Whallon 1991), attempting to see individual events in the Locality 36 patterns probably will be fruitless. A more productive approach to interpretation of spatial patterns is to consider how they suggest the overall organization of activities (Binford 1983).

How use of space was organized is an indirect indicator of the sorts of activities conducted within that space, since some activities require work space to be maintained whereas other activities do not (Binford 1983). Thus, the emphasis in the analyses above, and in the discussion following, is on how artifact and attribute distributions indicate spatial organization of work both at Locality 36, and perhaps more generally at all quarries.

Instead of reviewing each analytical result, this discussion attempts to synthesize all the results. It is intended to be integrative, drawing together the disparate patterns found above.

Quarry pit features, and the debris associated with them, dominate Locality 36 site space. Almost all distributions center on them, and there is a steady fall-off in the frequency of artifact classes with distance from them. Quarry pits are associated closely with exploitable opalite. Furthermore, once a quarry pit is initiated it becomes an access point for further quarrying—exploitation may expand out of a single pit, work an exposed face back and forth, or simply target adjacent areas because there is the likelihood of useful toolstone being found there too. The result of several thousand years of opalite extraction is that quarry features are embedded in debitage and opalite debris. Even when the topographic expression of pits and adits has been suppressed by erosion or burial, a distinctively large debris profile still characterizes bedrock extraction areas.

These characteristics of the Locality 36 extraction areas undoubtedly limited their utility for activities that require large areas of relatively clear space (e.g., domestic activities; cf. Binford 1978). From an organizational perspective—in terms of the limitations placed upon future actions in the same space—debris from quarrying restricted activities needing large areas of clear space (e.g., residential occupation). Quarrying debris would not have limited actions with less stringent space requirements, such as flintknapping which requires only a few square meters of workspace. If the activities performed in such spaces generate durable refuse, then they will yield strong spatial patterns that are detectable archaeologically.

Debris generated by repetitive actions may coalesce into accretional concentrations or "superfeatures." The debitage aprons at Locality 36 are probably a sort of "superfeature," composed of many discrete reduction feature/lithic scatters that overlap spatially. The debitage aprons are a mixture of debris generated by toolstone extraction and debitage created by toolstone processing. Debitage within the aprons can vary in size, perhaps due to the mode of extraction employed (e.g., around the outcrop opalite sources at Features 51 and 52), or due to the extent of overlap between different kinds of lithic reduction. As debitage analysis results have shown, however, these apron "superfeatures" differ in their technological genesis from reduction feature/lithic scatters and quarry pits, since they have more early reduction and extraction debris than the former, and more later reduction debris than the latter. As mentioned above, the ethnographic literature on

quarrying suggests that bedrock (or other point-source) quarries should have associated satellite reduction areas (see also Elston and Dugas 1992). The debitage apron "superfeatures" probably are composed of many hundreds of such associated reduction areas.

Another sort of "superfeature" at Locality 36 is the quarry pit complex. Individual features can be distinguished on the surface of such complexes, but our investigations found quarry pits dug into the berms of older features. With enough quarrying activity in a small area, clusters of surface pits and a complex subsurface stratigraphy form, yielding quarry pit complex "superfeatures" that are accretional (although still distinctive) repetitions of the same type of feature.

Individual reduction feature/lithic scatters are at the other end of a scale of feature complexity from such "superfeatures." This feature type was recognized explicitly on the basis of discrete, definable, margins determined by a fall-off in debitage density. By definition, reduction feature/lithic scatters can occur only away from quarry pit complexes and debitage aprons. Two distance groups, relative to quarry features, were discerned in analysis. The nearer may be simply reduction feature/lithic scatters not yet agglutinated into debitage aprons, for they are only a few meters away from quarry pits. The near-quarry pit feature group is similar to ethnographically described satellite lithic reduction areas directly associated with toolstone sources. Reduction feature/lithic scatters farther from quarry pits, such as those on the central ridgetop at Locality 36, may indicate a very different spatial organization. They have a high incidence of biface reduction, generally cover more area than features in the group nearer to quarry pits, and may be associated with buried hearths suggesting that they are fairly young (perhaps ca. 500 years or less in age).

Features reflect how space use was organized within Locality 36, but not what actions occurred in specific places or kinds of places. The distribution of debitage characterizations, stone tools, and stone tool attributes informs on this topic. Since the focus of almost all known prehistoric activities at Locality 36 was biface production, the following description integrates major spatial patterns into a thumbnail sketch of the spatial organization of toolstone extraction and stone tool production.

The extraction of toolstone involved a significant investment of labor (cf. Chapter 9, Chapter 12). Extraction efforts were restricted to areas where opalite could be exposed easily, i.e., the western slope of the central ridge. Extraction debris was widespread, scattering out from quarry pits and becoming part of the debitage aprons around them. It cannot be ascertained just how widely tuff, useless hunks of opalite, dirt, and other detritus from quarrying were spread from any given pit: churning, reworking, and engulfment in the debitage and debris carpets make this impossible.

Tools used in opalite extraction consisted of both local and nonlocal hammerstones. Opalite hammerstones appear to have been used in expedient fashion. Perhaps because they were less durable, or simply easier to obtain, they frequently were discarded unbroken within quarry pits. Although hammerstones of nonlocal material also were used in quarrying, they were discarded in quarry pits less often, and they commonly are found, broken, in reduction features.

Following extraction of toolstone pieces, initial core reduction occurred in four settings: in the quarry feature itself (or perhaps in a nearby inactive quarry pit); in the debitage apron where core reduction debitage forms part of the apron matrix; in reduction feature/lithic scatters; and in non-feature settings, where it never occurs in sufficient density to form a reduction feature/lithic scatter on its own. Core reduction is the most spatially extensive of all lithic reduction activities, suggesting that it was least organized or had the fewest concomitant space requirements.

Blank preparation and early biface thinning debitage commonly occurred in three settings: in quarry pits (again, whether pits were actively quarried at the time cannot be determined); within the debitage apron or in the "near" group of reduction feature/lithic scatters, i.e., quite near quarry pits; and in the "far" group of reduction feature/lithic scatters. Blank preparation and early biface thinning was the predominant lithic reduction activity in more distant reduction feature/lithic scatters. With only one exception, blank preparation flakes and early biface thinning flakes in the other two settings are simply two ingredients in a heterogeneous mix of debris and debitage. The sole exception is Feature 102, the oldest quarry pit known. Although not statistically significant when the *incidence* of early biface thinning is compared to that of other settings, the *frequency* of early biface flakes appears to be much greater than that of any other quarry pit deposit or even of the debitage apron. On the basis of debitage alone, it seems that prehistoric knappers were relatively indifferent as to where they produced early stage bifaces. Biface reduction flakes were not produced, however, in the same roving fashion as mass reduction flakes, since in all contrasts they are associated inversely with the non-feature setting.

Late biface thinning is associated with only two settings at Locality 36. Late biface thinning flakes and late stage bifaces were found in reduction feature/lithic scatters and in the non-feature area. Late biface thinning occasionally was undertaken at Locality 36, but both the debitage assemblage (cf. Chapter 4) and the biface assemblage (cf. Chapter 5) show that it was far less common than was early biface thinning.

The biface assemblage demonstrates a pattern of associations with feature contexts different from that of debitage. Overall, bifaces were discarded most often in quarry pits, but biface reduction stage (and attributes related to stage) have clear spatial patterns. Early stage bifaces were discarded most often within quarry pit contexts, were not heat-treated, and were complete, having been made on block blanks. Late stage bifaces were more common in reduction feature/lithic scatters where they were heat-treated significantly more often, were broken, and were produced from flake blanks. The latest stage bifaces were found in the non-feature area. Feature 102 has a biface assemblage more similar to that from reduction feature/lithic scatters than to that from quarry pits.

Presuming that bifaces were discarded in the contexts where they broke or otherwise were found unsuitable, a scenario of biface production as a whole can be sketched, incorporating both debitage and biface distribution studies. The reader should bear in mind that debitage suggests where reduction occurred, and the biface assemblage suggests where reduction failed. Initial blank preparation and early biface thinning occurred in contexts which we recognize as archaeological features. It was most often unsuccessful within quarry pits, either due to the block blanks on which the bifaces were produced or because the bifaces discarded there constitute the unsuccessful portion (i.e., the block blank bifaces that were successful were reduced beyond the point of recognition). When bifaces or biface blanks (often flake blanks) were removed from the quarry pit and quarry apron area to more distant parts of the site (more than about 20m from quarry pits) they were reduced further and heat-treated. Late stage biface production (Stage 4 and Stage 5) is rare at Locality 36, but when it did occur it almost always was removed from quarry pit areas.

Feature 102 is an interesting exception to much of the foregoing scenario, which raises the issue of change through time in how space was used at Locality 36. The distribution of swirled opalite from Feature 102 suggests that its use was often, but not invariably, during the "active" life of the feature. During its period of use, Feature 102 seems to have been a combination of quarry pit *and* reduction feature, as if the two contexts were not separate at all. If one hypothesizes that as quarry use becomes more intense the need to separate activities becomes greater, then perhaps Feature 102 attests to an early small-scale (but large-effort) use of Locality 36.

Change through time is suggested in the comparison of the three superfeature quarry complexes. Area A, youngest of the three, is therefore latest in reduction stages present, both in debitage incidence and bifaces. Area C, the oldest, also has a late biface assemblage (even when Feature 102 is removed from comparison), but has early debitage. Area B, intermediate in age, has both early debitage and early stage bifaces associated with it. These differences suggest change in the organization of where bifaces were produced. For example, during the period in which Area B was used, perhaps most later biface production occurred away from quarry pits, in spatially separate contexts now forming part of the debitage apron. In Area C, the coincidence of early biface thinning debitage and late bifaces could indicate that biface thinning occurred away from the quarry pit itself, but close enough that failed bifaces found their way back into the quarry features. Lastly, the entire production of bifaces may have occurred in a restricted spatial area in Area A.

The latest use of Locality 36, associated with Area A, is also likely to have been when discrete reduction features were established on the ridgetop. This suggests that biface reduction required the space around the quarry pits in Area A *and* sometimes additional work spaces (which we see as reduction feature/lithic scatters).

Distributional studies at Locality 36 have revealed much of the structure of biface production as well as use of the place. The gross patterns of debitage frequency probably are "signatures" of almost any quarry locality (although this remains unproven). Bedrock toolstone extraction creates a unique spatial signature of large debris from spatially extensive actions. Large debris also can occur away from extraction locales, if blocks are carried away from the pits for processing. Elsewhere, we have argued that such effort is rarely worthwhile energetically (Elston and Dugas 1992), even over distances of 100m or less. As expected, there is no evidence of large block transport farther than 10 to 20 meters from the Locality 36 quarry pits. In the main, areas removed from quarry pits should be dominated by small debris from activities less messy than toolstone extraction. Tool production is certainly one expected activity of this sort, as are routine domestic chores. Ample evidence of tool production away from quarry pits was found at Locality 36. No unequivocal evidence of domestic activity was found.

Chapter 11

THE ARCHAEOLOGY OF LOCALITY 221

Kristopher R. Carambelas, Kathryn Ataman, Eric E. Ingbar, and Dave N. Schmitt

Locality 221 lies at 5655 feet (1724 m) amsl and occupies the northern slope of a low, southeast-trending finger ridge emanating from Lower Red Hill in the southernmost portion of 26Ek3032 (Figure 107). The locality is a small (ca. 20 m diameter), isolated, light density opalite scatter associated with low opalite bedrock exposures (Figure 108). Toolstone scattered across it is a distinctive, high quality, off-white opalite with occasional swirls of red and pink, probably derived from bedrock deposits within the locality with the same distinctive coloring; on-site exposures, however, lack clear evidence of toolstone removal.

Data recovery at Locality 221 offered an opportunity to address several regional research issues (Intermountain Research 1988a) pertaining to the strategies and economics of toolstone procurement and reduction. The locality represents the southernmost exposure of toolstone within 26Ek3032, perhaps one of the first toolstone sources encountered by people accessing the quarries from the Humboldt River vicinity and other points south. It was suggested that, by virtue of its low intensity use and its peripheral location, quantitative and qualitative data might offer an opportunity to examine exploitation of a poorly represented source type (Intermountain Research 1990b:9). The present chapter suggests that the locality functioned as a biface reduction locus, and that toolstone probably was extracted from bedrock exposures or secondary cobbles within it.

Data Recovery Procedures

Field procedures reflected those employed at Locality 36 (cf. Chapter 3). Data recovery was intended to characterize the contents and spatial structure of the locality and define the assemblage composition and subsurface extent of buried cultural deposits. Field work commenced with an intensive surface reconnaissance for features and formed artifacts. No features were discovered, but all formed artifacts were collected and their locations flagged for instrument mapping.

A representative sample of surface artifacts was obtained by randomly placing 10 50 cm x 50 cm surface scrape collection units across the locality (Figure 109). One 1 m x 1 m unit was excavated adjacent a bedrock exposure in the center of the site to explore subsurface deposits and examine the outcrop for evidence of on-site quarrying (i.e., pits or adits); two 1 m x 1 m units were excavated north and south of the exposure to determine whether subsurface cultural deposits existed away from possible quarry features. Two units contained 50 cm by 50 cm control quadrants, material from which was screened through 1/8 in. mesh; the remaining material was sifted through 1/4 in. mesh. All three units were excavated to 20 cm below surface, the level at which clays and weathered tuff bedrock were encountered and artifact frequencies decreased.

Contours, units, and the locations of formed artifacts and outcrop exposures were mapped (cf. Figure 109). Table 60 details the work.

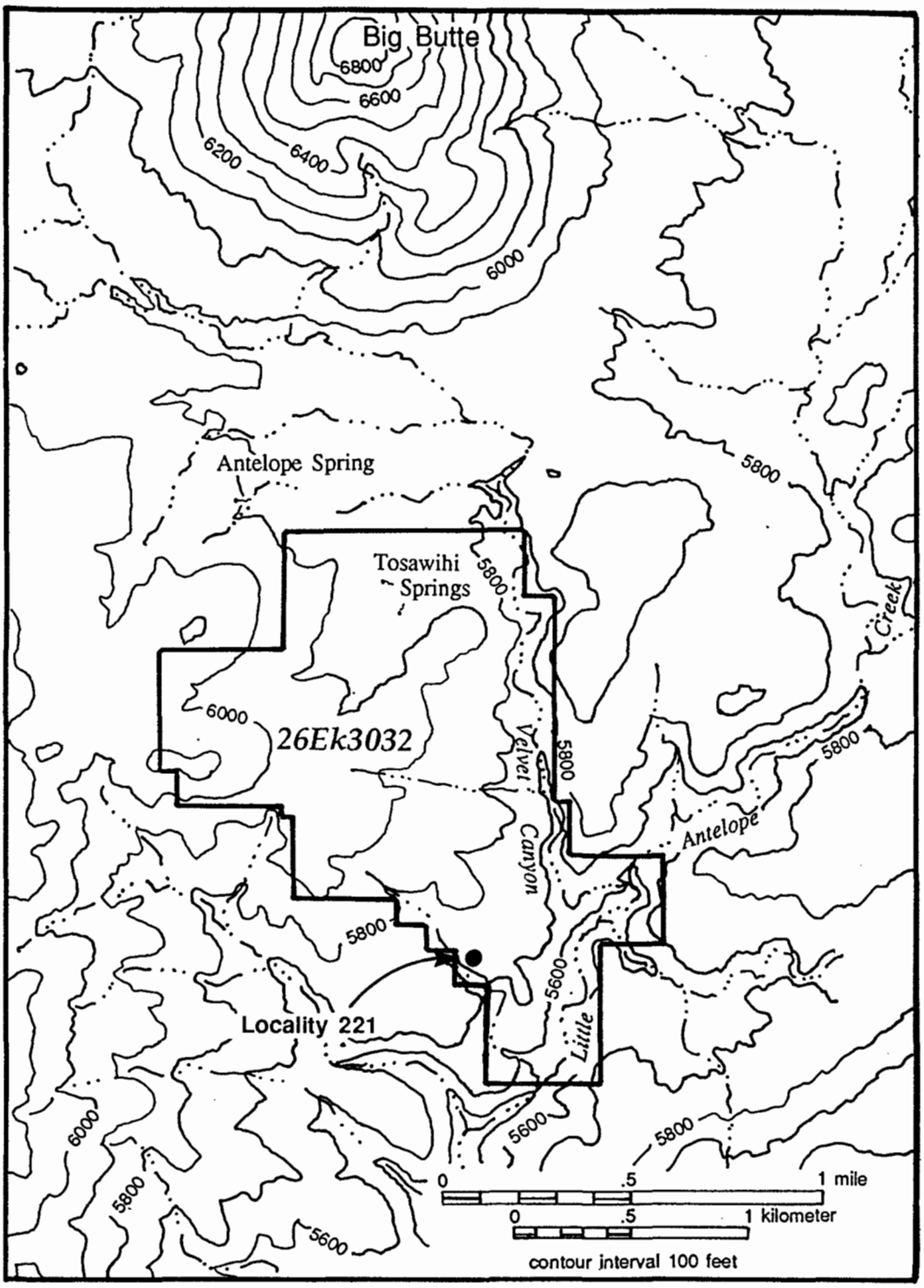


Figure 107. Location of Locality 221 relative to 26Ek3032 boundaries.



Figure 108. Overview of Locality 221.

Table 60. Concordance of Unit Type, Number, Reference, and Level of Excavation.

Unit Type and Number	Level	Unit Type and Number	Level
DSC 1	Surface	EU 11*	2-10 cm
DSC 2	Surface	EU 11	10-20 cm
DSC 3	Surface	EU 11*	10-20 cm
DSC 4	Surface	EU 12	Surface
DSC 5	Surface	EU 12*	Surface
DSC 6	Surface	EU 12	2-10 cm
DSC 7	Surface	EU 12*	2-10 cm
DSC 8	Surface	EU 12	10-20 cm
DSC 9	Surface	EU 12*	10-20 cm
DSC 10	Surface	EU 13	Surface
EU 11	Surface	EU 13	2-10 cm
EU 11	Surface*	EU 13	10-20 cm
EU 11	2-10 cm		

* Control unit; material screened through 1/8 in wire mesh.
DSC: Surface Collection Unit
EU: Excavation Unit

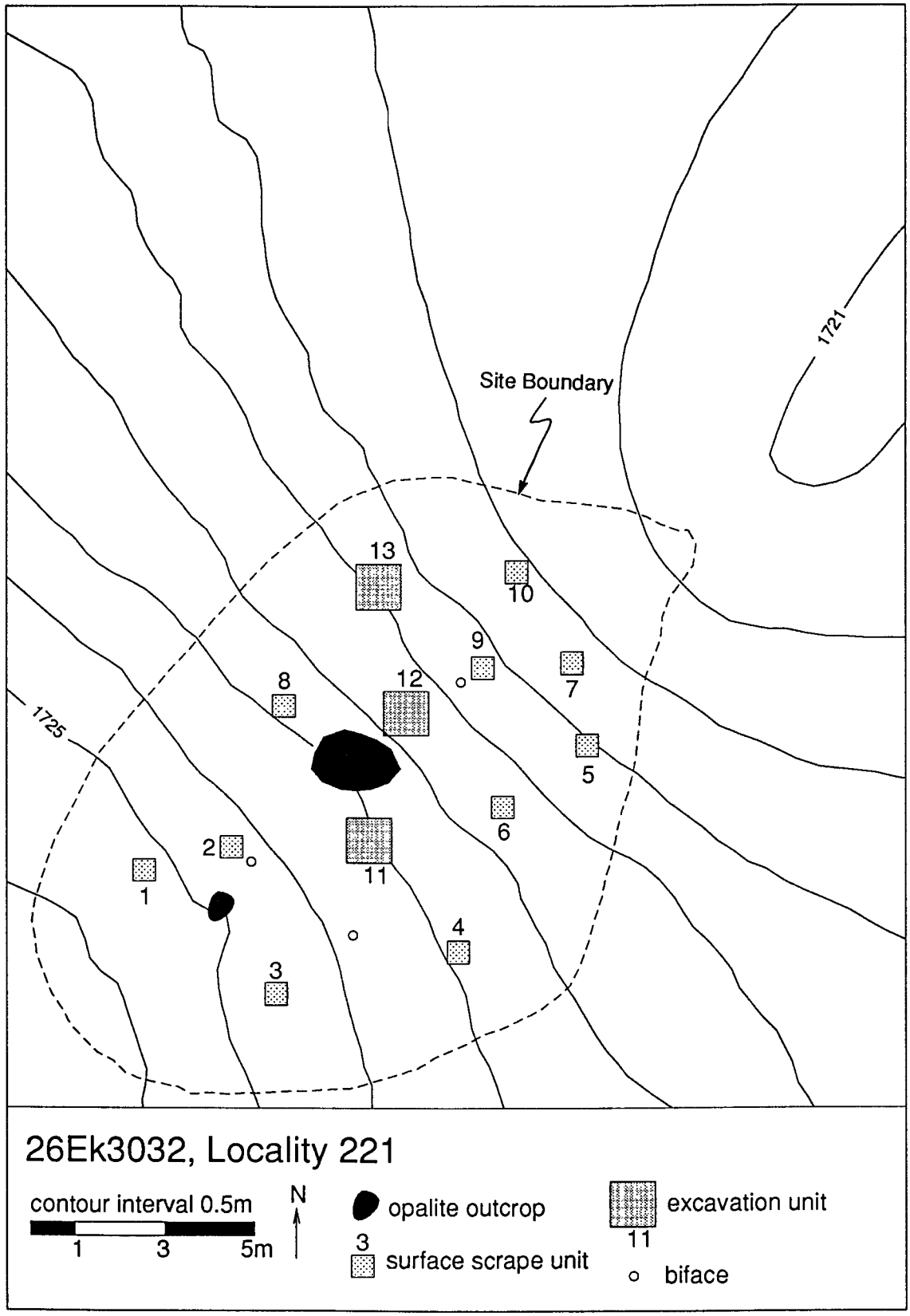


Figure 109. Topographic and unit location map of Locality 221.

Results

Subsurface cultural materials occur across the site. However, no features related to quarrying or evidence of toolstone removal from parent material were observed adjacent the bedrock outcrop. Recovered artifacts were limited to three non-diagnostic tools and a host of lithic debitage; analyses are presented below. Chapter 12 incorporates these results in a more general discussion of strategies of toolstone extraction and processing.

Biface and Debitage Analysis

The goals of analyses were to identify the types of reduction activities that created archaeological deposits at Locality 221 and to interpret the observed spatial patterning of the resulting debris. Specifically, we were concerned with the origin of the raw material, the nature of reduction technology, the extent to which raw materials were reduced, and the degree to which they were heat-treated.

The small size of debitage samples recovered precluded use of rigorous quantitative analytical methods, so debitage from each unit was analyzed by the qualitative typological technique outlined in Chapter 3. Additional data collected during analysis included the counts and weights of whole flakes and the weights of angular debris (Table 61). Results of the analysis are presented in Table 62.

Table 61. Counts and Weights of Debitage.

Unit Number	Level	Flake Count	Flake Weight (gm)	Angular Debris Weight (gm)	Unit Number	Level	Flake Count	Flake Weight (gm)	Angular Debris Weight (gm)
1	Surface	0	0.0	0.0	11	2-10 cm	8	372.6	2303.3
2	Surface	1	0.2	21.3	11*	2-10 cm	110	105	562.9
3	Surface	2	0.8	0.4	11	10-20 cm	30	85.2	136.2
4	Surface	27	79.3	27.5	11*	10-20 cm	23	209.6	2.5
5	Surface	31	149.7	3.8	12	Surface	103	159.3	137.3
6	Surface	4	3.8	10	12*	Surface	49	118.7	8
7	Surface	6	4.5	2.1	12	2-10 cm	77	230.1	468.5
8	Surface	20	68	55.3	12*	2-10 cm	48	59.8	6.6
9	Surface	20	36.9	68.9	12	10-20 cm	15	40.2	48.8
10	Surface	5	3.3	12.4	12*	10-20 cm	36	37.9	0.2
11	Surface	24	218	145.4	13	Surface	7	9.3	1.9
11*	Surface	0	0.0	0.0	13	2-10 cm	10	196.5	10
					13	10-20 cm	11	20.1	91.5
Totals							667	220.8	4124.8

Of the 25 debitage samples analyzed, 14 (56%) contain evidence of blank production and 11 (44%) contain evidence of Stage 2 edge preparation. Blank preparation (the removal of major irregularities from a flake blank; cf. Bloomer and Ingbar 1992), is apparent in only 6 (24%)

samples. This suggests that flank blanks produced at Locality 221 needed little modification prior to Stage 2 reduction because they already were fairly thin and regular. Evidence for primary biface thinning (Stage 3; cf. Callahan 1979:90-115) is present in 22 (88%) of the samples: 9 (36%) contain flakes produced in the course of early Stage 3 thinning; 6 (24%) contain flakes produced during late Stage 3 thinning; 7 (28%) have Stage 3 flakes that could not be classified. These data suggest that Stage 3 thinning occurred across most the site. No evidence of later stage thinning was evident.

Table 62. Results of Qualitative Typological Analysis.

Unit Number	Level	ND	BPRD	BPRP	EPRP	S3E	S3L	S3I	XL	HT
1	Surface									
2	Surface	X								
3	Surface	X								
4	Surface			X		X				
5	Surface		X			X				
6	Surface							X		
7	Surface		X					X		
8	Surface		X	X	X	X				
9	Surface		X		X	X				
10	Surface		X			X				
11	Surface		X		X			X		
11*	Surface									
11	2-10 cm		X	X	X			X		
11*	2-10 cm		X		X		X			
11	10-20 cm		X				X			
11*	10-20 cm		X	X						
12	Surface				X	X	X			
12*	Surface		X		X			X	X	
12	2-10 cm			X	X	X		X		
12*	2-10 cm			X		X	X		X	X
12	10-20 cm		X			X				
12*	10-20 cm				X		X			
13	Surface				X				X	X
13	2-10 cm		X					X	X	
13	10-20 cm	X	X		X		X			
Totals		3	14	6	11	9	6	7	4	2

* Control unit; material screened through 1/8 in. wire mesh

ND=Non-Diagnostic
BPRD=Blank Production
BPRP=Blank Preparation
EPRP=Edge Preparation
S3E=Early Stage 3 Biface
S3L=Late Stage 3 Biface
S3I=Indeterminate Stage 3 Biface
XL=Extra-Locale Material
HT=Heat-Treatment

The debitage assemblage is composed almost entirely of non-heat-treated material almost certainly deriving from outcrops within the locality. Extra-local lithic material, observed in only four (16%) samples, includes one quartzite hammerstone spall and three chalcedony flakes. Each chalcedony flake reflects Stage 3 reduction and exhibits differential luster, a characteristic of debitage removed from heat-treated bifaces. As at other Tosawihi sites, (cf. Bloomer, Ataman, and Ingbar 1992), bifaces often were heat-treated *during* Stage 3 reduction.

Only three bifaces (two complete and one fragmentary) were recovered from Locality 221. Each appears to have been manufactured from on-site material, and none is heat-treated. One complete biface was initiated on a flake blank and reduced to Stage 2 prior to discard; relatively small width/thickness ratio (1.71) may account for its abandonment. Amick (1985:144) has noted that the presence of bifaces 'without failures' early in the reduction trajectory probably reflects inability to thin the artifact, which was abandoned due to decreasing margin width. The other complete biface was produced from a block blank and reduced to early Stage 3 prior to its abandonment. The incomplete specimen consists of an end fragment produced by edge collapse during longitudinal thinning; it appears to have been reduced to Stage 3 prior to failure.

Spatial Patterning

Figure 110 plots the distribution of reduction stages (as indicated by debitage) across the locality. Tools and the location of heat-treated chalcedony are plotted as well. Blank production through late Stage 3 thinning occurs across most of the site, but the number of reduction stages increases near the largest bedrock outcrop. Flake counts and weights and the weight of angular debris (cf. Table 61) also increase near the outcrop. Two pieces of heat-treated chalcedony and a quartzite hammerstone spall were recovered from this area. Elsewhere, chalcedony occurs only at the northern end of the site. From these data, it appears that the reduction of local and extra-local materials was conducted primarily near the largest bedrock outcrop in the center of the locality.

Discussion

Goals of the present analysis include determining the geological origins of the lithic assemblage at Locality 221, the reduction techniques that created the artifacts, and the degree to which artifacts were heat-treated. Most artifacts exhibit the same texture and color as the stone outcrops; exceptions include one quartzite and three chalcedony flakes, comprising less than one percent of the total flake assemblage (n=667). However, evidence for toolstone extraction is absent. It is likely that prehistoric quarry features have been obscured by erosion on the steep slope (~10°) of the site, or that they now are covered by colluvium (cf. Chapter 8). We strongly suspect that the artifacts were derived from parent material at the locality.

Given the results of artifact analysis, it seems reasonable to suggest that biface production was the primary activity carried out at Locality 221. Biface production was initiated on large flake blanks (rather than on core blanks) that needed little modification prior to Stage 2 reduction, and it continued through Stage 3 (cf. Callahan 1979:33-35). Completed bifaces then were transported elsewhere for use or further reduction. Local materials were not heat-treated at the locality, but at least one Stage 3 biface manufactured from an extra-local, heat-treated chalcedony was brought there and subsequently flaked.

It is difficult to assess the spatial organization of biface production at Locality 221 because reduction activities are not strongly patterned. More artifacts were recovered from units central to the site; however, evidence for blank production through Stage 3 thinning occurs in most samples. Patterns that once existed may have been obscured by the movement of artifacts and sediments down the steep slope.

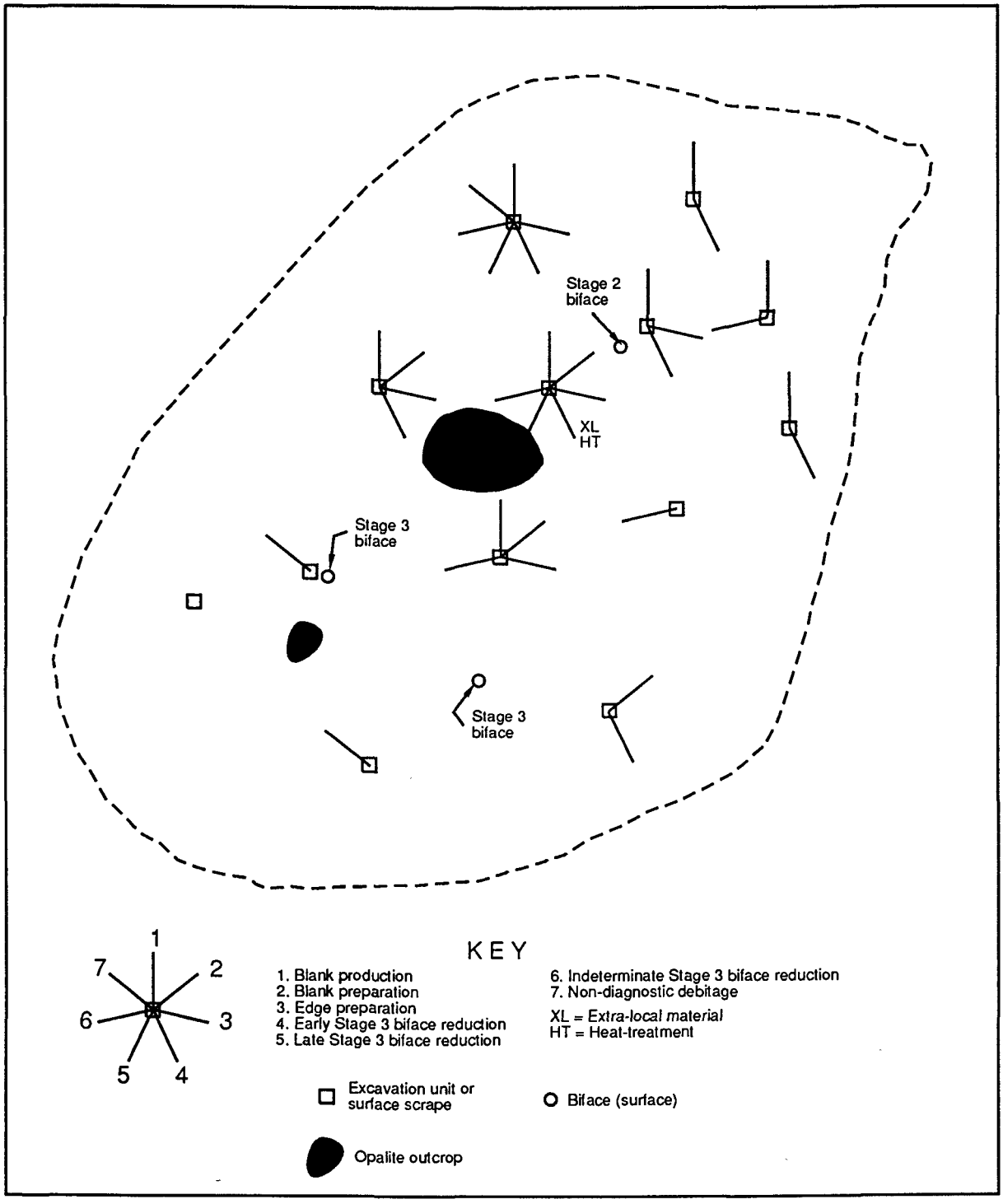


Figure 110. Star plot of reduction stages and extra-local material at Locality 221.

Conclusions

Both the artifact assemblage and geographic location of Locality 221 suggest that it was used for toolstone extraction and biface production. The site is located on a steep slope, and has no other associated resources. Except for a few pieces of extra-local material—one probably derived from a hammerstone—procurement and production activities focused exclusively on opalite. The lack of quarry features suggests that toolstone was procured from bedrock outcrops that are no longer visible or from secondary cobbles or boulders. It appears that Locality 221 offered a limited amount of quality toolstone for a small investment of time and effort. Based on its position relative to the southernmost limits of toolstone outcrops at the Tosawihi Quarries, as well as the minimal investments of time and energy needed to extract toolstone packages from it, we suspect that the locality was perhaps one the first places exploited by groups entering the quarries from the south. Unfortunately, the absence of time diagnostic artifacts and organic material for radiocarbon dating make this hypothesis untestable.

Chapter 12

THE ECONOMICS OF TOOLSTONE EXTRACTION AND PROCESSING

Kathryn Ataman, Kristopher R. Carambelas, and Robert G. Elston

This chapter examines the ways in which Tosawihi quarriers manipulated benefits and costs of quarrying at Locality 36. We look first at technological organization, then at strategies of extraction and processing.

Recall that one assumption of our economic model (cf. Chapter 1; Elston 1992c) is that foragers seek to maximize the benefit/cost ratio of toolstone procurement, thus achieving the greatest *efficiency* (Christenson 1980; Torrence 1986, 1989). We argued that toolstone confers no direct benefits, and that its utility is realized only by its ability to increase the return of other resources. However, since toolstone utility must be amortised over some interval subsequent to its procurement, one might never obtain utility equal to or greater than the time and energy invested in toolstone acquisition. The probability of such loss is *venture risk* (Elston 1992c). Thus, we reasoned, prudent foragers should seek to minimize venture risk by increasing the benefit/cost ratio of toolstone procurement.

This formulation, however, is a bit too simplistic because, while foragers can employ strategies that lower the time and energy invested in toolstone procurement, they also can invest more in order to increase the net rate of return, or *profitability*. As we shall see, changing the return rate may either increase or decrease efficiency (raising or lowering the benefit/cost ratio) and still minimize venture risk.

We suggest in Chapter 1 that cost minimization strategies are applied best to the indirect costs of toolstone procurement, such as lost opportunity and local subsistence, through manipulation of scheduling, labor organization, positioning, and activity segmentation. These strategies are manifest in the archaeological record as variability in site location, activity segmentation, and assemblage content, all of which have been investigated intensively by previous work at Tosawihi (Elston and Raven 1992; Leach and Botkin 1992). One reason to avoid giving a lot of weight to cost minimization or efficiency strategies is that constraints commonly decrease choices available for that option, particularly among the direct costs of toolstone procurement (e.g., time and energy for search, extraction, and processing).

For example, the kinds of toolstone and procurement opportunities available to hunter-gatherers are given by the lithic terrane in which they operate, while existing technology and physiological limits restrict possible techniques and strategies for lithic extraction, processing, and transport. Let us imagine that there are only three basic procurement strategies, listed in order of increasing cost as calculated for the duration of the foray: encounter procurement (glimpse and grab an isolated piece), intensive surface collection (spending time in a surface patch of toolstone), and quarrying (excavation for toolstone; cf. Elston 1992c). Theoretically, a forager can vary the benefit/cost ratio of toolstone procurement by choosing among the three strategies, but *only* if the lithic terrane is such that all three are possible. Otherwise, fewer potential opportunities for cost minimization will be available through strategic choice.

Strategies that emphasize efficiency (cost minimization) are likely to do so at the expense of intake. Consider that, while it is possible to reduce time and energy invested in toolstone procurement by relying only on encounter (the cheapest strategy over the short run), little toolstone is likely to be produced except in the richest lithic terranes where encounter rates are extremely high; in short, nothing ventured, nothing gained. Yet, such a cost-minimizing strategy may not be viable if task demands, or overall fitness, depend on acquisition of some minimum toolstone utility per unit time.

In modeling benefit/cost models of lithic procurement, the interval over which cost should be averaged is relevant to choice of procurement strategy when several are possible. If the benefit of toolstone procurement is grams of material and if the cost is time, one can calculate costs over a continuum ranging from the duration of a particular procurement episode, to a season of procurement, a year, or a lifetime. Hypothetical net returns for different strategies are graphed in Figure 111 and modeled in Table 63. In the first 10 minutes (interval A), encounter procurement produces a return of 10 grams for a benefit/cost ratio of 1.0, while intensive surface collection and quarrying entail non-productive activities such as prospecting and testing. In 100 minutes (interval B), encounter procurement, limited by the toolstone encounter rate of this particular patch, has produced no additional material, and its benefit/cost ratio, based on the initial 10 grams, falls to 0.1; quarrying, now involving overburden removal, has continued to produce nothing. In the meantime, however, surface collection yields 100 grams for a benefit/cost ratio of 1.0. At 500 minutes, quarrying has produced 1000 grams of toolstone for a benefit/cost ratio of 2.0, but at previous encounter rates, neither encounter procurement nor surface collection has produced additional material, and their benefit/cost ratios are orders of magnitude lower.

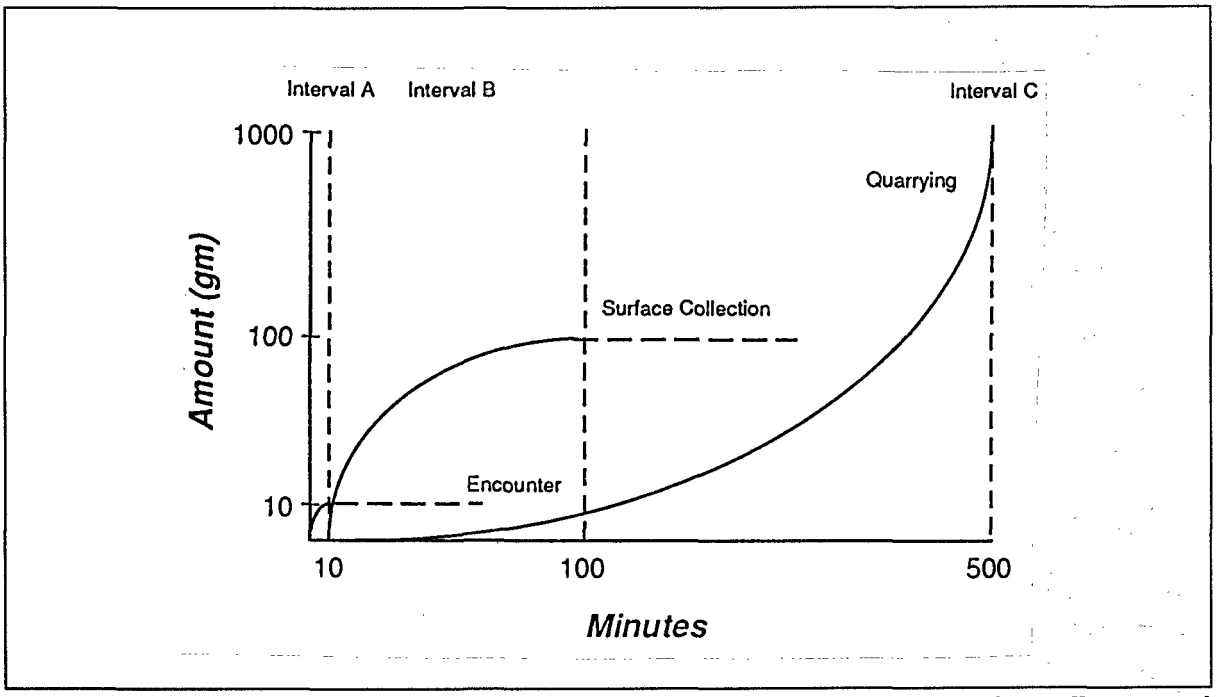


Figure 111. Hypothetical net return rates for encounter procurement, surface collection and quarrying.

Table 63. Hypothetical Benefit/Cost (B/C) Ratios for Three Lithic Procurement Strategies.

	Maximum gm per Episode	B C @ Interval A 10 min.	B C @ Interval B 100 min.	B C @ Interval C 500 min.
Encounter	10	1.0	0.1	0.02
Surface Collection	100	0.0	1.0	0.2
Quarrying	1,000	0.0	0.0	2.0

This exercise suggests that if foragers base strategic lithic procurement decisions on short-term efficiency (highest benefit/cost ratio), they always should choose encounter procurement or surface collection over quarrying, even when encounter rates are relatively low. Since, however, we cannot deny the existence of Tosawihi Quarries, we must assume that prehistoric foragers frequently took a longer view. Indeed, over the interval of a day (ca. 500 minutes), or longer, quarrying clearly is the better choice. If some minimum amount of toolstone is required, averaging cost over even longer periods is necessary to make the right decision. For example, if encounter rate limits the yield of encounter procurement to 10 grams per 500 minutes of search and processing time, it would take 50,000 minutes (nearly .10 person year) to obtain the 1000 grams of toolstone procured in 500 minutes of quarrying in our model.

Our modeling exercise also illustrates the difference between the goal of efficiency and that of achieving the greatest profit (Stephens and Krebs 1986:9). In the example above, the *efficiency* (benefit/cost ratio) of 10 minutes of encounter procurement and 100 minutes of surface collection is the same (1.0), but the *profit* (net return) of surface collection is 10 times greater. Of all techniques for toolstone procurement, quarrying bedrock is the most labor intensive, but has the greatest potential for return. In our model, the cost of quarrying is 50 times that of encounter procurement, but the net return is 100 times greater. Although rate maximization *may* result in increased efficiency (as in our example), this is not necessarily true in every case. If we decrease the yield of quarrying in our model to 450 grams in 500 minutes, efficiency falls to 0.9, but net return (profit) still is 4.5 times that of surface collection over the same interval.

At first glance, a rate maximizing strategy seems to increase venture risk, simply because short term labor investment is so much higher. This is true to the degree that return cannot be predicted, but, as we have suggested previously, one of the great advantages of quarrying over other forms of procurement is the increased predictability of return. Thus, we argue, people establish quarries in order to increase *profitability* without increasing venture risk.

Indeed, bedrock quarries such as Tosawihi are *prima facie* evidence that foragers preferred rate maximizing over cost minimizing strategies of toolstone procurement in some contexts. Once quarriers have decided to extract toolstone from a particular source, although constrained technologically, variability in the toolstone gives them some latitude for choice in whether to go for lower cost or better return rates. However, the archaeological record frequently does not allow the two to be distinguished. Foragers seem likely to emphasize return rates when a minimum amount of toolstone must be procured over a particular interval. The intensification of quarrying at Tosawihi and the tendency to pursue ever more costly material through time suggests that maximizing goals became increasingly important there, particularly through the Late Prehistoric.

We devote considerable discussion in this chapter to the following question: Given the decision to quarry opalite at Locality 36, what was the relationship of efficiency to rate

maximization in toolstone extraction? A related question asks under what circumstances fitness, in some sense, comes to demand greater investment in the procurement of a resource such as toolstone. Increased population, development of trade, and transformation of toolstone into a commodity are among the possibilities. Finally, we examine Tosawihi processing strategies in light of indications for a market economy proposed by Torrence (1986).

Technological Organization

Economic behavior involves the ways people organize themselves to accomplish specific tasks; the ways in which extraction and processing tasks were organized at Tosawihi influenced costs and benefits of the work. On the simplest political level, individuals may work alone to provide for themselves or their families, while under more complex political systems, a labor force may be paid or coerced to produce for others. We use the term "technological organization" to refer to group composition, task differentiation, and spatial task segregation involved in toolstone extraction and processing. This may be at variance with other definitions of the term (Elston et al. 1992; Kelly 1988); here we focus solely on the specifics of activity organization at Locality 36.

Data bearing on these aspects of economic behavior were recovered from various contexts. The distribution of quarry features across the landscape, strategies used in toolstone extraction, patterning of production stages within quarry pits, and the spatial relationship between quarrying and processing features and debris are all potential avenues for understanding the organization of work.

Investigation of these issues is not straightforward, however, due primarily to the nature of the archaeological record. One of the most significant factors hampering examination of technological organization at Locality 36 is lack of fine chronological control. Previously existing artifact distribution patterns may have been obscured or altered by later activity, but since few features can be dated, things associated in space may or may not be contemporaneous. For example, many reduction features are spatially discrete. At Locality 36 (cf. Chapter 10), they are concentrated along the northeastern edge of the site in the areas of highest elevation and lowest debitage density. Yet it is likely that reduction features also exist in areas near quarry features where thick debitage deposits obscure their presence and character. The debitage aprons do not yield a picture sensible to us in terms of our needs; that is, we cannot "see" individual quarrying/reduction efforts. Nor can we see quarrying efforts through time, *i.e.*, as a sequence of individual quarrying events. So, in addition to empirical archaeological data, ideas based on our own quarrying experiments form the basis for some of the following observations.

Group Composition and Size

In previous work at Tosawihi, based on evidence of activities at sites peripheral to quarry sites, we suggested that visitors were likely to have consisted of household groups (cf. Elston 1992b). Evidence from Locality 36 for activities other than quarrying are confined to a few hearths (all relatively young in age) and a small number of flake tools, ground stone fragments, and finished bifaces, together representing infrequent short-term camping; these data are silent regarding the gender, age, or size of quarrying groups. We can say only that family groups were not resident there, but probably located themselves closer to subsistence resources (food and water).

Task Differentiation

Although some quarry features at Locality 36 grew quite large over time, the physical evidence indicates that individual episodes of quarrying were conducted in relatively small workings. At any one time, quarriers probably exposed only a few square meters of bedrock. Consequently, the confined space available would have restricted to one or two the number of individuals actually working in a pit. Our extraction and processing experiments (Carambelas and Raven 1991; Elston 1992b) suggest that three or four people is the optimal group size for quarrying in a single pit, balancing the available work area (i.e., pit size) and differences in rates of extraction and processing. Two individuals could manage, albeit at a slightly slower pace; a solitary quarrier would find the going very slow. A group of three provides labor to spell the quarrier, and someone to fill and empty baskets, clear away debris, and test extracted material. Some tasks could be assigned on the basis of age (older children or elderly people could do some jobs), but a quarrying task group probably included at least two able bodied adults. If several pits were exploited simultaneously, of course, more people would have been needed.

Processing proceeds at a rate much faster than extraction. For example, in experimental extraction of moderate difficulty (Elston 1992b), one skilled flintknapper processed the extraction returns of two person days in less than one day. Quarriers could spell themselves from the exertion of quarrying by rotating processing, but the greatest processing returns probably would be achieved with the best knapper responsible for all processing. This analysis also points to a minimum work group size of three adults.

Task Segregation

Since it is difficult to move large pieces of toolstone very far, it is convenient to reduce them in or immediately adjacent the quarry pit. Even block blanks for large bifaces were not moved far from the quarry pit for reduction. On the other hand, reduction of flake blanks, partially worked bifaces, or small blocks from which less weight must be removed tended to take place at a greater distance from quarry pits. This is probably why, as we have seen in Chapter 10, a higher proportion of flake blank-based bifaces was recovered from reduction features than from quarry pits.

But, before examining the archaeological evidence for task segregation, the contemporaneity of existing patterns of features and artifacts must be considered. As noted earlier, the chronological data from Locality 36 indicates that the site was exploited over a long time and that there is some patterning to use of the place *through* time. Area C, in the southwestern part of the site, contains the oldest deposits, dating to 4000 B.P., Area B, in the northwestern part of the site was utilized most intensively between 500 and 1500 B.P., and Area A in the southeast was used over the last five hundred years. In addition, the five hearths located in the course of our excavations (in the northeastern portion of the site) yielded late radiocarbon dates and the large subsurface Feature 102 dates to 4000 B.P. (cf. Chapters 8, 9; Figure 92). There is some overlap between the time periods during which the three areas were quarried (the earliest sample recovered is, in fact, from area B, which yielded the longest span of radiocarbon dates), but there is enough patterning to suggest differential use of space through time. Thus, the patterns revealed in the course of our analyses (cf. Chapter 10) cannot be treated as static; changes in site utilization must be considered.

Reduction features at Locality 36 are densest in areas away from quarry pits, and they contain discarded bifaces made on flake blanks more often than do quarry pits. Reduction features also contain bifaces of later reduction stage, later stage debitage, and greater incidence of heat-treatment. If reduction features are considered to span all periods, then task segregation can be postulated for an unspecified period of time, but if they are considered to post-date the activity in Area C, then a change in strategies of task location is indicated.

There is some evidence to suggest that the latter is, in fact, the case. Many of the reduction features are near hearths, all of which date late in the site's history, while Feature 102, a buried quarry pit in Area C, is the oldest dated quarry feature. Biface reduction in Feature 102 differs somewhat from that in other quarry features; it exhibits a higher proportion of flake blank-based bifaces, and the distribution of distinctive opalite extracted from the feature suggests that processing (and even later stage reduction) took place in or very near the quarry pit. This may reflect a change in the amount of task segregation from the earliest (less segregated) to latest (more segregated) eras of site use.

Toolstone Extraction

In previous chapters we showed how toolstone extraction at Locality 36 focused on beds of opalite buried beneath various deposits of soil and lithic material. Two activities exemplify toolstone extraction: removal of overburden from bedrock and extraction of toolstone packages from parent material. Below, assuming quarrying is a rate maximizing procurement strategy, we propose how each of these activities may have aimed toward efficiency, and we assess our propositions in light of archaeological evidence.

To approach the economics of overburden removal, we first discuss the types of deposits overlying bedrock at Locality 36 and estimate the rates at which each can be removed. We then examine the types and depths of overlying deposits in Areas A, B, and C (cf. Figure 52) to determine the costs involved in exposing opalite at each. Based on this, we propose the order in which toolstone extraction should have proceeded in each area. Radiocarbon dates obtained from each group are compared to our proposed sequence.

To ascertain the economics of extracting toolstone packages from parent material, we discuss variability in toolstone quality and ease of extraction, estimate return rates for various qualities of toolstone, and predict which of these qualities should evidence the greatest intensity of extraction. To check the validity of our prediction, we analyze the degree to which the various qualities of stone actually were extracted.

Overburden Removal

Deposits overlying opalite bedrock at Locality 36 are a consequence of natural and cultural processes. Natural deposits include sands and gravels, eolian silts and silt loams of the present soil surface, the reddish silty clay of a well developed paleosol, and rhyolitic and kaolinitic tuffs

(cf. Chapter 7). Cultural deposits created by toolstone extraction and processing are composed of chunks, shatter, chips, flakes, and hash (Elston and Dugas 1992); rejected and broken biface fragments and the tools used in extraction and processing are present as well. All these cultural items are contained within a silty or clayey soil matrix.

As archaeologists, we distinguish depositions on the basis of attributes such as texture, consistency, and structure. An attribute of concern to quarriers, however, was the difficulty involved in loosening and removing each type of deposit. Quarrying experiments (Carambelas and Raven 1991) indicate that rates for removing different materials are highly variable. Figure 112 illustrates the types of deposits present at Locality 36 and their estimated rates of excavation (cf. Elston 1992b:Table 236). Loose surficial material can be removed quickly, as can silty soils and silty quarry fill. Slower rates of excavation are associated with the clayey quarry fill and the silty clay paleosol. Tuff bedrock is associated with the slowest rates of excavation. These types of deposits are not distributed uniformly across the locality (cf. Chapter 7).

We propose that toolstone extraction should have commenced where toolstone-quality opalite could have been uncovered in the least time, based on the variable distribution of deposits and the differential rates at which they can be removed. Once the most easily extracted material was "mined out," extraction would have proceeded to areas where progressively greater effort was required to expose bedrock. To evaluate this hypothesis, we determine the deposit type, and the minimum and maximum depths of natural deposits overlying opalite bedrock, in each of three areas exposed by backhoe trenching (cf. Chapter 7). We then estimate the amount of time required to loosen and remove deposits in each area to predict the order in which toolstone extraction should have proceeded.

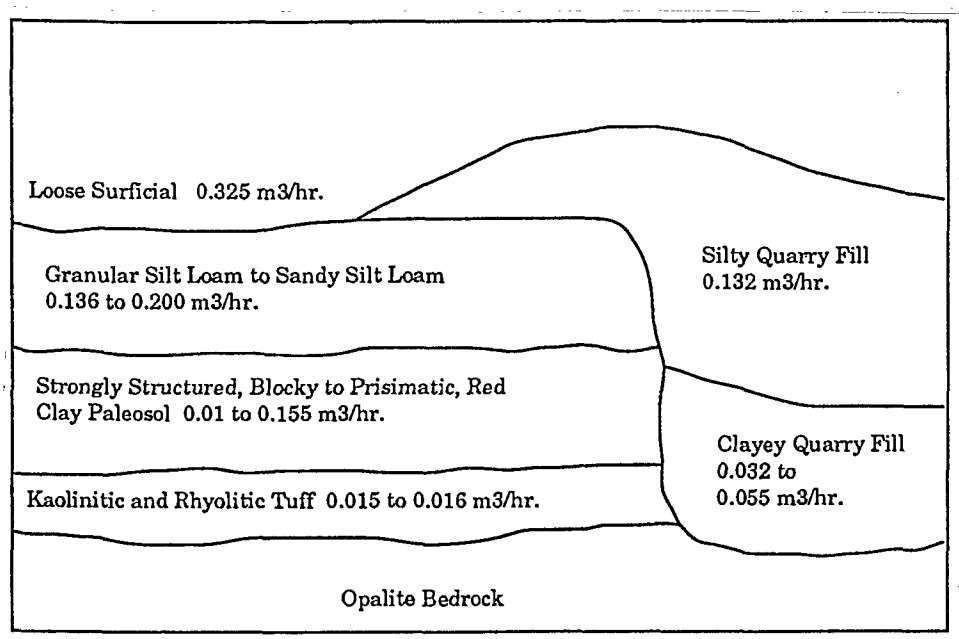


Figure 112. Deposit types and estimated rates of excavation.

Deposits Overlying Opalite Bedrock

We used the profiles presented in Chapter 8 (Figures 8.6, 8.13, and 8.21) to estimate the depth of deposits overlying bedrock. Area A contains the greatest depth of deposits, followed by Areas B and C, respectively. Area A deposits consist of a silt rich soil that ranges between 68 cm and 94 cm thick, and tuff bedrock (76 cm) or weathered bedrock and clay (22 cm). Opalite bedrock lying below these deposits grades from massive tuff to massive opalite. Area B deposits consist of a clayey silt and silty clay paleosol; the former is between 20 cm and 26 cm thick, and the latter, between 32 cm and 82 cm. Opalite bedrock is encountered beneath the paleosol. Only one deposit overlies opalite bedrock in Area C, a silt loam soil ranging between 20 cm and 28 cm thick.

Silty deposits are likely to be deeper now than they were at times in the prehistoric past. The Area A profiles (cf. Figure 60), for example, indicate that a rhyolite hammerstone was located in a non-quarry feature context some 42 cm below the present soil surface. Moreover, a bedrock ledge in the Area C profile (cf. Figure 75), now buried by 28 cm of colluvium, evidences patination and fine cracking and jointing, suggesting that the ledge was exposed at the surface in the past (cf. Chapter 8). These observations are considered when estimates for overburden removal are calculated below.

Costs of Overburden Removal

Table 64 presents data on type and depth of deposit, estimated rates of excavation, estimated time to remove each deposit, and estimated time to uncover bedrock. These are divided further into minimum and maximum estimates. Based on these data, it is evident that bedrock in Area A is the most costly to uncover, followed by Areas B and C, respectively. Minimum estimates indicate that bedrock in Area A is at least three times more costly to uncover than bedrock in Area B, and at least 17 times more costly to expose than that in Area C. Maximum estimates indicate an even profounder difference: Area A bedrock is at least four times costlier to uncover than the Area B bedrock, and upwards of 28 times more costly to uncover than the Area C bedrock. However, these estimates are predicated on the current depth of deposits overlying opalite beds.

Table 64. Excavation Rates to Opalite Bedrock at Areas A, B, and C.

	MAXIMUM OVERBURDEN REMOVAL				MINIMUM OVERBURDEN REMOVAL			
Area	Deposit Type	Depth of Cover (m)	Rate of Excavation (m^3/hour)	Removal Time (hour)	Deposit Type	Depth of Cover (m)	Rate of Excavation (m^3/hour)	Removal Time (hour)
A	SSL	.94	.133- .20	6.912-4.70	SL	.68	.136- .20	5.0-3.40
	TB	.76	.015- .016	50.667-47.5	WB/C	.22	.015- .016	14.667-13.75
	total			57.579-52.2				19.667-17.15
B	CS	.26	.136- .20	1.912-1.30	CS	.2	.136- .20	1.471-1.0
	CP	.82	.068- .07	12.059-11.714	CP	.32	.068- .07	4.706-4.571
	total			13.971-13.014				6.177-5.571
C	SL	.28	.136- .20	2.059-1.40	SL	.2	.136- .20	1.471-1.0
	total			2.059-1.40				1.471-1.0

CP=Clayey Paleosol SSL=Sandy Silt Loam TB=Tuff Bedrock
CS=Clayey Silt SL=Silt Loam WB/C=Weather Bedrock/Clay

Approximately 42 cm of silt have been deposited in Area A since the discard of a hammerstone in a non-quarry feature context, and approximately 28 cm of silt have accumulated over the bedrock ledge in Area C. Assuming the hammerstone was deposited on a working surface away from a quarry feature, the amount of deposit to be removed by quarriers is reduced by 44.7 percent, leaving approximately 52 cm of silty soil. However, 52 fewer centimeters of silt to remove at this place would reduce the total estimated amount of time to reach bedrock by only 5 to 7 percent. On the other hand, 28 fewer centimeters of silt in Area C would reduce the amount of time required to reach bedrock by 100 percent. These observations support our argument that bedrock in Area A was the most costly to expose, and that in Area C, least costly.

Our hypothesis asserts a relationship between the variable cost of exposing bedrock and the placement and development of quarry features. Specifically, we expect that toolstone extraction commenced where the costs of uncovering bedrock were lowest (Area C), followed by extraction at places increasingly more costly to uncover (Area B, then Area A). If this is true, radiocarbon dates from Area C should be generally older than those from Area B, which in turn should be generally older than those from Area A.

The 27 radiocarbon dates obtained from quarry features at Areas A, B, and C are plotted in Figure 79. A general trend is perceptible in this figure which seems to satisfy our expectations. Dates associated with Area A are relatively recent, while those associated with Areas B and C are progressively older. A notable exception to our prediction consists of a relatively old date at Area B.

Five pre-3500 B.P. radiocarbon dates were obtained from Locality 36. Four were recovered from Area C, and one (4090±100) from Area B. The date from Area B apparently constitutes a deviation from our expectation. In order to determine if this date differs significantly from those of Area C, we compared the dates between the two areas statistically (cf. Thomas 1986:249-251). Our results (Table 65) indicate that in only two instances are Area C dates significantly different from the Area B date. This prompts us to suggest that, although limited evidence of early quarrying is present in Area B, most toolstone extraction was conducted initially in the most cost effective area, Area C.

Table 65. Comparison of Pre-3500 B. P. Radiocarbon Dates Between Areas B and C.

Area B		Area C	
Reference No.	Date	Reference No.	Date
2599-220-53	4090±100	2599-159-6	3890±70
		2599-161-8	3830±80
		2599-160-7	3810±60*
		2599-162-9	3670±90*

*Significant at 0.05 level

Procuring Toolstone Packages from Bedrock

Once deposits overlying bedrock were removed, quarriers extracted toolstone packages from parent material. The features they created and the extraction methods they used were affected by

bedrock geology; the toolstone quality of bedrock motivated quarriers to focus efforts in particular places (cf Chapter 9). We presume that these efforts tended toward rate maximization. A similar presumption was evaluated by Torrence (1986), who also recognized the effects of geology on toolstone extraction. The methods we use to evaluate our hypothesis are similar to those used to evaluate the efficiency of toolstone extraction at the Sta Nychia and Demenegaki obsidian quarries (Torrence 1986:171-18). Below, we briefly review the toolstone quality typology introduced in Chapter 9, estimate extraction return rates for various qualities of toolstone, and assess the extent of extraction for each quality as observed in backhoe trenches at Locality 36.

Variation in Toolstone Quality

As toolstone, opalite ranges from poor quality material found in poorly silicified or highly fractured beds to above average quality material located in massive, relatively homogeneous beds. The ease with which toolstone can be extracted from bedrock is related inversely to its quality; lower quality toolstone is easier to extract than high quality toolstone (cf. Chapter 9). One might think that quarriers would ignore the poorest material in favor of the best, unless good material were so massively emplaced that it could not be extracted; in that case, quarriers should ignore it as well. But, clearly, toolstone *was* extracted; what we seek are quantitative means of describing the trade-offs between toolstone quality and ease of extraction. Then we can ascertain which qualities of toolstone provided the most efficient extraction returns per unit of time or effort. Quarrying experiments conducted at Tosawihi yielded data that allow generation of such estimates.

Variation in Extraction Return Rates

Four of five quarrying experiments attempted to extract toolstone packages from buried bedrock. One attempt focused on weathered, poor quality material, a second on massive, high quality material, a third on average material, and a fourth on material grading from below average to average quality. Toolstone packages were assessed by a flintknapper in order to determine their suitability for processing. As a consequence, numerical data generated by these experiments (cf. Carambelas and Raven 1991; Elston 1992b) allow us to estimate a net extraction return rate (*neRr*) for the different qualities of stone that we attempted to extract (Table 66). The *neRr* is simply the rate at which a mass of stone suitable for processing can be extracted in some unit of time (Elston 1992b). That is,

$neRr = neR_i / T_i$ where

neR_i = total net return of unrejected toolstone (gm) obtained in excavation event i

T_i = total amount of time (min.) spent in excavation event i

Table 66. Estimated *neRr* for Various Toolstone Quality Rankings.

Experiment Number	Toolstone Quality Ranking	Total Time of Excavation Event (min.)	Total Net Extraction Return (gm)	Net Extraction Return Rate (gm/min.)
1	Poor	300.0	0	0
2	Above Average	240.0	0	0
3*	Average	360.0	?	?
4	Below Average to Average	820.0	53,600.0	65.37

* 19,300.0 grams of toolstone obtained during experiment but not assessed by knapper

Our data do not allow estimates for each quality of toolstone. Nevertheless, we can provide estimates for the two extremes, and for a point somewhere between. A *neRr* of 0 is estimated for poor quality material, since the stone was too fractured to produce toolstone packages of an acceptable size. Also, poor quality stone may not produce tools even if packages of sufficient size are obtained because the material is so poorly silicified that it cannot be flaked. A *neRr* of 0 also is estimated for above average quality toolstone. This massive, homogenous material resisted hammerstones, and its lack of fractures disallowed the use of wedges to force chunks from parent material. The highest *neRr* (65.37 gm/min.) is estimated for opalite that grades from below average to average in quality. Fractures in the bedrock facilitated toolstone removal from parent material, yet the quality of the stone allowed flake propagation and tool production.

One quarrying experiment was conducted on a bed of opalite assessed as average in quality; a gross return of 19,330.0 grams was realized, but the potential of the material for processing was not assessed. No experiment was conducted on opalite judged to be below average in quality. Consequently, we offer *neRr* estimates for neither average nor below average quality stone. Nevertheless, we suspect the *neRr* for below average to average quality toolstone either approaches or lies just beyond the point at which extraction efforts realized diminishing returns. At the very least we can estimate with confidence that below average and average quality stone has a *neRr* that is relatively greater than poor or above average quality stone. With these estimates in mind we can anticipate the interaction between toolstone quality and degree of extraction.

Our hypothesis for efficient toolstone extraction suggests that quarriers should have focused effort on bedrock that provided the best *neRr*. Therefore, we expect that toolstone extraction from beds that are either poor or above average in quality should have been less frequent than toolstone extraction from beds of below average to average quality. Toward evaluating this hypothesis, we examine the intensity of extraction in opalite of various qualities. Differences in the degree of extraction between below average, below average to average, and average quality opalite remains to be investigated.

Intensity of Toolstone Extraction

The present shape of quarry features and opalite bedrock is a consequence of at least 4,000 years of intermittent toolstone extraction. Here we estimate the intensity with which different qualities of stone were extracted from bedrock. Intensity of extraction is simply a measure of the

extent to which a particular deposit was quarried. Measures of intensity of extraction can be calculated in a number of ways; ours is a subjective measure (cf. Torrence 1986:171, 178), outlined below.

Figure 113 illustrates how we estimated intensity of extraction. First, we assumed that each trench wall serves as a two dimensional line transect, sampling variability in toolstone quality and amount of toolstone removed. Using the bedrock quality maps drafted by a lithics specialist (cf. Figure 85a), we estimated the position of each quality grade and plotted its boundaries on the profiles of trenches 1, 2, 3, 4, 5, 7, 8, 10, and 11 (cf. Figures 8.4, 8.6, 8.9, 8.12, 8.13, 8.17, 8.18, 8.20, and 8.21). For example, the entire length of bedrock exposed in Figure 113 is 37 m; of this, approximately 8.5 m is poor quality toolstone, while below average and average quality bedrock account for an estimated 15 m and 13.5 m, respectively.

Second, from the unexcavated portions of bedrock and tuff illustrated in the profiles, we estimated the position of the original, unquarried bedrock surface relative to the present quarried surface, and calculated the area between the two surfaces using a digitizer. Assuming that the area between the two surfaces resulted from toolstone extraction, and that the stone removed was of the same quality as that remaining on the quarried bedrock face, two measures were obtained: the estimated length of bedrock exposed in the trench and the estimated area excavated from the bedrock.

Third, a measure for the intensity of extraction was obtained by dividing the total estimated area excavated from each quality grade (A) by the total estimated length of that quality

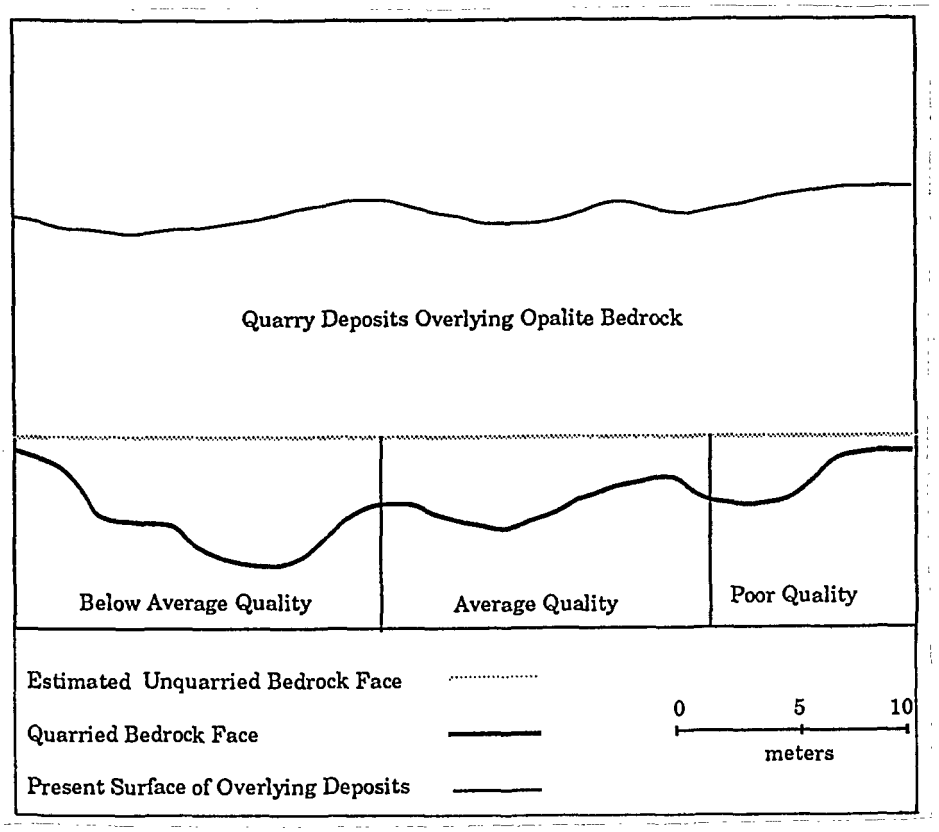


Figure 113. Schematic of estimated unquarried and quarried bedrock faces.

grade (L). The quotient represents the average amount of area removed per meter length of that quality grade. Table 67 presents estimated length and area measurements for opalite bedrock observed and rated; quotients for each quality grade are plotted in Figure 114.

Table 67. Estimated Length and Estimated Area Excavated from Bedrock.

Toolstone Quality Ranking	Location	Estimated Length of Bedrock Observed in Profile (m)	Estimated Area Excavated from Bedrock Observed in Profile (m^2)
Tuff	Trench 1	7.400	0.000
	Trench 5	0.342	0.000
	Trench 10	0.859	0.031
	Trench 11	2.125	0.000
	Trench 3	8.330	1.585
	Trench 8	5.200	0.647
Totals		**24.256**	**2.263**
Poor	Trench 2	6.650	0.000
	Trench 7	5.592	0.000
	Trench 11	2.250	0.083
	Trench 8	3.700	0.803
Totals		**18.192**	**0.886**
Poor to Below Average	Trench 10	1.503	0.319
	Trench 11	2.250	0.176
Totals		**3.753**	**0.495**
Below Average	Trench 2	1.800	0.004
	Trench 7	1.850	0.019
	Trench 4	9.600	1.841
	Trench 5	3.227	0.477
	Trench 10	0.859	0.069
	Trench 11	0.875	0.005
	Trench 3	1.700	1.445
Totals		**19.911**	**3.860**
Below Average to Average	Trench 4	8.950	0.500
	Trench 11	7.500	0.377
Totals		**16.450**	**0.877**
Average	Trench 1	11.200	2.489
	Trench 2	7.950	1.510
	Trench 7	5.958	1.167
	Trench 4	7.650	0.858
	Trench 5	11.131	3.883
	Trench 10	4.079	0.744
	Trench 5	6.500	1.073
Totals		**54.468**	**11.724**
Below Average To Above Average	Trench 3	0.971	0.299
Totals		**0.971**	**0.299**
Above Average	Trench 3	6.199	0.000
Totals		**6.199**	**0.000**

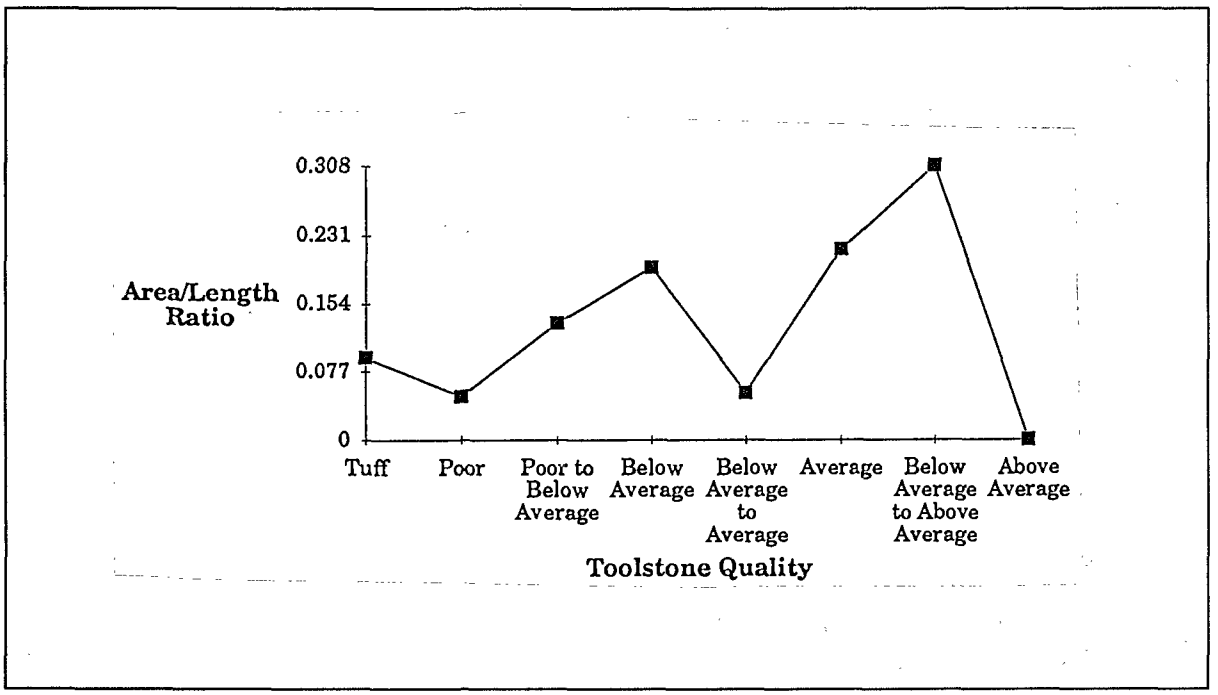


Figure 114. Area excavated per length of bedrock.

As anticipated, poor and above average quality opalite was not utilized or was underutilized compared to other qualities of bedrock (with the exception of below average to average quality toolstone, discussed below). Above average opalite apparently was not utilized. However, this material was found only in a small band (Trench 3) at the very back of an adit (Feature 41). The opalite in the adit probably was both impenetrable and extremely difficult to reach. Poor quality stone apparently received some attention, but much less than other qualities of stone.

An obvious exception to our prediction is evident. The estimated *neRr* for below average to average quality opalite is notably different from the *neRr* for poor and above average quality bedrock, but the intensity of extraction of this stone is not much different from that of poor quality stone. At this point, we surmise that our estimated *neRr* for this quality of stone represents either a rate lower than the below average and the average quality stone, or that our assessment of bedrock quality was less accurate than for the two extremes. The latter seems more plausible given the complex nature of the bedrock. In summary, bedrock exposed at Locality 36 leads us to conclude that most toolstone extraction was conditioned by the potential net returns quarriers could achieve from the various qualities of toolstone.

Toolstone Processing

The focus of opalite processing at Locality 36 was biface production. We previously addressed production efficiency in terms of biface transport costs (cf. Elston 1992b); based on distributions of bifaces across the project area, we decided that transport cost was the factor most influencing the extent to which bifaces were reduced before export from the quarry vicinity. Our

prior work at sites peripheral to the Quarries proper (Elston and Raven 1992), indicated that the most commonly exported artifact form was a mid- to late Stage 3 heat-treated biface. Experimental replication studies suggested that in this form and at this point in the reduction sequence, the bulk of waste mass had been removed (Figure 115), and the greatest risk of manufacture failure had been avoided.

In Chapter 5 we showed that bifaces produced at Locality 36 and other Tosawihi *quarrying* sites were transported away from those sites in a similar form (un-heat-treated, early Stage 3), while bifaces exported from the Tosawihi production area as a whole were advanced farther along the reduction sequence (heat-treated mid- to late Stage 3). This suggests that support camps for Locality 36 quarriers were located away from the quarry area (nearer water and food sources) and that bifaces probably were reduced there before export.

But processing efficiency can be examined from other perspectives. Torrence (1986) defines four aspects of production around which efficiency of production can be evaluated: sophistication, simplification, standardization, and specialization. This scheme considers the ways in which processing is accomplished and the design of the finished product. Since only the production end of the lithic procurement, processing, and tool use system can be examined at Locality 36, we rely to some degree on general data to evaluate these aspects of production efficiency.

Toolkit Composition

One aspect of production efficiency involves the configuration of the tool repertoire. Torrence (1986) argues that single purpose toolkits are sophisticated and more efficient than

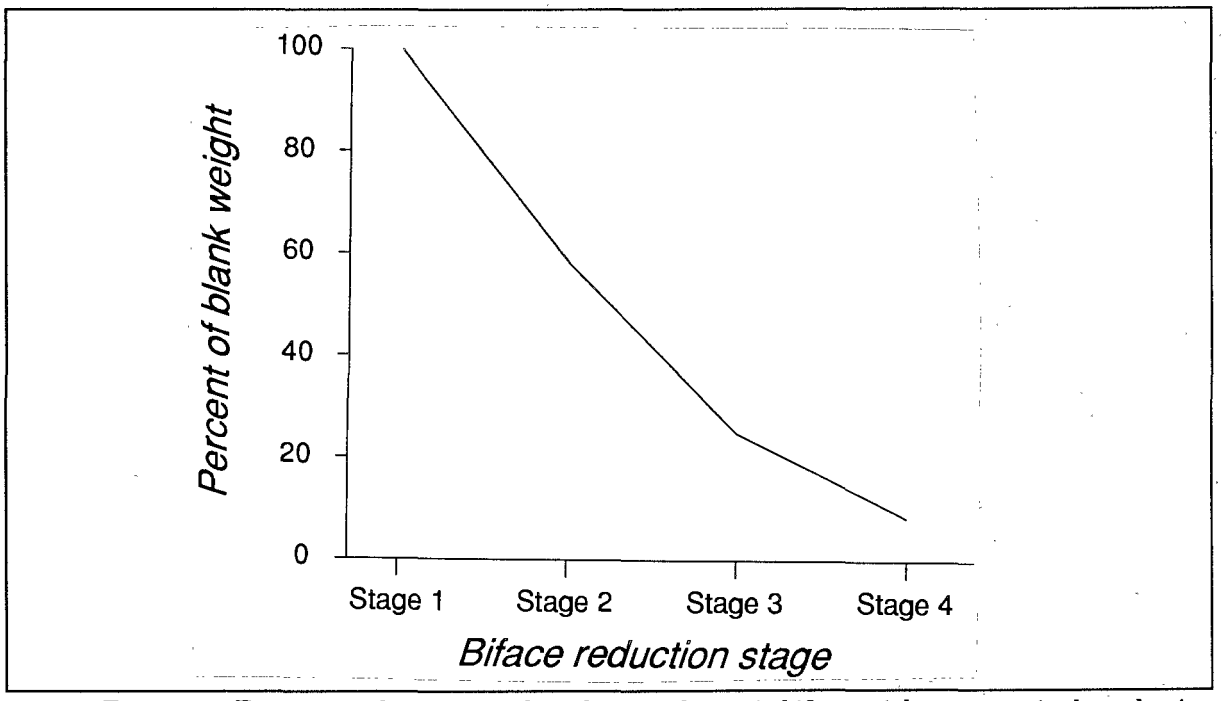


Figure 115. Experimental replication data showing change in biface weight at stages in the reduction sequence.

generalized ones and that, therefore, one criterion for recognizing production efficiency is the presence of specialized toolkits. There is considerable evidence for the prehistoric use of specialized toolkits in the Great Basin; caches of hunting tools, sewing kits, flint-knapping kits, duck decoy repair kits, etc., recovered from dry contexts (often in cave deposits; Hester 1974; Heizer and Kreiger 1956; Thomas 1985; Ingbar 1985) attest to the concept of specialized toolkits, but some bundles are composed of multiple, specific toolkits (Loutham 1990) that may have been transported as units. Historic hunter-gatherers of the Great Basin often participated in foraging trips in which a wide variety of resources was sought (Downs 1966; Thomas, Pendleton, and Cappanari 1986) and for which various tools would be needed. In these situations, mobile foragers might find it most efficient to carry a flexible toolkit composed of a very few, multipurpose items, such a kit being lighter in weight and thus easier to transport; alternatively, the make-up of a toolkit might vary depending on the purpose of the trip.

At Locality 36, the only tool for which we have clear evidence of manufacture is the biface. Bifaces exported from Tosawihi were intended primarily as bifacial knives (Ataman and Bloomer 1990, 1992). Bifacial knives are effective, multipurpose tools and can be resharpened easily without much risk of breakage. The ubiquitous distribution of bifaces at Great Basin archaeological sites indicates that before the introduction of metal tools, the biface may have been one of the most important elements of many prehistoric toolkits.

Production Standardization

Production standardization is another criterion which can be used to evaluate production efficiency. The bifaces produced at Locality 36 are homogeneous in form (cf. Chapter 5). Most pieces in the assemblage are of the same stage (early Stage 3), few are heat-treated, and size variation is minimal. Compared to other Tosawihi sites, the pieces in the biface assemblage from Locality 36 exhibit a lower range of variation in every dimension, even though the site was used for at least four thousand years. Thus, in terms of product standardization, our data suggests that processing at Locality 36 was organized in a cost effective way.

Technological Simplification

Simplification of both technological procedures and tool design, which may reduce the number of manufacturing stages, creates efficiency by requiring less production time. However, decisions to use particular techniques, such as using flakes rather than blocks as biface blanks, are influenced by factors not easily observed in the archaeological record. In the example at hand, flake blanks may be preferred when bedrock structure allows flakes to be detached easily or when massive blocks from which flake blanks can be struck can be removed easily.

In terms of tool design, bifaces are rather simple; the formal differences between most bifaces often are due to raw material variation, although certain small specimens serve as preforms for projectile points which may convey ethnic, stylistic, and functional information.

Differences in manufacturing techniques can be recognized most readily at production sites such as Locality 36. Square edge and end-thinning techniques were found in many parts of the site (cf. Chapters 5,10), so it is likely that they were components of the technological repertoire

throughout the exploitation of the quarry. These two techniques are represented in similar proportions in a variety of contexts. It is more difficult to examine changes in the proportions of flake blank-based bifaces through time. This type of biface blank was most common in the area of the site exploited earliest (Feature 102 in Area C), and slightly less common in the reduction features excavated near the Late Archaic hearths. Flake blank-based bifaces are least common in the quarry pits of Areas A and B, which date primarily from 1500 B.P to the present. It is likely that, while this was never a dominant technique, it was practiced to some extent throughout site history. Proportional differences between contexts are not great, and we have insufficient chronological control to determine whether the use of these more efficient techniques increased or decreased through time.

Production Specialization

Specialization, in terms of access to resources, exclusive reliance on high quality raw material, and organization of labor is another aspect of production efficiency (Arnold 1985; Seeman 1985). There are many raw material sources in the greater Tosawihi vicinity and control of access would have been difficult to effect. Ethnographic accounts provide no indication that such control over toolstone sources existed, although family-owned nut groves and other property are documented historically (Downs 1966; Fowler 1986).

The question of craft-specialization is also difficult to evaluate. Historic accounts of craft specialists exist, such as arrow makers (Fowler and Matley 1979, Figure 57) and commercial basket weavers (d'Azevedo 1986), but it is possible that such accounts refer to remnant knowledge by older people who remembered shared craft skills or who developed them in response to white demand. If specialist knappers existed, it is unlikely they possessed exclusive skills; rather, they probably were more skilled than others in their group and worked faster, with a higher success rate.

The quarriers at Locality 36 do not seem to have concentrated on the exploitation of the highest quality material (cf. Chapter 9). It seems to have been more efficient to exploit medium quality material which was less costly to extract, and could be worked effectively, rather than aim for higher quality material that was more difficult to extract. The savings achieved by working more uniform, high quality material, with less discard of material flaw-induced failures appears not to have offset the greater difficulty of extraction.

Thus, while many aspects of toolstone processing at Locality 36 may have been cost-effective, evaluation of all the factors involved is problematic. The technology was simple and probably was not practiced exclusively by specialists. Biface design was standardized, and bifaces were the most effective tool form for performing the widest number of tasks.

Summary and Discussion

If our previous conclusions are correct (cf. Elston and Raven 1992) and no important factors remain undetected, people probably visited the Tosawihi Quarries with their families, and, if their visits lasted more than a few days, some members of the group undoubtedly gathered food for the

group. Quarrying was done by a minimum of three adults. Children may have assisted either quarrying or food gathering. The extent to which task differentiation and segregation were features of quarrying and biface production at Locality 36 may have changed through time.

Our experiential and circumstantial evidence suggests a likely scenario:

Extraction of toolstone packages from opalite bedrock at Locality 36 commenced no later than 4,000 B.P. The task involved two costly procedures: removing overburden from bedrock opalite, then hammering and/or wedging usable toolstone packages from the parent material. The archaeological record of both activities supports the notion that quarriers attempted to keep costs low and return rates high.

Overburden removal involved the break-up and dislocation of deposits of various thicknesses and levels of extraction difficulty. Stratigraphy and radiocarbon dates from each of three areas suggest that quarrying commenced where overburden removal was easiest and subsequently proceeded into areas where it became increasingly more costly. Thus, over the four thousand years of intermittent use, quarriers kept extraction costs low at Locality 36 by focusing on quarryable bedrock that could be reached with the least effort.

Extraction of toolstone packages from bedrock involved wedging and hammering blocks of opalite from parent material; structural features of the bedrock facilitated removal, while massiveness of bedrock inhibited it. The archaeological record created by this procedure suggests that quarriers attempted to keep toolstone return rates high by focusing on areas of bedrock that returned the greatest amount of usable toolstone per unit of time invested, and that they ignored areas offering lower return rates.

For the period of earliest exploitation (ca. 4000 b.p.), there is no evidence for task segregation; processing took place in or adjacent quarry pits. The use of flakes as biface blanks was more common than in later periods, possibly because the toolstone in Trench 3 (from which most of the early dates derive) occurred optimally, deposited in a narrow band of high quality material from which flakes could be detached easily. In contrast to later periods, even later stage reduction took place immediately around the pit, and less heat-treatment is evident. Sites away from the quarries contain time-diagnostic artifacts from this period, but there is little to suggest that early quarriers camped at Locality 36. This implies short visits by small numbers of people or several family groups working in separated areas.

On the other end of the time scale, if we assume that reduction features near late-dated hearths are also late, we must conclude a change in technological organization. Under this scenario, later stage reduction and heat-treatment, as well as flake blank-based biface reduction, took place in these reduction features, while biface reduction near the pits was more block-based and earlier in stage. In addition, hearths and the few flake tools and ground stone fragments also are located in these areas.

What could cause this change? In our previous work at Tosawihi, we noted an intensification of production toward the end of the Archaic period. Segregation of activities, implied task differentiation, and evidence for some ancillary activities at Locality 36 during this period could be explained by such intensification. Larger groups, perhaps staying for longer visits, spread their activities over a larger portion of the area and left more evidence behind.

Some of this is speculative, notably that undated reduction features near late-Archaic hearths also date to the end of the Archaic. Nonetheless, the scenario offered here provides a model which will be useful for comparison as data from other Great Basin quarries become available.

Chapter 13

THE VIEW FROM LOCALITY 36: RECAPITULATION AND PROSPECTUS

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Robert G. Elston, Eric E. Ingbar, and Melinda Leach

This final chapter summarizes our understanding of Locality 36, but, as we promised in the Epilogue of Part One of this series of reports (Elston and Raven 1992), we also summarize the findings of all our work at Tosawihi Quarries and evaluate its archaeological significance.

The Place of Tosawihi Quarries in Prehistory

The importance of Tosawihi to prehistoric foragers is reflected in the size of the quarry complex, the length of time that the quarries were utilized, and the regional distribution of the material procured from them (cf. Chapter 1). Tosawihi constitutes one of the largest prehistoric bedrock quarry complexes in North America. Encompassing 800 acres, with at least 1,000 more acres of ancillary processing sites, the Tosawihi Quarries are comparable in size to quarry complexes found at Flint Ridge, Ohio (Holmes 1919), Spanish Diggings, Oklahoma (Bryan 1950), Alibates, Texas (Bryan 1950), Knife River Flint, North Dakota (Ahler 1986), and Allendale, South Carolina (Goodyear and Charles 1984). Chipped stone artifacts produced from Tosawihi opalite indicate that the material was utilized from Clovis times to the present, a period of about 11,000 years. Moreover, the Tosawihi Quarries supplied material for trade over great distances; artifacts produced from Tosawihi opalite have been observed at sites 175 km away.

Recent ethnographic work among Tosawihi Shoshone, who presently live in Nevada, Idaho, and Utah, indicates that the Quarries were economically, socially, and spiritually significant to historic users of the opalite deposits, and that trade of opalite in the historic period may have been more extensive than can be ascertained by the prehistoric archaeological evidence at the quarries.

A Deductive Theoretical Approach to Lithic Procurement

The magnitude of the archaeological record at Tosawihi Quarries demanded some means to focus inquiry. A purely empirical approach would not have indicated or ranked relevant data classes, methods of data collection, or techniques of data analysis; consequently, our research would have been more tentative and probably much less informative than it has turned out to be. As it happened, some of us already were thinking about subsistence strategies and resource procurement in terms of microeconomics and evolutionary ecology (Raven and Elston 1989; Elston and Budy 1990), both of which predict behavior on the basis of benefits and costs. Study of the Tosawihi phenomenon afforded an opportunity to develop these ideas with regard to lithic procurement, which we have shown to be well suited for cost-benefit analysis.

Taphonomy is less problematic for cost-benefit analyses of lithic procurement than of organic resource acquisition because lithic procurement often leaves large quantities of non-perishable byproducts that unambiguously mark localities of toolstone extraction, processing, and

manufacturing. While the locations of toolstone sources remain constant through time (but cf. LeBlanc 1991:268-277), cultural and technological factors affecting the benefit/cost equation were free to vary. Thus, we assumed that much of the archaeological variability observed at Tosawihi reflects variability in human behavior rather than taphonomy.

Our model of lithic production, based on economic theory and data derived from experimental quarrying and biface reduction, permitted a highly deductive approach to the archaeology of Tosawihi Quarries. We asked how people would have behaved at Tosawihi had they made purely economic decisions, with payoffs in risk reduction, personal survival, or fitness. Yet, as our studies have demonstrated, application of the model takes us far beyond mere definition of Tosawihi as a special purpose site with economic importance.

The structure of Tosawihi Quarries (distribution and content of extraction, processing, and base camp sites) is explained in terms of the economics of procuring and transporting toolstone. *Tosawihi quarriers preferred efficient solutions to economic problems involving indirect costs* (i.e., by strategic use of the landscape), but they sought to increase net toolstone returns through judicious quarrying strategies. We have few data with which to apply the economic model outside the production sphere around Tosawihi. Nevertheless, it begins to illuminate other aspects of prehistoric economic behavior at a regional scale. For example, including visits to Tosawihi Quarries in the seasonal round must have incurred opportunity costs. Thinking about how prehistoric people could have minimized these, we have begun to confront labor organization, technological organization, mobility, scheduling, and positioning as components of larger subsistence strategies, elements that figure in current middle range theory. In the final analysis, however, our focus on economic relationships and fitness as ultimate causes of human behavior seeks to subsume middle range explanations of variability.

The task of modeling the economics of lithic procurement is challenging, and numerous theoretical issues remain to be worked out. For example, we are discontent with warranting arguments based mainly on risk and would prefer a more direct relationship with fitness. Finding one will require resolution of appropriate currencies to employ in the model. Costs expressed as time and energy are straightforward, but utility expressed as grams of material or as functionality are only approximations of increased efficiency in the capture and processing of food resources, the real utility gained from use of stone tools. We also must reduce our present uncertainty over when it is better to frame expectations in terms of cost minimization (efficiency) and when in terms of maximization of net returns (profit). We ultimately may be constrained by what is visible in the archaeological record.

Although we wish to emphasize our approach as deductive, we do not want to leave the impression that the model has been applied in a fully developed form from the outset. On the contrary, we began to study Tosawihi with a few basic ideas that, for the most part, were operationalized only vaguely. We have revised our schemes continuously as the work progressed, and still regard our model rudimentary in its present form.

Lithic Procurement and Processing at Locality 36

The most basic questions posed in our investigations at Locality 36 centered on how opalite was extracted, on how extracted opalite was processed, and on non-quarrying activities that may have occurred in conjunction with opalite extraction. We found that, with the exception of a few artifacts and features not directly attributable to quarrying activity including hearths and

millingstone fragments), toolstone extraction and early stage processing were the focus of activity at Locality 36 (cf. Chapters 4, 5). Most flake tools in the assemblage were produced and used expediently and it is likely that they were used primarily in the manufacture and maintenance of quarrying tools. The few projectile points may or may not be connected to quarrying; sourcing and hydration data are consistent with patterns observed previously (cf. Chapter 5).

Experimental Quarrying and Processing

The size and form of toolstone packages extracted from bedrock limited the size and form of tools produced. Given that the production of bifaces of a certain size, shape, and stage was the primary goal of lithic procurement at Locality 36 (cf. Chapter 5), we employed data generated from actualistic quarrying and replication experiments to estimate the minimum size of toolstone packages needed to produce such artifacts. We observed that, at the very least, toolstone packages more than three times the weight of a typical Stage 3 biface would have been required. Toolstone packages not meeting this minimum size were likely to be discarded, and certain areas of the bedrock may not have been quarried because potential packages were too small.

Actualistic quarrying and replication experiments generated data to model the time and effort required to extract and process toolstone (cf. Chapter 12; Elston 1992b). We used experimental quarrying data to estimate the time required to remove overburden from toolstone beds, and to estimate return rates for different qualities of stone. Temporal variation in quarrying activity between Areas A, B, and C can be accounted for, at least in part, by the variable amount of time required to reach toolstone beds; the estimated costs of overburden removal increase from Area C to Area B to Area A, and this sequence is paralleled by radiocarbon dates progressing from oldest to youngest. Extraction of toolstone from opalite bedrock, once overburden had been removed, was contingent on the quality of the bedrock and the rate at which toolstone packages could be removed; quarriers apparently focused most of their efforts on areas of bedrock that provided the most usable toolstone per unit of time spent in extraction.

Data generated by replication experiments, combined with that derived from quarrying experiments, allowed us to estimate much of the total costs in time and effort of lithic procurement at Tosawihi, and to examine where processing was done best (Elston 1992b). Experimental bifaces similar to those observed at Tosawihi require approximately one hour per biface to produce, with "processing" accounting for 18 percent of the time and "extraction" comprising the other 82 percent. Because up to 95 percent of the extracted toolstone package mass was removed in processing (cf. Elston 1992b), in most instances it paid quarriers to process toolstone to some degree prior to its export.

Biface Production

Bifaces were the intended product of extraction and processing efforts at Locality 36; there is no evidence for flake production (except for biface blank production) represented in the technological repertoire. In fact, the cores and modified chunks present in the assemblage probably are by-products of early stage biface processing. Breakage and thinning failure were equally responsible for biface discard, a pattern quite different from that at non-quarry sites, where breakage accounts for almost all biface discard.

Locality 36 bifaces were derived from flake blank and block cores, almost exclusively of raw material occurring on-site. Mass reduction, blank preparation, and early biface thinning were the most frequent stages of reduction undertaken; late bifacial thinning and tool finishing were relatively rare. Blank preparation and early biface thinning occurred surprisingly often in quarry pit contexts. It is *not* surprising, however, that heat-treatment of opalite (undertaken to increase raw material workability) is less common than at non-quarry Tosawihi sites, since the technique is associated most often with later stage reduction.

Using a simple simulation model (cf. Chapter 5), we determined that bifaces were removed from Locality 36 in early Stage 3, a form somewhat earlier than we have proposed for export from non-quarry sites (mid to late Stage 3). Based on this difference in export product and on the non-residential character of the site, we suggested that bifaces produced at Locality 36 were reduced initially at the quarries, then removed to nearby camp/processing sites where they were reduced further and often heat-treated before export from the Tosawihi area.

A number of specialized reduction techniques, such as the use of flake and block blanks, end-thinning, and thinning from a square edge, were noted in the course of our studies. The use of these techniques appears not temporally variable, but related to stages of production executed at the site and to the nature of the particular biface blank employed. Whether biface production at Locality 36 may have been conducted by craft specialists remains uncertain; standardized biface size and morphology suggest specialized production, but they are not conclusive hallmarks of craft specialization.

Variation in Bedrock Setting and Quarrying Strategy

Our investigations of toolstone extraction revealed that bedrock topography (cf. Chapter 9) affected the way in which toolstone packages were removed from parent material at Locality 36, and that it influenced decisions to exploit certain areas of the bedrock. Factors comprising bedrock topography include location and inclination of opalite beds, variation in bedrock structure, quality and ease of extraction of opalite bedrock, and size and shape of packages procured from parent material.

Beds of opalite are not distributed evenly across the locality, owing to differential emplacement of silica throughout the underlying bed of tuff (cf. Chapter 7); backhoe trenching revealed that placement of quarry features was predicated on this distribution (cf. Chapter 9). Trenches excavated through quarry features exposed toolstone-quality beds of opalite, while trenches excavated in non-quarry feature contexts uncovered unsilicified beds of tuff, underscoring the significance of pre-extraction prospecting.

The inclination of opalite beds relative to the surface from which quarriers worked, or what we have termed the "bedrock setting" (cf. Chapters 8 and 9), determined the type of quarry feature that was produced. Adits formed as quarriers pursued toolstone on beds that tended toward or intersected the surface from which they worked (a Type I or II setting; cf. Chapter 7:Figure 54). Quarry features in Area C (cf. Chapter 7:Figure 52) demonstrate this relationship. Pits and scoured surfaces formed as quarriers excavated stone from beds nearly horizontal to the working surface (Type III); each quarry feature in Area A and many in Area B are consequences of this bedrock setting. Features exhibiting attributes of both pits and adits were noted in bedrock settings intermediate between Type II and Type III, as in the southern and the western portions of Area B.

Toolstone extraction from parent material was facilitated or inhibited by the structural features of opalite beds (cf. Chapter 9). Fractures, joints, and tuff stringers and pockets assist separation of large chunks of stone from parent material; quarriers succeeded in removing toolstone packages from bedrock by placing wedges into these features or by hammering directly on them. On the other hand, massive opalite is nearly free of structural features; wedges could not be forced into the rock, and hammering directly upon it was futile. Across much of the bedrock exposed by the backhoe, we observed that quarry features are located in areas where structural features are well developed, and that they tend to terminate where bedrock becomes massive.

An inverse relationship between the toolstone quality of opalite and the ease with which it could be extracted was demonstrated: as opalite quality grades from poor to above average, the ease with which it can be extracted grades from relenting to obstinate (cf. Chapter 9). Tosawihi quarriers appear to have traded quality for ease of extraction in attempting to return the most usable stone per unit of time invested (cf. Chapter 12).

Artifact and Feature Distributions

The study of artifact distributions at Locality 36 reveals patterns at different levels: within artifact classes, between them, and at varying spatial scales (*e.g.*, across the entire locality, between feature contexts; cf. Chapter 10). Quarry pits and the associated debris dominate the site space. Almost all distributions center on quarry pits, and there is a steady fall-off in the frequency of artifact classes away from them. Quarry pits are associated spatially with usable toolstone deposits. Several thousand years of opalite extraction have embedded quarry features in a carpet of debitage and opalite debris. Even when erosion or burial render pits and adits invisible on the surface, a distinctively large debris pile often characterizes bedrock extraction areas. These debitage "aprons" probably are a sort of "superfeature," composed of overlapping reduction feature/lithic scatters. As debitage analysis has shown, such superfeatures differ from reduction feature/lithic scatters and quarry pits in their technological genesis since they contain more early reduction and extraction debris than the former, and more later reduction debris than the latter.

Another sort of superfeature at Locality 36 is the quarry pit complex. Individual features on the surface of such complexes can be distinguished readily, but our investigations demonstrate clearly that quarry pits often were initiated on the berms of older features. Reduction feature/lithic scatters lie at the other end of a scale of feature complexity from such superfeatures. This feature type was recognized on the basis of discrete, definable, margins determined by a fall-off in debitage density. By definition, they can occur only away from quarry pit complexes and debitage aprons. Reduction feature/lithic scatters located near quarry pits simply may not yet be agglutinated into debitage aprons, while those farther from quarry pits may show a very different organization. The latter type manifest a high incidence of biface reduction, generally cover more area than features in the group nearer quarry pits, and may be associated with buried hearths suggesting that they are fairly young (perhaps ca. 500 years or less in age).

Feature distributions reflect how use of space was organized at Locality 36, but not what actions occurred in specific places or kinds of places. The distribution of debitage types and reduction attributes, stone tools, and stone tool attributes confirm that the focus of almost all activities was extraction of toolstone and production of bifaces; evidence for other activities from feature and artifact distributions is rare.

Tools used in the extraction of toolstone consisted primarily of hammerstones, made of opalite and of stone types exotic to the immediate vicinity. Opalite hammerstones were used

expediently and discarded in quarry pits, as were other extraction tools, including bone and stone wedges; those of non-local material were more fragmented and often were recovered from reduction features (cf. Chapter 6). We assume that most debitage was discarded at the place it was created.

Debitage analysis suggests that, following toolstone extraction, initial processing occurred in one of four settings: within quarry features, on debitage aprons, at reduction/lithic scatters, and in non-feature settings. Initial processing or core reduction, therefore, is the most widespread of all lithic reduction activities, suggesting that it was organized least or had the fewest spatial constraints. The next stage of processing (blank preparation and early biface thinning) occurred most commonly in three settings: quarry pits, debitage aprons (or the group of reduction/lithic scatters nearest to quarry pits), and reduction/lithic scatters farthest from quarry pits. Debitage distribution suggests that prehistoric knappers were relatively indifferent as to the particular kind of feature setting in which they produced early stage bifaces, but clearly they preferred to work on these objects in feature settings. Late biface thinning, on the other hand, is associated with only two settings, occurring in reduction feature/lithic scatters and in non-feature areas.

The pattern of associations with feature contexts among bifaces differs from the patterns we have observed in debitage. On the whole, bifaces were discarded most often in quarry pits, and stage of biface reduction and attributes related to it have clear spatial patterns. Complete but un-heat-treated early stage bifaces made on block blanks were discarded most often in quarry pits. On the other hand, broken, late stage bifaces produced from flake blanks are more common in reduction feature/lithic scatters.

Assuming that bifaces also were discarded in the contexts where they broke or were found unsuitable, a scenario of biface production incorporating both debitage and biface distribution studies can be sketched. Remember that debitage suggests where reduction occurred and the biface assemblage suggests where reduction failed: Initial blank preparation and early biface thinning occurred in contexts which we recognize as archaeological features. Early stage reduction of block blanks failed most often in quarry pits, but flake blank discards are rare in this context. This dichotomy in the context of reduction for the two blank types makes economic sense when the place of final processing and heat-treatment is removed from place of extraction. Compared to flake blanks, blocks tend to weigh more, have greater waste-to-tool ratios, and higher failure rates. The marginal value model presented previously (Elston 1992b) suggests a considerable payoff in reduction of blocks at the point of extraction. When bifaces or biface blanks (often flake blanks) were removed from the quarry pit and quarry apron to more distant parts of the site (more than about 20 m from quarry pits), they were reduced further and heat-treated. Late stage production (Stage 4 and Stage 5) is rare at Locality 36, but when it did occur, it almost always was away from quarry pit areas.

Chronological Change at Locality 36

Stratigraphy and radiocarbon dates reveal some temporally and spatially variable patterns of toolstone exploitation at Locality 36.

The Type 2 setting, where beds of opalite toolstone embedded in softer tuff intersect a sloping surface, is common at Tosawihi Quarries, and offers a relatively low cost opportunity for prehistoric quarriers. At Locality 36, this opportunity was seized in Feature 102, in the least costly bedrock setting, about 4000 years ago. Thus, the first instance of bedrock quarrying presently known at the locality occurs in the middle of the No Name Phase (Elston and Budy 1990). If even

earlier quarrying occurred at Locality 36, trenching failed to sample it and its evidence has been destroyed by subsequent quarrying. Earlier quarrying would have been most likely in Area B, which, although highly churned, returned the earliest radiocarbon date of 4090 B.P.

Even though exploitable toolstone remained in Feature 102, quarrying there ceased after a relatively short interval. Perhaps those early quarriers could pick and choose among other localities offering the same or better returns. In any case, Feature 102 was abandoned, and it filled with colluvium. This, and other examples of buried features with no surface expression, reminds us not to let all our attention be captured by the impressive surface archaeology of Tosawihi Quarries. The complex subsurface deposits are likely to contain many features unforeshadowed by the nature of the surface veneer.

It is possible that lack of radiocarbon dates between 3,700 B.P. and about 1400 B.P. at Locality 36 indicates a real hiatus in quarrying there. If true, however, it is counter to the steady increase in the intensity of quarrying at Tosawihi, culminating in the Late Prehistoric (Elston and Drews 1992). Radiocarbon dates from Locality 36 indicate an increase in quarrying intensity between 620 B.P and 220 B.P., during the latter part of the Eagle Rock Phase (Elston and Budy 1990), possibly extending into the early protohistoric. During this last interval of quarrying, all three quarry areas were utilized, and quarriers worked toolstone in Area A and portions of Area B where extraction appears most costly. If this is true, competition for toolstone at Tosawihi was so great by this time, that simply moving to a fresh, more productive quarry location was no longer an option.

Variation in the distribution of biface reduction through time suggests change in use of space at Locality 36. We proposed previously that as quarry use intensifies, and coarse debris accumulates, quarrying areas should become less suitable for certain activities, which should tend to be moved elsewhere. Feature 102 in Area C is the earliest quarry feature so far discovered at the locality, and the distribution of distinctive swirled opalite bifaces and debitage indicates that reduction most frequently occurred *within* the quarry pit. Thus, it seems there was little separation of processing by context when quarrying first began. In fact, Area C generally contains late bifaces and early debitage, suggesting that biface thinning occurred somewhat outside quarry pits, but close enough for failed bifaces to be discarded in pits. Both early stage bifaces and early stage debitage are associated with Area B, perhaps indicating that, later on, most later stage reduction occurred at some distance from quarry pits in contexts now comprising part of the debitage apron. Area A, the youngest of the three, contains high proportions of late stage bifaces and debitage. This suggests a return to late stage reduction in close proximity to quarry features, perhaps because Area A was not used long enough for accumulation of coarse debris to become a problem. Such accumulation also may have been retarded in Area A by the nature of the soft tuff bedrock and continued accumulation of loess. Area A appears to be associated with the latest use of Locality 36, when discrete reduction features and hearths were established on the ridge top nearby. This suggests that biface reduction required the space around the quarry pits in Area A and, sometimes, additional space nearby.

The Significance of Locality 36

Locality 36 has provided, for the first time at Tosawihi, an in-depth view into toolstone extraction and processing, two significant components of any lithic production system. Few other quarry studies have relied on such intensive subsurface excavation, which has been invaluable for

examining extraction strategies. We now understand better how parent material inhibited or facilitated toolstone extraction, as well as how it influenced decisions to concentrate efforts in one part of the locality or another. We have confirmed the validity of our distance minimization transport model, gained better understanding of how the early stages of tool production were organized in space and time, and learned more of the relationship between specific processing techniques and blank morphology.

The ability of prehistoric people to modify the landscape (and archaeological deposits) through bedrock quarrying is well demonstrated at Locality 36. For example, the southern portion of Area B probably was a Type 2 setting originally, but it has been modified so extensively by quarrying that no evidence of its original morphology remains. That bedrock faces were sculpted into arcuate alcoves and pushed back many meters, while hundreds of square meters of bedrock surface were planed smooth, testifies eloquently to the effects of persistence over archaeological time, and to the extraordinary time and effort put into lithic procurement at Locality 36.

Locality 36 and Its Relationship to Other Tosawihi Research

The research design employed at Locality 36 grew out of our previous inquiries at Tosawihi. Conclusions of this earlier work are discussed in Chapter 1; here, we briefly consider whether findings derived from Locality 36 are consistent with earlier conclusions and how they may augment them.

A theme in all our earlier conclusions was that the prehistoric attraction of Tosawihi was toolstone, not food. We found nothing at Locality 36 to suggest otherwise. At Locality 36 and among almost all other Tosawihi sites we have studied, evidence for procurement and processing of any resource other than chipped stone is rare. Locality 36 is consistent with our earlier conclusion that quarries seldom were used as base camps, serving instead as peripheral/ ephemeral use areas in either the diurnal or logistical radius of base camps, save for the possibility that the large lithic scatters and a few hearths on the central ridge, dating later than 500 B.P., *may* reflect a change to short-lived residential occupations of the site.

The archaeology of Locality 36 is consistent with another theme of our earlier conclusions, that quarrying was relatively standardized in terms of the products removed from toolstone sources. Tool production at Locality 36 may have differed in detail, but on the whole was quite similar to that at other quarry localities we have examined; it suggests how Locality 36 fit in a settlement pattern and tool production sphere. First, we know that Locality 36 was exploited for its toolstone deposits and little else. Second, compared to other Tosawihi sites, the stone tools produced at Locality 36 are similar in kind (bifaces), shape, and size, and were transported off site at approximately the same point in the biface reduction sequence. Third, Locality 36 fits into regional settlement in terms of its role as a toolstone source, never serving, so far as we can tell, as a long term base camp or hub in its own right.

Prior to confronting Locality 36, we had had no opportunity to examine the "heart" of the Tosawihi quarries. Even so, the overall pattern of peripheral site composition and distribution relative to natural resources suggested that intensification of use occurred in the Late Prehistoric. Chronological change evident at Locality 36 confirms the larger pattern of Late Archaic intensification.

Perhaps it is not surprising that Locality 36 resembles sites within a two mile radius; in fact, our earlier study demonstrated that, even 12 km away, biface production, as opposed to use,

remained primary. Yet, there is no denying that similarity of assemblages is strongly determined by proximity to toolstone such that the central quarries at Tosawihi (i.e., site 26Ek3032) have a strongly deterministic effect on the sites around them; with greater distance the effects of toolstone production on assemblage content, site arrangement, etc., diminish.

Significance of a Sample Survey in the Tosawihi Quarries Vicinity

After four seasons of testing and data recovery at more than 70 locales in and around the Tosawihi Quarries (26Ek3032), we learned a great deal about prehistoric economic behavior relative to the extraction and processing of lithic material (Elston and Raven 1992). Still, unanswered but important questions remained about the role of the quarries and their peripheries in a larger geographic and economic system. Did the outlying uplands function as part of an economic system that supported exploitation of the Tosawihi Quarries? Did use of the uplands, as a whole, focus explicitly on heretofore unknown toolstone sources, on 26Ek3032 sources, or did some other, non-lithic resources invite their occupation?

To answer such questions, we mounted a 10.3% random, stratified sample survey of about 28,000 acres surrounding the Tosawihi Quarries (Leach and Botkin 1992). The survey was intended to provide a larger context within which to view the quarries and to evaluate how quarrying fit into the larger prehistoric settlement/subsistence round.

We found that the attraction of the principal quarries dominated lithic exploitation throughout the survey region, and perhaps the territory beyond. Sixty-one mapped silicification zones within the study area were field-checked for toolstone quality and evidence of prehistoric use, and the nature and intensity of quarrying efforts were assessed. The largest silicification zones immediately adjacent the main quarries were used most intensively. They offered a broader selection of assayable material than did smaller, more scattered sources, and were convenient to the intensively-used quarrying and logistical support facilities of 26Ek3032. Opalite sources considerably beyond the main quarries went largely unexploited. Their generally poor quality seems only partly the cause; instead, distance from the "known" and well-tested deposits of 26Ek3032 appears to account for their lack of use. Thus, proximity to previously-explored sources and to support facilities appears to have conditioned use and reuse of adjacent sources.

Old quarry facilities (quarry pits) attracted repeated reuse. Scavenging usable toolstone in old quarry pit berms, using old hearths and other facilities, exploiting old exposures and the like, may have provided the most cost-effective methods of toolstone acquisition in some circumstances. Moreover, once established, it always was cheaper to return to the quarries for toolstone than to initiate new exploitation of previously untapped (and possibly unprofitable) sources beyond the periphery.

The *production sphere* of Tosawihi Quarries extends for a considerable distance beyond the quarries themselves (though the density of reduction features declines dramatically with distance). The evidence of biface and debitage discard within the survey region suggests that most lithic production originated at the quarries rather than at raw material sources well beyond them. The formed artifact assemblage of the survey study area is dominated by bifaces, and represents an extension of the same homogeneous production trajectory established at 26Ek3032. The survey assemblage contains higher proportions of late stage bifaces than do other Tosawihi study areas (e.g., the Eastern and Western Peripheries; cf. Bloomer, Ataman, and Ingbar 1992); the region is geographically and technologically farther along a production and distribution network that originates at the quarries. Spatial variability in the distribution of bifaces patterns predictably.

Large proportions of bifaces (particularly early stage bifaces) were discarded nearer the quarries, where they were produced and broken in manufacture. Later stage bifaces tended to be produced and discarded farther away. Yet, the occurrence of early stage bifaces and middle stage reduction debris out to the limits of the study area suggests that the survey region still fell well within the Tosawihi *"zone of production."*

To the limits of the survey area the archaeological record is dominated by lithic production: opalite tools were *produced* but *used* relatively little. Observed artifacts pertain overwhelmingly to the extraction and processing of opalite. At examined water sources, assemblages derive predominantly from opalite processing even when far from opalite supplies. Maintenance/ subsistence components of these locales, although occasionally abundant, appear to reflect tasks ancillary to toolstone processing (like comparable remains at similar sites studied in the heart of the quarries [cf. Leach 1992]).

Having discovered that the Tosawihi *zone of production* extends to and perhaps even beyond the limits of our survey region, we acknowledge that our understanding of the way Tosawihi products were transported over greater distances and how ultimately they were *used* falls far short of complete. The role of Tosawihi opalite in regional trade and exchange networks, and the function of Tosawihi products in daily subsistence and technological activities can be informed only by survey and excavation of sites farther afield.

Directions for Future Research

As with any large-scale research project, our work has generated as many questions as answers. Some of these can be addressed using different perspectives and techniques to examine the data and artifacts already collected; others require additional fieldwork.

The Tosawihi Quarries in a Larger Regional Context

Principal among the objectives of future Tosawihi research will be documentation of the role played by the quarries in the prehistoric adaptive strategies of the broader Upper Humboldt region. To date, our economic models and analyses have emphasized costs and returns of toolstone procurement. Work has focused almost exclusively on the quarries proper and the surrounding zone of toolstone production, and technological studies have emphasized aspects of toolstone extraction and processing. To understand the function of Tosawihi Quarries and the role of Tosawihi opalite from a regional perspective, the scope of inquiry must be expanded into the zone of toolstone use. It is here where the benefits of toolstone procurement accrue, where we expect to find evidence of the use of Tosawihi opalite in daily subsistence chores and technological activities, and where its role in regional trade and exchange networks should be expressed most clearly.

Examination of the influence of costs and benefits on technological organization in lithic terranes different from Tosawihi include studies of sites in the Carson Desert (Raven and Elston 1989) and of outcrop quarries and workshops in the Maverick Springs Range (Moore 1991a). In the region around Tosawihi Quarries, however, the economics of tool use and maintenance have been modeled only in the study of James Creek Shelter (Elston and Budy 1990). Further attention devoted to developing these models, and testing expectations derived from them against the

archaeological record, will be enlightening. A first step would involve re-examination of extant archaeological collections from sites in north central Nevada at various distances from Tosawihi, but within the zone of Tosawihi toolstone use. These include the Valmy sites (Elston et al. 1981), Treaty Hill (Davis, Fowler, and Rusco 1976; Rusco and Jensen 1979), Rock Creek (Clay and *Hemphill 1986), James Creek Shelter (Elston and Budy 1990), South Fork Shelter (Heizer,* Baumhoff, and Clewlow 1968; Spencer et al. 1987), Rossi Mine Sites (Rusco et al. 1982), and the Carlin sites (Rusco, Davis, and Jensen 1979). Insights gained from such studies then could be applied to a more formal regional survey.

In order to examine the role of Tosawihi opalite as a commodity in trade networks, it will be necessary to sample sites along suspected transportation corridors between Tosawihi and the Humboldt Sink, western Utah, and the Snake River.

Questions Specific to Locality 36 and Tosawihi

Chronology

Among the many questions which invite further research, chronology figures prominently, in both long and short time frames. In the Great Basin, where surface sites dominate, organic preservation is often poor, and where many components of archaeological assemblages persist through long periods, dating almost always is difficult. This is compounded by the heavy disturbance produced by quarrying activity.

In previous work at Tosawihi, radiocarbon assays, time diagnostic projectile points, and obsidian hydration studies provided broad outlines of prehistoric activity, while extensive radiocarbon samples from Locality 36 have allowed tentative reconstruction of a sequence of utilization of that site. We observe three periods of exploitation at Tosawihi: 1) the Pre-archaic is represented widely but not extensively, and exploitation may have been confined to expedient use of opalite; quarrying or opalite collection may not have been the main object of visits to the area; 2) through most of the Archaic we see continuous use of the quarries and substantial extraction efforts; 3) in the Late Archaic there occurred an intensification of quarry use, whether produced by larger populations, more groups, or other impetus for increased demand.

Further inquiry into chronology could clarify this pattern and could address more specific questions about strategies of toolstone procurement and processing. Carbonate samples can be dated in order to provide gross measures to limit the age of overlying deposits and indicate later disturbance. In the case of quarry sites, carbonate dates could indicate reworking of previously abandoned deposits in the absence of charcoal or clear stratigraphic patterning.

The analysis of larger obsidian samples using hydration and sourcing techniques could provide a range of detailed data at sites where quantities of obsidian debitage occur. This does not apply to Locality 36, where only a few obsidian artifacts were recovered, but numerous assemblages from sites in the Eastern and Western Peripheries yielded large obsidian debitage samples. The relative intensity of occupation at various sites in various periods, the integrity of reduction features, the use of space at different periods, and differences in the organization of space through time could be investigated with such data.

Similarly, sourcing opalite will be useful. For example, tracing the source of opalite in dated reduction features can help delineate chronological patterns of intra-site use. Color, pattern,

and texture differences appear to have some utility in source definition, but chemical analyses may be more precise. Under ultraviolet light, at least some varieties of Tosawihi opalite reflect light with a characteristic green glow. We compared samples of Tosawihi opalite to other Nevada cherts with promising results. Non-obsidian projectile points made of what appear to be raw materials exotic to Tosawihi reflect differently from Tosawihi material under ultraviolet light, but we are unable to discriminate among Tosawihi opalite sources. Similarly, a pilot study using neutron activation analysis successfully sorted Tosawihi chert from other white cherts (Elston 1992a), but whether different Tosawihi sources can be distinguished remains to be determined. Another untested, but potentially useful, fine-grained sourcing technique is proton-induced x-ray emission (PIXE; cf. Banks 1990).

Fine grained analysis of stratigraphic patterns may lead to better chronological control over quarrying strategy sequences and duration of utilization. Since only one large scale outcrop quarry (26Ek3208) and one quarry pit complex (Locality 36) have been investigated in detail (and they were quite different from one another), it would be informative to see if the same internal stratigraphic structures exist in other large sites. This could resolve whether the same strategies were used in similar geological circumstances or whether the differences are temporally dependent.

The excavation of rockshelters (several occur within the boundaries of 26EK3032) could contribute chronological data through better stratigraphic control and preservation of organic remains. In addition to greater potential for datable carbon samples, rockshelters often yield subsistence data and seasonal occupation indicators which are scarce at presently excavated Tosawihi sites. This in turn could help to refine the model of quarry use.

We are interested particularly in the earliest use of the quarries. What factors increased demand for toolstone and led people to undertake the difficult task of bedrock quarrying? Detailed studies of a number of Tosawihi Quarry localities are needed in order to understand the nature of the earliest quarrying. Locality 36 is a start, demonstrating that intensive quarrying took place there as early as 4000 years ago, but whether this site is typical of other quarries is unknown. The factors leading to first use of specific quarrying areas remains to be discovered.

Technological Issues

In a production setting, such as a quarry, technology is an important factor in determining strategies of production and processing. We have designed our analyses to evaluate variability in technology and in technological organization through time, but with only limited success. For the most part, we have noted an unchanging technology in biface production throughout the use of the quarries, although we have recognized some changes in use of space and labor organization through time (cf. Chapter 12). A more fine-grained approach could determine if this actually is the case or if more subtle changes are indicated.

Specialized reduction techniques were noted at Locality 36; although these do not pattern obviously through time, no analytical exercise has been applied to other Tosawihi assemblages. Other specialized techniques may remain to be observed, and we have yet to look at characteristics (such as flake scar patterning or incidence of particular failure types) which could vary through time and provide evidence for technological change. Perhaps the lack of technological change is characteristic only of the Tosawihi production sphere; further away, temporally different strategies of tool use and maintenance may be revealed.

We have looked briefly at how the artifact assemblages from Locality 36 compare to other Tosawihi quarry sites (cf. Chapters 4, 5, 6), but our artifact sample from other sites is limited. With data in hand we cannot make statistically reliable statements regarding the similarity of Locality 36 to other quarries. Larger samples would allow us to examine common or variable responses to particular extraction and processing problems, and would help resolve whether extraction and processing strategies are more nearly a function of geological setting or of other factors.

It also would be useful to examine the details of biface manufacture at sites to which unfinished Tosawihi bifaces were transported for final reduction and use. If later stages of reduction follow patterns observed at Tosawihi sites, a technology common to both producers and users of Tosawihi bifaces would be indicated. Differences might reflect craft-specialization among producers, differential access to the raw material source, or other differences.

Site Formation

As a result of our investigations at 26Ek3208 and especially at Locality 36, we understand a great deal more about site formation processes at quarries than previously; several specific problems remain unresolved, however, or demand more attention. Natural versus cultural deposition and sorting of quarry deposits still is problematic in that the natural rate of modification by geomorphic agents is unknown. To investigate this problem, a long term detailed sampling program could be initiated, perhaps undertaken over the course of a year, during which the deposition, infiltration, and mixing of cultural and natural materials due to runoff, wind, frost action, gravity, subsidence, and other factors would be monitored within experimentally produced debris deposits or selected prehistoric deposits located in the various geomorphic settings previously identified at quarry sites. Monitoring could include periodic sampling and analysis of materials caught in sediment traps or extracted directly from debris deposits. Close observation of the movement of large debris clasts, fine sediment, and individual artifacts over time would be important for understanding the potential for cultural and natural material accumulations in diverse geomorphic settings. In addition, as noted above, obsidian hydration and sourcing could be used to examine feature contexts and perhaps reveal whether discrete features are younger and dispersed features older once a clear understanding of the influences of slope, soil type, and other geomorphic factors are better documented.

In addition to site modifications due to natural processes, the stages of quarry pit formation are not well understood. Isolation of columns of pit deposits by the intersection of four or more trenches, recording of the multiple aspects revealed in the profiles, and detailed stratigraphic excavation based on three dimensional exposures could lead to a more secure reconstruction of pit formation processes. Finally, total excavation of quarry pit fill would reveal the ultimate shape and size of pits better than does trenching alone.

Spatial Analysis

In previous work, we observed a general pattern of artifact distribution whereby larger, less finished artifacts are more frequent near areas of extraction and artifacts become smaller and more finished with increasing distance from the quarry areas. This pattern is consistent with a

benefit/cost model proposed subsequent to initial survey and testing and, as noted above, was supported by results from a survey of 28,000 acres in the hinterlands of the quarries. But on a finer scale, we have not observed if spatial patterns in the distributions and locations of functionally distinct artifact classes and activity areas *within* the quarry area support the patterns of distance minimization that we observed at its outskirts. While it may be unnecessary to excavate further to achieve this objective, more intensive survey along unbroken transects, detailed mapping, and in-situ technological analysis are indicated.

In the same vein, although we collected a good deal of functional data about sites peripheral to the quarries, we did not examine them on a feature-by-feature basis. By contrasting very specifically the activities which took place at the various sites and within different contexts at particular sites (with additional chronological input) we could view the relationships among activities, organization of space, labor, and technology. Much of the needed data are contained in our previous reports (especially Elston and Raven 1992), but some technological reevaluation and *additional feature excavation would* be needed.

Much of the discussion above relates to the uniqueness of Locality 36 in the Tosawihi context. At this point, we have some indications that Locality 36 is in some ways unlike other quarry sites such as 26Ek3208, 26Ek3084, Locality 26, and the outcrop quarries in Velvet Canyon (Elston, Raven, and Budy 1987). However, we cannot judge the extent of similarity or difference absent a similar level of investigation at several other quarry sites.

Methodological and Technical Issues

Intensive archaeological study of large bedrock quarries rarely has been undertaken (cf. Chapter 1). Quarries present an imposing challenge to archaeological research. Limitations on labor and funding for study of the volume of material presented by quarry sites, and the complexity of their archaeological records, require efficient, focussed, field and laboratory research. Consequently, we think it incumbent upon us to make a few brief comments about methods and techniques, particularly regarding the need for their further refinement.

Sampling

Sampling is a key component of research in quarries, since it is impossible to collect every artifact on such sites. The purpose of sampling is not to order the collection of objects; rather, sampling strategies order the collection of observations. Which observations are important is determined, of course, by the research design of any given inquiry. The salient point is that observations need not correspond directly to artifacts.

For example, the systematic random sample design of surface scrapes at Locality 36 (cf. Chapter 3) caused equal areas to be collected within each 10 m by 10 m block across the site. Counts and weights of flakes and angular debris (i.e., observations) made on the samples were extremely useful in defining site structure (cf. Chapter 10). Many samples, however, contained too few pieces of debitage to permit their characterization in debitage analysis. By the same token, samples from the debitage aprons and quarry pits contained many pieces of debitage. In fact, our original research design called for surface scrape samples to be used only as observations of count

and weight; however, had we known in advance that we also would conduct more detailed analyses of the debitage, a different sampling strategy would have been selected. One of the drawbacks to areal sampling strategies is that when areas of high and low density are sampled at equal areal intensity, a size-diversity relationship is created (cf. Grayson 1984). In settings such as quarries, where densities of artifacts vary widely, sampling strategies must be tailored to the retrieval of observations, not solely of equal areas or even artifacts. A sampling strategy to overcome this problem would involve excavating contiguous units of known size until a minimum number (ca. 200-300) of items were collected. Thus, some parts of the site might take five or six surface scrape units to sample, others (such as debitage aprons) only one.

Stratigraphy and Excavation Strategies

Stratigraphy is always an important attribute of archaeological sites and this is nowhere more true than at quarry sites. Our work at Tosawihi disclosed extremely complicated anthropic stratigraphic sequences. Stratigraphic studies at quarries, including detailed profile drawings and descriptions of sediments, are necessary almost from the outset of research in order to allow an initial look at stratigraphy and determine appropriate sampling, recording, and dating strategies.

As work at Locality 36 has shown, one of the most important requirements of stratigraphic research at quarry sites is a thorough understanding of bedrock morphology in relation to younger natural sediments. While the Locality 36 research has been successful in this regard, more research on the relationship between different kinds of bedrock exposures and the resulting stratigraphic sequences would be extremely useful.

Part of the stratigraphic complexity owes to the overlaying of many quarrying episodes and their attendant debris. The tortuous stratigraphy created by human actions is complicated further by natural processes, as we have seen (cf. Chapters 7 and 8). Both archaeologists and geologists must study such complicated phenomena. For example, size variation in clast-supported stratigraphic units (cf. Chapter 8) could be the result of excavation within a single quarry pit (as exploitation strategies and actions changed with the development of the pit) or it could be caused by overlapping quarry rubble deposits from many different pits. Without some technique to separate rocks from different quarry pits (see discussion below on sourcing), the sole way to determine the genesis of a stratigraphic column is to remove each stratigraphic unit completely to derive a three dimensional profile of quarry complex stratigraphy.

Excavation strategies using mechanical trenching and other mechanized earth moving techniques, are integral to stratigraphic studies of quarries. Despite the loss of provenience on materials excavated by mechanical trenching, it is the most effective way to determine stratigraphic relationships and to guide other, more time consuming excavation techniques. The use of graders can be extremely fruitful. The utility of large scale scraping can be quite high, particularly in quarry sites, where features such as quarry pits and hearths can be detected easily. We recommend the use of mechanical excavation in general, then, as a mainstream excavation strategy in quarry settings. Obviously, we do not advocate the wholesale destruction of quarry sites by over-use of such equipment, nor should mechanized excavation supplant hand excavation or thorough surface recording.

Hand excavation within and outside quarry pits offers the most controlled method of site observation. Given its costs, and bearing in mind the provisos discussed above concerning sampling, hand excavations must be used in problem-solving fashion. For example, part of our

research design at Locality 36 called for hand excavations in reduction feature/lithic scatters. We attempted to maximize the diversity of features sampled in hand excavations. For our purposes, this strategy worked quite well. However, we cannot use the data recovered to describe in detail the three dimensional occurrence of any particular reduction feature/lithic scatter. Data necessary for this sort of description would have required trading a few excavation units in many features for many units in one. Hand-excavation of entire features at Tosawihi is indicated.

Another issue for consideration at quarry sites concerns the most efficacious size of hand excavation units. Our basic excavation unit at Locality 36 was 50 cm x 50 cm x 10 cm. In some settings, these small units recovered more debitage than we could analyze and the samples had to be split (cf. Chapter 4). Other settings were extremely low in debitage density. The trend in archaeological research has been toward ever smaller excavation units, providing tighter spatial control. This is useful in some contexts, but as would be true if mechanized equipment were not used, one may miss the forest for the trees by using very small units as windows into much larger spatial phenomena. Quarry features and many of the associated lithic scatters are big, covering tens of square meters, and their spatial patterning usually is evident at large scales, not small ones. Thus, it is worth considering using larger excavation units to cover more area with little more effort.

Dating Techniques

The development of new dating techniques is always needed in archaeological research. Once established, quarries may be used for thousands of years, making dating essential to studies of toolstone acquisition through time. Because quarry sites tend to contain huge amounts of inorganic remains, there is a pressing need for better methods of dating such material. The abundance of inorganic artifacts and debris masks datable organic remains, further exacerbating the problem. Obsidian hydration dating is presently our sole technique for inorganic dating at Tosawihi, and it is best used as a relative technique rather than for absolute age determination. Extant techniques not used at Locality 36, yet perhaps useful at other quarry sites, include thermoluminescence and archaeomagnetic dating. Although these two techniques have stringent requirements concerning sample context, the necessary conditions for using them may be present in other quarry localities, particularly those in which heat-treatment of raw material was common. Since silicious stone in a quarry may be relatively uniform in chemical composition and samples selected can be from similar depositional contexts, measuring patination rinds on artifacts (Purdy 1981) might provide a useful *local* relative dating technique.

Remote Sensing and Mapping

Remote sensing could be an extremely important tool in quarry research. The ability to detect surface and subsurface variation in archaeological and geological deposits could be very cost effective and could help focus inquiry. One potential use of remote sensing is to determine bedrock morphology, perhaps with ground penetrating radar. As shown at Locality 36 (cf. Chapters 9 and 12), thorough knowledge of bedrock morphology assists stratigraphic and anthropological interpretation immensely. Other remote sensing technologies, such as multi-spectral scanning, infrared photography, etc., could be useful in mapping quarries if the albedo of waste rock is distinctive from background reflection.

Mapping quarry sites is rarely undertaken, probably because of their size. We were fortunate at Locality 36 to have an excellent photogrammetric map in hand prior to initiating fieldwork. Although this map was prepared at 1 m contour intervals, we could have obtained even finer contour intervals, perhaps allowing us to discern individual quarry pits. Whether through photogrammetry or terrestrial survey, detailed maps of quarry localities substantially aid field planning. In any case, one topic for future consideration is the accuracy with which quarry features can be discerned on photogrammetric maps relative to maps made by terrestrial survey. And, the efficacy of combining aerial photogrammetry or terrestrial survey with remote sensing data to generate accurate portrayals of quarry sites should be explored.

Phased Fieldwork

Many of the comments made above suggest that a particular field method be used to guide further field inquiry. A logical extension of this is the notion that quarry investigations should, ideally, proceed in phases. Each phase can inform the next, given sufficient time to process results of the earlier work. In this fashion, the available resources for a research project can be used most effectively. Practical considerations may impede undertaking phased field research, but it is a goal worthy of seeking.

Material Sourcing

Sourcing lithic raw material is an inviting prospect. Above, we mentioned how sourcing opalite to particular quarry locations in the Tosawihi area could be useful, and the same benefits could accrue to any quarry study. Presently, obsidian sourcing is the most developed lithic sourcing technique available. Chert sourcing through chemical characterization (e.g., neutron activation, x-ray fluorescence) or qualitative attributes (color, texture, fluorescence under ultraviolet light) is in its infancy. In quarry sites, the need is particularly pressing for a sourcing technique that is fast, inexpensive, and can be applied to many artifacts. Ultraviolet fluorescence may provide a useful technique for many materials (Hofman, Todd, and Collins 1991), including Tosawihi opalite (Elston 1992a).

Tool and Debitage Analysis

In the research presented here and in other reports on Tosawihi research (Elston and Raven 1992), we have outlined our analytical techniques explicitly so that others can use, criticize, or discard them.

Earlier (cf. Chapter 4), we contrasted three debitage analysis techniques for these same reasons, concluding that, while mass analysis is fast and repeatable, it is less accurate and thus has less utility than other techniques. One suggestion for future research in quarry settings is to *continue* using a variety of analytical techniques on the same debitage assemblage. It then may be possible to determine why some techniques work in one setting but not in another. Mass analysis may be suitable in some regions or at some site types, while unsuitable at others. Also

analyses of controlled experimental reduction sequences could be continued, but in a "realistic" fashion by mixing many sequences to simulate the undoubtedly common mixtures of debitage found in quarries (and many other sites too). Continued experimental flintknapping is a third direction for future research. A fourth, overarching methodological need is for a technique of debitage analysis that yields information at the same level of generality as our hypotheses. To examine variation in the transport and reduction of toolstone in the Tosawihi vicinity, or at any other quarry, we must develop a reliable assessment of core or biface reduction stage *and* size simultaneously.

Analysis of stone tools from Locality 36 indicates a need for continued research on the causes of failure in stone tool manufacture and how (or if) they are evident on broken pieces. More replications using various flintknappers, tools, and raw materials will help refine the breakage typology.

Another question involves how best to detect specialist flintknappers in the archaeological record of quarry localities and other sites. Once again, we believe the answer lies partly in continued experimentation. Close contrasts of tools and debitage from discrete archaeological features might contribute usefully.

Site Structure Studies

The distributional studies presented here (cf. Chapter 10) are merely an initial step toward understanding site structure. Our distributional analyses suggest that size profiles of debris channel certain activities to occur elsewhere. Can this be shown at other sites (regardless of where they are)? The question remains open. As well, there is great need for a body of theory concerning site structure (Binford 1983), since at the moment it remains a largely speculative enterprise in which the archaeologist attempts to find individual behavioral events. This is not much more than story-telling, particularly in complicated trash deposits like those of quarry sites. Lastly, how typical is Locality 36 of bedrock quarry sites in general? Is there a consistent pattern of debitage aprons, quarry pits, and distinct reduction features? There is much ground for comparative research on such questions.

Experimental Studies and Actualistic Research

Experimental and actualistic studies of lithic reduction, quarrying, and toolstone extraction have played an important role in the Tosawihi research. Our experimental studies are not yet conclusive, and perhaps none ever can be, since there are many variables affecting any human action. Nonetheless, there is definite need for more such studies in the future.

Experimental flintknapping should be one part of an integrated program of experimentation. Making the entire quarrying, extraction, and processing sequence a single experimental program would permit measurement of the energy or time needed to make a stone tool. As our discussion of the economics of extraction and processing at Locality 36 showed, benefit-cost ratios may vary depending upon how toolstone occurs. Expansion of this kind of integrated experimental program within Tosawihi quarries holds promise for the future.

On the other end of the spectrum from experimental quarrying, extraction, and processing lies experimental tool use. We have done experimental butchery, woodworking, and other tasks with Tosawihi opalite replications, but have not formalized these into an experimental program. Perhaps by comparing the functional properties of Tosawihi opalite with those of other regionally available lithic raw materials we could determine if Tosawihi opalite was a superior material and hence attractive to hunter-gatherers. As well, we do not understand the use histories of Tosawihi bifaces outside their production sphere; experimental tool use in tandem with regional archaeological research could inform about the entire cycle of use, maintenance, and discard of Tosawihi opalite.

Potential for Continued Problem-Oriented Analyses Using Curated Tosawihi Collections

Our four-year program of archaeological survey, testing, and data recovery at Tosawihi has resulted in collection of more than a million artifacts, artifact lots, and cultural and noncultural samples (rock and soil specimens, radiocarbon and flotation samples, and the like). The Tosawihi collection, curated by the Nevada State Museum, Carson City, Nevada, probably represents the largest fully-documented archaeological assemblage in the state and one of the best documented quarry collections in the world. Results of in-depth artifact analyses and data from site and feature inventories reside in a flexible, translatable database management system.

Thus, there has been amassed a superb collection, with attendant databases, that can provide almost unlimited research opportunities to other investigators. We have spent some pages in this chapter developing issues for future research, and many of them are accessible with the data in hand. Using the collections and mapped data, researchers can explore in far greater detail than we have the relationships between activities in space and time.

Many reduction features were collected in their entirety, providing opportunities for in-depth technological and spatial analyses, as well as other kinds of question-driven debitage and tool studies. For example, sampled reduction features at Locality 36 could be compared with other Tosawihi features, wholly-excavated during testing and data recovery at peripheral sites, to address the spatial and technological variability manifest between quarrying locales and other, functionally-discrete locations. As raw material-sourcing techniques are refined, questions about intra-quarry material transport can be pursued. Finally, the magnitude of our collections provides an opportunity to examine methodological issues relating to sampling and collection technique.

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Appendix A

Debitage

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	wt.(g)	>G0 Angular debris wt. (g)
2599.0	0	0	0.00	0.00	QEI	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QM*BEI	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QMBE*L	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QM*B*E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QM e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QM e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	QM E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	Q*	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	Q* BE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	72	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	111	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	111	0	0.00	0.00	M*B*EI	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	111	0	0.00	0.00	MB*E*I	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	111	0	0.00	0.00	Mb	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	QM E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*MB	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*MBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*MBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	102	0	0.00	0.00	Q*Mb	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MB	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QMBE*L	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q* EI	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QM e	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Tech-nological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
2599.0	71	0	0.00	0.00	Q*MBel	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MEl	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*ME	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QM*BEl	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QmB*E*l	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MbE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q* E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*Me	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q* e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*ME	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	QMBEl	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*MBEl	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	71	0	0.00	0.00	Q*Mbe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*MBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*MBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*Mb	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*MBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M*be	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	QM*BE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	22	0	0.00	0.00	Q*M E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	22	0	0.00	0.00	QMBEL	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	22	0	0.00	0.00	QMBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	22	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	27	0	0.00	0.00	Q*ME	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	32	0	0.00	0.00	Q*Me	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	QMb	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*MBe	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M e	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M E	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
2599.0	42	0	0.00	0.00	Q*M E	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	qmB*E*	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*M	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*Mb	unanalyzed	unanalyzed	opalite	n/a																			
2599.0	42	0	0.00	0.00	Q*MBE	unanalyzed	unanalyzed	opalite	n/a																			
4002.1	0	0	103.39	68.19	unanalyzed	Mass Reduction	Q	opalite	1.00	665.6	4	826.8	3	86.4	5	87.2	4	107.1	20	90.5	18	11.4	17	5.2	6	5	618.60	721.7
4006.1	42	6	102.57	64.28	qM*B*e	Mass Reduction	MBe	opalite	1.00	174.5	1	728.5	5	613.1	24	493.4	20	194.3	38	325.0	60	118.9	198	59.4	88	4	716.80	1269.0
4007.1	42	7	102.36	63.30	QM*b	Mass Reduction	MBe	opalite	1.00	111.7	1	356.2	2	161.3	8	379.5	12	152.1	41	114.9	25	70.0	110	22.2	34	4	412.00	744.5
4009.1	42	0	101.95	61.34	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	552.4	3	33.8	1	100.4	4	41.1	5	16.9	3	2.6	5	0.9	2	2	1131.70	1227.7
4010.1	42	10	101.74	60.36	Q*M*be	Mass Reduction	MB	opalite	1.00	0.0	0	831.5	6	303.9	7	527.4	12	119.1	23	296.6	31	43.9	73	27.5	35	6	452.70	1115.9
4010.3	42	0	101.74	60.36	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	2.7	1	0	0.00	0.0
4012.1	0	0	101.33	58.40	unanalyzed	Mass Reduction	MBe	opalite	1.00	0.0	0	0.0	0	118.6	4	190.3	6	56.1	14	30.4	8	26.7	46	6.6	9	0	0.00	67.4
4076.1	72	0	72.28	108.22	unanalyzed	Early thinning	MBe	opalite	1.00	69.3	1	127.7	1	79.9	3	147.6	5	51.4	10	50.0	9	31.9	51	5.3	7	1	140.00	318.0
4077.1	72	77	72.95	107.48	m E	Early thinning	El	opalite	1.00	0.0	0	0.0	0	20.5	1	87.0	2	48.7	13	43.8	14	36.8	93	21.8	34	0	0.00	129.0
4079.1	72	79	74.29	106.00	M*bE	Early thinning	BE	opalite	1.00	0.0	0	0.0	0	314.9	16	255.9	13	334.8	64	193.8	45	132.3	251	42.2	69	2	59.40	587.2
4082.1	73	82	76.30	103.78	qM*BE	Early thinning	BEl	opalite	1.00	0.0	0	0.0	0	13.8	1	260.7	12	111.5	25	131.7	25	70.7	156	32.8	43	3	186.50	449.2
4083.1	73	83	76.97	103.04	qMbE*	Mass Reduction	BE	opalite	1.00	0.0	0	0.0	0	160.4	6	204.2	9	105.0	35	105.0	24	77.0	147	22.5	46	2	130.80	502.2
4083.3	73	0	76.97	103.04	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.9	1	0	0.00	0.0
4087.1	71	87	79.65	100.08	mB*e	Mass Reduction	MBE	opalite	1.00	0.0	0	0.0	0	65.3	3	143.5	5	98.8	28	83.6	21	43.5	83	23.4	36	0	0.00	156.4
4088.1	71	88	80.32	99.34	mBE*	Early thinning	BEl	opalite	1.00	0.0	0	0.0	0	33.9	2	178.0	8	103.0	36	62.4	17	65.2	130	25.0	50	0	0.00	212.0
4091.1	71	91	0.00	0.00	M*be	Early thinning	BEl	opalite	1.00	0.0	0	0.0	0	22.4	2	137.5	6	52.5	15	91.3	20	32.7	66	20.7	33	0	0.00	174.6
4092.1	0	0	83.00	96.38	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	58.2	1	35.1	1	15.8	5	0.0	0	5.4	11	1.6	2	3	294.50	429.2
4096.1	72	96	0.00	0.00	M*Be	Edging	MBe	opalite	1.00	0.0	0	335.3	5	95.9	2	96.7	5	65.6	17	35.8	13	38.1	83	13.4	25	0	0.00	37.7
4097.1	72	0	76.14	108.40	unanalyzed	Mass Reduction	MB	opalite	1.00	360.4	1	144.2	1	52.5	3	257.4	6	34.5	9	56.0	11	16.7	44	6.3	19	0	0.00	74.6
4097.2	72	0	76.14	108.40	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.3	1	0.6	1	0	0.00	0.0
4099.1	72	99	74.78	106.94	QMBE	Early thinning	BE	opalite	1.00	0.0	0	152.7	2	41.4	5	119.0	5	55.4	19	91.5	25	39.3	111	31.6	66	4	346.10	634.6
4102.1	72	102	72.74	104.75	MBE	Mass Reduction	BE	opalite	1.00	0.0	0	0.0	0	157.3	5	51.7	4	110.6	25	63.2	16	39.6	86	15.3	31	1	39.10	250.9
4107.1	0	0	67.14	64.14	unanalyzed	Early thinning	BE	opalite	1.00	0.0	0	212.4	3	114.9	5	587.8	26	154.9	48	332.2	70	108.8	238	75.8	118	1	45.80	911.1
4107.2	0	0	67.14	64.14	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.7	1	0.0	0	0	0.00	0.0
4110.1	49	0	66.70	61.18	unanalyzed	Early thinning	BE	opalite	1.00	0.0	0	97.3	1	216.5	6	100.1	3	145.3	20	101.9	15	64.9	74	19.9	31	0	0.00	638.3
4113.1	49	0	66.26	58.21	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	557.5	1	236.9	6	205.9	5	47.6	4	111.0	7	3.9	6	0.3	2	8	2547.80	409.1
4115.1	49	0	65.96	56.23	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	1709.6	5	88.8	1	100.4	2	0.0	0	0.0	0	0.0	0	0.0	0	4	3345.80	3577.1
4117.1	49	0	65.67	54.25	unanalyzed	Mass Reduction	BE	opalite	1.00	0.0	0	0.0	0	184.2	7	224.7	5	124.2	29	105.9	19	78.2	126	15.7	32	0	0.00	673.1
4118.1	49	0	65.52	53.26	unanalyzed	Edging	qMB	opalite	1.00	332.4	2	320.8	2	6.5	1	74.0	4	55.0	8	34.5	8	15.4	21	13.8	20	1	322.10	814.9

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
4119.1	0	0	65.38	52.28	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	233.9	1	54.9	2	195.2	4	15.6	3	1.2	2	2.6	2	0.0	0	2	649.10	1347.5
4120.1	0	0	65.23	51.29	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	554.2	7	37.5	1	66.0	1	0.0	0	0.0	0	0.0	0	0.0	0	15	3800.00	4000.0
4121.1	0	0	65.08	50.30	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	230.0	2	0.0	0	170.0	2	0.0	0	0.0	0	0.0	0	0.0	0	13	3112.00	3259.0
4123.1	0	0	64.79	48.32	unanalyzed	Mass Reduction	MB?	opalite	1.00	0.0	0	0.0	0	32.8	3	62.6	4	100.3	24	155.8	23	20.0	43	10.4	23	5	3200.00	3056.0
4581.1	87	501	94.70	126.09	MBe	unanalyzed	unanalyzed	opalite	n/a																			
4582.1	38	502	101.97	113.46	mBE	Mass Reduction	qMB	opalite	1.00	0.0	0	0.0	0	18.3	2	422.1	22	40.4	19	39.4	11	9.9	23	7.4	10	0	0.00	53.0
4584.1	92	504	80.06	140.62	M*BE	Mass Reduction	qMB	opalite	1.00	209.2	1	392.9	6	78.6	6	373.8	14	114.8	21	75.1	15	19.9	36	8.0	15	0	0.00	77.0
4585.1	92	505	78.56	140.12	mBE*	unanalyzed	unanalyzed	opalite	n/a																			
4586.1	92	506	81.56	141.12	too small	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.3	1	0.6	3	0.2	2	0	0.00	1.1
4587.1	63	507	139.28	78.35	BEL*	unanalyzed	unanalyzed	opalite	n/a																			
4587.1	63	507	139.28	78.35	mB L	unanalyzed	unanalyzed	opalite	n/a																			
4588.1	63	508	138.48	78.95	EL	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	24.4	2	21.9	5	3.3	2	4.5	15	3.7	11	0	0.00	19.6
4588.1	63	508	138.48	78.95	ME	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	24.4	2	21.9	5	3.3	2	4.5	15	3.7	11	0	0.00	19.6
4588.1	63	508	138.48	78.95	ME	N TOO SMALL	too small	opalite	1.00																			
4589.1	63	509	137.28	76.11	B*	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	13.9	1	5.3	2	12.0	4	2.3	5	3.0	6	0	0.00	46.9
4590.1	6	510	162.27	29.99	mBE	Mass Reduction	mBE	opalite	1.00	0.0	0	210.7	2	76.8	9	358.2	17	48.1	22	111.2	24	33.9	95	37.3	63	0	0.00	44.5
4591.1	6	511	161.77	29.49	qMBe	Mass Reduction	qMBE	opalite	1.00	0.0	0	469.7	5	230.5	16	944.9	36	134.3	61	246.0	61	38.4	94	51.2	95	1	121.10	236.2
4592.1	6	512	161.27	30.49	mBE	unanalyzed	unanalyzed	opalite	n/a																			
4593.1	6	513	160.77	28.99	BEl	unanalyzed	unanalyzed	opalite	n/a																			
4594.1	6	514	162.27	31.99	BE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	4.4	3	8.3	2	3.9	10	2.7	8	0	0.00	10.1
4595.1	6	515	163.27	29.49	MBE	Mass Reduction	MBe	opalite	1.00	0.0	0	0.0	0	0.0	0	215.0	3	34.8	13	39.8	8	14.1	28	5.1	14	0	0.00	71.4
4596.1	6	0	161.77	27.49	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	19.7	2	3.1	2	5.5	2	5.2	12	6.2	14	0	0.00	0.6
4597.1	6	517	163.27	29.99	El	unanalyzed	unanalyzed	opalite	n/a																			
4598.1	6	518	159.77	28.99	BE	unanalyzed	unanalyzed	opalite	n/a																			
4599.1	6	519	159.77	31.99	Mbe	unanalyzed	unanalyzed	opalite	n/a																			
4600.1	87	520	92.70	128.09	B	unanalyzed	unanalyzed	opalite	n/a																			
4601.1	87	521	93.70	127.09	MB*e	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	12.5	1	99.1	4	8.4	3	24.9	6	9.7	18	5.1	11	0	0.00	12.3
4602.1	87	522	95.70	127.59	B	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	35.6	4	5.0	11	2.0	10	0	0.00	29.9
4603.1	87	523	96.20	126.59	too small	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	1.4	1	0.0	0	1.1	3	1.5	5	0	0.00	0.0
4604.1	87	524	94.20	125.59	too small	unanalyzed	unanalyzed	opalite	n/a																			
4605.1	87	525	92.70	124.09	too small	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	3.5	1	2.6	6	0.7	2	0	0.00	0.0
4606.1	92	526	79.86	141.07	MBe	unanalyzed	unanalyzed	opalite	n/a																			
4607.1	92	527	80.86	142.07	BE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	10.6	3	0.0	0	3.3	5	1.5	5	0	0.00	1.1
4608.1	92	528	79.86	143.07	b	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	6.4	1	2.4	5	2.3	4	0	0.00	2.0
4608.2	92	0	79.86	143.07	unanalyzed	N TOO SMALL	too small	jasper	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.6	1	0.0	0	0	0.00	0.0
4609.1	92	529	78.36	142.07	MB*E	unanalyzed	unanalyzed	opalite	n/a																			
4610.1	92	530	77.86	141.07	BEl	unanalyzed	unanalyzed	opalite	n/a																			
4611.1	92	531	77.36	138.57	mB*E	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	67.6	4	0.0	0	4.8	3	9.1	3	4.8	16	4.8	8	1	14.70	18.4
4612.1	92	532	81.36	140.07	BE	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
4613.1	63	533	141.30	78.57	L	N TOO SMALL	too small	opalite	n/a																			
4613.1	63	533	141.30	78.57	B	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	16.3	4	26.9	6	5.3	15	0.0	0	0	0.00	22.6
4613.1	63	533	141.30	78.57	L	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	16.3	4	26.9	6	5.3	15	0.0	0	0	0.00	22.6
4614.1	63	534	140.80	76.57	bEL	Early thinning	BE	opalite	n/a																			
4614.1	63	534	140.80	76.57	BE	Early thinning	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	17.8	5	39.6	9	13.4	28	10.7	22	0	0.00	34.9
4614.1	63	534	140.80	76.57	bEL	Early thinning	BE	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	17.8	5	39.6	9	13.4	28	10.7	22	0	0.00	34.9
4615.1	63	535	140.30	77.07	BEI	Early thinning	too small	opalite	n/a																			
4615.1	63	535	140.30	77.07	BE	Early thinning	too small	opalite	1.00	0.0	0	96.9	1	16.7	1	63.7	2	40.5	10	39.4	10	12.6	36	6.9	18	0	0.00	20.0
4615.1	63	535	140.30	77.07	BEI	Early thinning	too small	opalite	1.00	0.0	0	96.9	1	16.7	1	63.7	2	40.5	10	39.4	10	12.6	36	6.9	18	0	0.00	20.0
4616.1	63	536	139.80	80.57	BEL	unanalyzed	unanalyzed	opalite	n/a																			
4616.1	63	536	139.80	80.57	mBEL	unanalyzed	unanalyzed	opalite	n/a																			
4617.1	63	537	137.80	80.07	E	unanalyzed	unanalyzed	opalite	n/a																			
4618.1	63	538	137.30	78.57	Mb	unanalyzed	unanalyzed	opalite	n/a																			
4618.1	63	538	137.30	78.57	BE	unanalyzed	unanalyzed	opalite	n/a																			
4619.1	63	539	0.00	0.00	mBE	unanalyzed	unanalyzed	opalite	n/a																			
4620.1	38	540	101.72	110.21	too small	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	2.3	1	0.5	2	1.7	4	0	0.00	0.8
4621.1	38	541	102.22	115.71	BE	unanalyzed	unanalyzed	opalite	n/a																			
4622.1	38	542	102.22	115.71	b	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	9.2	2	2.6	1	2.3	9	1.2	3	0	0.00	0.0
4623.1	38	543	103.72	113.71	too small	unanalyzed	unanalyzed	opalite	n/a																			
4624.1	86	544	81.60	121.18	MB*E	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	99.7	1	22.1	5	22.9	5	6.0	11	1.0	5	0	0.00	0.0
4625.1	86	545	81.10	123.18	B*E	unanalyzed	unanalyzed	opalite	n/a																			
4626.1	86	546	79.60	121.18	BE	Edging	BE?	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	33.4	7	17.4	7	17.2	47	9.5	29	0	0.00	13.2
4626.2	86	0	79.60	121.18	unanalyzed	N TOO SMALL	too small	jasper	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.4	1	0	0.00	0.0
4627.1	86	547	80.10	123.18	MBE	Mass Reduction	BE	opalite	1.00	0.0	0	0.0	0	85.7	5	285.7	14	81.0	16	113.3	23	43.2	103	25.1	51	0	0.00	6.4
4628.1	86	548	79.10	123.68	MBE	Mass Reduction	mBE	opalite	1.00	0.0	0	0.0	0	0.0	0	311.1	8	41.4	9	110.9	27	19.4	44	18.2	36	2	143.40	370.1
4629.1	86	549	79.10	125.18	BE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	1.3	1	8.1	2	3.2	9	3.6	8	0	0.00	8.1
4630.1	86	550	78.10	124.68	MBE	unanalyzed	unanalyzed	opalite	n/a																			
4631.1	86	551	77.60	124.68	mBE	Mass Reduction	mBE	opalite	1.00	0.0	0	0.0	0	26.1	1	87.0	5	38.8	13	88.4	24	15.4	38	17.5	40	0	0.00	178.4
4632.1	86	552	77.60	121.68	BE	unanalyzed	unanalyzed	opalite	n/a																			
4633.1	86	553	77.10	121.18	MBE	unanalyzed	unanalyzed	opalite	n/a																			
4634.1	86	554	78.10	125.18	qMB*E	unanalyzed	unanalyzed	opalite	n/a																			
4635.1	86	555	77.60	125.18	BE*	unanalyzed	unanalyzed	opalite	n/a																			
4636.1	63	536	137.30	80.07	BE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	8.9	2	0.0	0	6.5	9	0.4	3	0	0.00	9.5
4637.1	63	537	137.30	78.07	B*EL	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	32.8	1	0.0	0	21.1	5	45.5	14	13.6	33	9.0	22	0	0.00	9.6
4637.1	63	537	137.30	78.07	B*EL	Early thinning	BEI	opalite	n/a																			
4637.1	63	537	137.30	78.07	B*E	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	32.8	1	0.0	0	21.1	5	45.5	14	13.6	33	9.0	22	0	0.00	9.6
4638.1	63	538	0.00	0.00	mBE	unanalyzed	unanalyzed	opalite	n/a																			
5002.1	0	0	103.39	68.19	QM E	unanalyzed	unanalyzed	opalite	n/a																			
5005.1	0	0	102.77	65.26	QMB	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	wt.(g)	>G0 Angular debris wt. (g)
5006.1	0	0	138.00	26.00	QMB L	unanalyzed	unanalyzed	opalite	n/a																			
5007.1	0	0	102.36	63.30	QM	unanalyzed	unanalyzed	opalite	n/a																			
5009.1	0	0	101.95	61.34	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5011.1	0	0	155.00	31.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5020.1	0	0	138.00	19.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5021.1	0	0	147.00	10.00	QMBEL	unanalyzed	unanalyzed	opalite	n/a																			
5023.1	0	0	142.00	9.00	QMB L	unanalyzed	unanalyzed	opalite	n/a																			
5024.1	0	0	146.00	2.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5034.1	0	0	111.00	26.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5038.1	0	0	122.00	39.00	QMBEL	unanalyzed	unanalyzed	opalite	n/a																			
5045.1	0	0	155.00	49.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5051.1	0	0	143.00	56.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5059.1	0	0	120.00	49.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5060.1	0	0	120.00	43.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5067.1	0	0	104.00	66.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5072.1	0	0	99.00	65.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5073.1	0	0	88.00	50.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5077.1	0	0	85.00	70.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5078.1	0	0	83.00	72.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5085.1	0	0	107.00	82.00	QM L	unanalyzed	unanalyzed	opalite	n/a																			
5099.1	0	0	92.00	105.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5107.1	0	0	81.00	127.00	M E	unanalyzed	unanalyzed	opalite	n/a																			
5113.1	0	0	73.00	101.00	QM E	unanalyzed	unanalyzed	opalite	n/a																			
5114.1	0	0	72.00	109.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5120.1	0	0	62.00	99.00	MBE	unanalyzed	unanalyzed	opalite	n/a																			
5135.1	0	0	44.00	92.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5136.1	0	0	40.00	99.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5155.1	0	0	78.00	69.00	QM EL	unanalyzed	unanalyzed	opalite	n/a																			
5157.1	0	0	79.00	70.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5163.1	0	0	68.00	73.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5176.1	0	0	38.00	53.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5177.1	0	0	39.00	63.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5178.1	0	0	36.00	64.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5180.1	0	0	22.00	62.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5181.1	0	0	29.00	70.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5183.1	0	0	37.00	75.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5200.1	0	0	46.00	119.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5202.1	0	0	102.00	107.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5205.1	0	0	90.00	111.00	QM	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
5208.1	0	0	104.00	116.00	M	unanalyzed	unanalyzed	opalite	n/a																			
5209.1	0	0	108.00	125.00	M	unanalyzed	unanalyzed	opalite	n/a																			
5211.1	0	0	97.00	121.00	MB	unanalyzed	unanalyzed	opalite	n/a																			
5238.1	0	0	137.00	88.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5310.1	0	0	71.00	12.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5311.1	0	0	85.00	14.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5312.1	0	0	87.00	15.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5317.1	0	0	101.00	14.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5330.1	0	0	79.00	23.00	QMBE	unanalyzed	unanalyzed	opalite	n/a																			
5343.1	0	0	100.00	36.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5352.1	0	0	109.00	48.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5367.1	0	0	33.00	43.00	QMB	unanalyzed	unanalyzed	opalite	n/a																			
5370.1	0	0	43.00	39.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5375.1	0	0	56.00	46.00	QM E	unanalyzed	unanalyzed	opalite	n/a																			
5405.1	0	0	144.00	140.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5416.1	0	0	111.00	148.00	M	unanalyzed	unanalyzed	opalite	n/a																			
5425.1	0	0	88.00	138.00	B	unanalyzed	unanalyzed	opalite	n/a																			
5426.1	0	0	82.00	132.00	M	unanalyzed	unanalyzed	opalite	n/a																			
5433.1	0	0	61.00	131.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5434.1	0	0	61.00	138.00	M	unanalyzed	unanalyzed	opalite	n/a																			
5475.1	0	0	95.00	160.00	MB	unanalyzed	unanalyzed	opalite	n/a																			
5484.1	0	0	112.00	173.00	M	unanalyzed	unanalyzed	opalite	n/a																			
5489.1	0	0	87.00	178.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
5520.1	0	0	154.00	158.00	QM	unanalyzed	unanalyzed	opalite	n/a																			
6041.1	38	502	101.97	113.46	mBE	Mass Reduction	MBe	opalite	1.00	0.0	0	0.0	0	107.1	2	144.9	5	50.2	13	58.9	12	14.0	24	7.9	15	0	0.00	11.7
6081.1	92	504	80.06	140.62	MBe	Mass Reduction	QMb	opalite	1.00	127.3	1	1324.1	8	108.0	5	640.7	18	89.4	21	165.9	29	14.8	15	10.8	17	1	31.30	352.2
6081.1	92	504	80.06	140.62	M*bE	Mass Reduction	QMb	opalite	1.00	127.3	1	1324.1	8	108.0	5	640.7	18	89.4	21	165.9	29	14.8	15	10.8	17	1	31.30	352.2
6081.1	92	504	80.06	140.62	M*bE	Mass Reduction	QMb	opalite	1.00																			
6101.1	92	505	78.56	140.12	M*Be	unanalyzed	unanalyzed	opalite	n/a																			
6121.1	92	0	81.56	141.12	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	18.0	4	3.4	1	3.1	7	0.4	2	0	0.00	3.6
6201.1	6	510	162.27	29.99	qMBE*I	Mass Reduction	MBE	opalite	1.00	0.0	0	1200.3	5	1274.1	60	2051.6	69	635.6	179	504.9	126	334.1	676	88.8	188	6	486.80	1424.6
6221.1	6	511	161.77	29.49	QMBE*	Mass Reduction	MBE	opalite	1.00	0.0	0	183.7	1	583.9	41	4380.5	151	597.9	189	1416.7	379	259.5	688	*****	749	14	1554.40	4282.9
6241.1	6	512	161.27	30.49	MBEI	unanalyzed	unanalyzed	opalite	n/a																			
6261.1	6	513	160.77	28.99	BE*I	unanalyzed	unanalyzed	opalite	n/a																			
6281.1	6	514	162.27	31.99	q BE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	82.7	3	0.0	0	37.0	7	0.0	0	7.4	17	3.8	13	1	269.10	346.0
6301.1	6	515	163.27	29.49	M*BEI	Early thinning	mBE	opalite	1.00	601.6	0	1248.5	3	0.0	0	585.9	17	816.2	101	34.9	64	175.9	322	34.9	62	8	1523.00	1955.8
6321.1	6	516	161.77	27.49	mBE	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	0.0	0	56.3	1	12.8	6	41.6	9	11.5	24	15.7	36	0	0.00	91.7
6341.1	6	517	163.27	29.99	M*bEI	Mass Reduction	MB	opalite	1.00	0.0	0	794.5	4	87.9	7	1393.7	31	101.7	30	221.0	47	48.0	121	31.1	51	3	319.90	756.7
6361.1	6	518	159.77	28.99	mbE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	7.2	3	5.4	3	4.5	15	3.1	10	0	0.00	33.1

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
6381.1	6	519	159.77	31.99	mB	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	11.2	2	28.7	4	6.0	12	1.6	6	0	0.00	9.4
6401.1	87	520	92.70	128.09	E	unanalyzed	unanalyzed	opalite	n/a																			
6421.1	87	521	93.70	127.09	MBe	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	20.6	1	6.1	4	7.9	2	7.4	19	2.1	3	0	0.00	16.6
6441.1	87	522	95.70	127.59	M*B*e	Mass Reduction	qMB	opalite	n/a																			
6441.1	87	522	95.70	127.59	M*B*e	Mass Reduction	qMB	opalite	1.00	0.0	0	772.3	3	0.0	0	418.4	13	67.3	18	84.8	12	14.7	37	11.2	18	0	0.00	254.6
6441.1	87	522	95.70	127.59	MB	Mass Reduction	qMB	opalite	1.00	0.0	0	772.3	3	0.0	0	418.4	13	67.3	18	84.8	12	14.7	37	11.2	18	0	0.00	254.6
6461.1	87	523	96.20	126.59	be	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	2.5	1	3.1	1	2.7	8	1.1	3	0	0.00	2.0
6481.1	87	524	94.20	125.59	MBe	unanalyzed	unanalyzed	opalite	n/a																			
6501.1	87	525	92.70	124.09	e	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	4.7	2	7.0	2	2.5	7	2.0	2	0	0.00	5.9
6521.1	92	526	79.86	141.07	M*BE	unanalyzed	unanalyzed	opalite	n/a																			
6541.1	92	0	80.86	142.07	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	4.1	1	18.6	2	2.3	7	1.9	3	0	0.00	12.9
6561.1	92	0	79.86	143.07	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	5.1	1	1.2	1	4.2	7	2.1	4	0	0.00	37.2
6581.1	92	529	78.36	142.07	M E	unanalyzed	unanalyzed	opalite	n/a																			
6621.1	92	0	77.36	138.57	unanalyzed	Mass Reduction	MBE?	opalite	1.00	0.0	0	0.0	0	0.0	0	74.6	2	41.4	10	39.5	7	11.8	24	11.4	15	0	0.00	135.1
6641.1	92	532	81.36	140.07	MBe	unanalyzed	unanalyzed	opalite	n/a																			
6661.1	63	533	141.30	78.57	M	Mass Reduction	mBE	opalite	1.00																			
6661.1	63	533	141.30	78.57	MBEL*	Mass Reduction	mBE	opalite	1.00	0.0	0	0.0	0	93.7	3	9.7	1	28.6	10	42.6	11	16.2	36	8.1	10	0	0.00	99.6
6661.1	63	533	141.30	78.57	M	Mass Reduction	mBE	opalite	1.00	0.0	0	0.0	0	93.7	3	9.7	1	28.6	10	42.6	11	16.2	36	8.1	10	0	0.00	99.6
6661.2	63	533	141.30	78.57	too small	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	3.1	1	0.0	0	0.0	0	0.0	0	0	0.00	0.0
6681.1	63	534	140.80	76.57	mBE*I	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	36.5	2	22.2	1	32.1	10	14.3	5	26.0	51	10.6	20	0	0.00	37.9
6701.1	63	535	140.30	77.07	BE	Early thinning	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	18.8	8	13.6	5	12.2	34	5.0	13	0	0.00	1.2
6701.1	63	535	140.30	77.07	BE	Early thinning	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	18.8	8	13.6	5	12.2	34	5.0	13	0	0.00	1.2
6701.1	63	535	140.30	77.07	BE	Early thinning	too small	opalite	1.00																			
6701.2	63	0	140.30	77.07	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.3	1	0.0	0	0	0.00	0.0
6721.1	63	536	139.80	80.57	bEL	unanalyzed	unanalyzed	opalite	n/a																			
6741.1	63	537	137.80	80.07	EL	unanalyzed	unanalyzed	opalite	n/a																			
6761.1	63	538	137.30	78.57	MBE	unanalyzed	unanalyzed	opalite	n/a																			
6761.1	63	538	137.30	78.57	E	unanalyzed	unanalyzed	opalite	n/a																			
6781.1	63	539	139.30	76.07	MBE*	unanalyzed	unanalyzed	opalite	n/a																			
6801.1	38	540	101.72	110.21	MBe	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	26.4	1	6.4	1	12.2	2	2.2	2	0.3	1	0	0.00	21.7
6821.1	38	541	102.22	115.71	too small	unanalyzed	unanalyzed	opalite																				
6841.1	38	542	102.22	115.71	too small	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.5	1	0.7	2	0	0.00	8.9
6881.1	86	544	81.60	121.18	MB*E	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	67.6	2	52.6	2	18.7	5	47.3	10	16.5	23	2.9	7	0	0.00	0.0
6901.1	86	545	81.10	123.18	MB*EI	unanalyzed	unanalyzed	opalite	n/a																			
6921.1	86	546	79.60	121.18	mBE*I	Early thinning	BEL	opalite	1.00	0.0	0	0.0	0	24.3	1	150.2	6	106.2	31	238.3	54	79.4	178	74.9	154	0	0.00	44.2
6921.2	86	0	79.60	121.18	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.8	1	0.0	0	0	0.00	0.0
6941.1	86	547	80.10	123.18	MBEI	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	27.0	1	312.8	13	141.7	30	221.3	46	70.4	155	52.2	117	0	0.00	8.1
6961.1	86	548	79.10	123.68	M*BE	Mass Reduction	MBE	opalite	1.00	0.0	0	441.7	3	182.6	6	662.0	21	115.6	31	321.7	76	49.3	83	70.0	93	1	79.10	224.9
6981.1	86	549	79.10	125.18	MBE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	91.4	1	0.0	0	16.3	8	34.2	9	3.4	12	8.6	18	0	0.00	39.2

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
7001.1	86	550	78.10	124.68	qM*BE	unanalyzed	unanalyzed	opalite	n/a																			
7021.1	86	551	77.60	124.68	QM*bE	Mass Reduction	MBE	opalite	1.00	168.9	1	210.6	2	133.6	7	582.5	21	217.3	39	215.1	50	60.5	109	25.8	46	3	2426.40	3271.5
7041.1	86	552	77.60	121.68	MBe	unanalyzed	unanalyzed	opalite	n/a																			
7061.1	86	553	77.10	121.18	mBEl	unanalyzed	unanalyzed	opalite	n/a																			
7061.10	86	553	77.10	121.18	too small	unanalyzed	unanalyzed	opalite	n/a																			
7081.10	86	554	78.10	125.18	qMBE	unanalyzed	unanalyzed	opalite	n/a																			
7107.1	86	555	0.00	0.00	MBe	unanalyzed	unanalyzed	opalite	n/a																			
7121.1	63	556	137.30	80.07	mBE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	13.7	1	0.0	0	5.0	1	28.5	5	7.0	13	1.1	3	0	0.00	59.5
7141.1	63	557	137.30	78.07	M*bE	Mass Reduction	MB	opalite	1.00	0.0	0	166.4	1	49.5	3	402.7	12	37.6	7	24.2	8	13.0	40	19.9	36	0	0.00	258.0
7161.1	63	558	138.80	77.07	BE*l	unanalyzed	unanalyzed	opalite	n/a																			
7161.1	63	558	138.80	77.07	MBE	unanalyzed	unanalyzed	opalite	n/a																			
8001.2	105	566	140.71	73.86	mB*e	unanalyzed	unanalyzed	opalite	n/a																			
8021.2	105	567	140.71	74.86	mB*	unanalyzed	unanalyzed	opalite	n/a																			
8041.2	106	568	125.02	92.92	MBE	unanalyzed	unanalyzed	opalite	n/a																			
8061.2	106	569	125.02	93.92	MBE	unanalyzed	unanalyzed	opalite	n/a																			
8081.2	107	570	125.31	98.43	M*Be	unanalyzed	unanalyzed	opalite	n/a																			
8101.2	107	571	124.31	98.43	BE*	unanalyzed	unanalyzed	opalite	n/a																			
8121.3	108	572	122.77	122.43	B*E	unanalyzed	unanalyzed	opalite	n/a																			
8141.4	108	573	122.77	123.42	BE*	unanalyzed	unanalyzed	opalite	n/a																			
8161.2	109	574	102.55	102.22	C*mel	unanalyzed	unanalyzed	opalite	n/a																			
8181.2	109	575	102.55	103.22	bE 109	unanalyzed	unanalyzed	opalite	n/a																			
8201.2	110	576	105.94	110.68	BE	unanalyzed	unanalyzed	opalite	n/a																			
8221.2	110	577	105.94	111.68	BE	unanalyzed	unanalyzed	opalite	n/a																			
8241.1	106	578	124.02	93.92	MBE	unanalyzed	unanalyzed	opalite	n/a																			
8261.1	106	579	125.02	91.92	MB*E*l	unanalyzed	unanalyzed	opalite	n/a																			
8281.1	107	580	125.31	97.43	mbE*	unanalyzed	unanalyzed	opalite	n/a																			
8301.1	107	581	126.31	98.43	M*BE	unanalyzed	unanalyzed	opalite	n/a																			
8321.1	109	582	101.55	103.22	C* E	unanalyzed	unanalyzed	opalite	n/a																			
8341.1	102	588	66.64	47.88	QMbe	Early thinning	MB	opalite	0.13	852.5	3	0.0	0	123.4	8	368.7	11	137.1	38	74.3	16	68.2	149	28.2	45	8	3151.30	4064.0
8341.14	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.5	1	0.5	1	0	0.00	0.3
8341.15	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	32.9	1	0.0	0	7.1	2	0.0	0	1.5	3	0.0	0	0	0.00	0.0
8342.18	102	588	66.64	47.88	MBE*	Mass Reduction	MB	opalite	0.13	94.7	1	257.6	3	210.0	8	514.3	17	100.7	22	134.5	27	30.3	62	38.2	48	9	1169.40	1422.8
8342.19	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.4	1	0.5	1	0.0	0	0.0	0	0	0.00	0.0
8342.20	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.1	1	0.0	0	0	0.00	0.0
8342.21			66.64	47.88				jasper	1.00	0.0	0	0.0	0	12.0	1	0.0	0	1.5	1	0.0	0	0.0	0	0.0	0	0	0.00	46.0
8343.1	102	588	66.64	47.88	QMbe	Early thinning	MBE	opalite	0.13	162.7	1	498.3	1	176.7	5	256.0	9	127.5	33	43.1	11	99.4	201	10.0	20	6	1039.80	1501.8
8343.3	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	6.4	1	0.0	0	1.7	5	0.0	0	0	0.00	0.0
8343.4	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	3.4	4	0.0	0	0	0.00	0.0
8344.1	102	588	66.64	47.88	QMbe	Mass Reduction	mBE	opalite	1.00	138.4	1	396.6	1	219.4	8	400.3	14	140.8	35	106.0	25	78.9	170	32.3	67	7	3067.80	4197.9

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
8344.12	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.4	3	1.4	3	0	0.00	5.0
8345.1	102	588	66.64	47.88	Q*Mbe	unanalyzed	unanalyzed	opalite	n/a																			
8345.2	102	0	66.64	47.88	unanalyzed	Early thinning	BEI	opalite	0.25	407.1	2	244.7	2	176.6	7	198.0	10	219.5	63	107.2	20	258.8	507	27.3	64	2	462.80	3800.0
8345.4	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	13.0	1	1.5	1	2.1	1	2.4	8	0.6	3	0	0.00	0.0
8346.1	102	588	66.64	47.88	Q*mBE	Early thinning	EI	opalite	1.00	0.0	0	0.0	0	87.5	6	164.9	7	126.6	34	172.1	38	195.6	386	71.7	128	5	429.80	1543.9
8346.2	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	5.5	1	0.0	0	1.4	1	0.0	0	0	0.00	0.0
8346.3	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.3	3	0.0	0	0	0.00	0.0
8347.1	102	588	66.64	47.88	Q*Mbe	Early thinning	BE	opalite	0.25	57.7	1	0.0	0	131.3	7	399.9	10	133.0	30	73.2	18	86.2	202	33.3	75	10	1392.00	0.0
8347.2	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	9.0	4	0.0	0	12.2	17	0.0	0	0	0.00	0.0
8348.1	102	588	66.64	47.88	Q*MbE	unanalyzed	unanalyzed	opalite	n/a																			
8348.2	102	0	66.64	47.88	unanalyzed	Early thinning	BEI	opalite	1.00	0.0	0	140.2	1	194.0	9	253.2	10	245.0	66	116.2	29	192.4	415	71.9	160	14	1022.30	5600.0
8349.2	102	0	66.64	47.88	unanalyzed	Early thinning	MBe	opalite	0.25	0.0	0	266.5	1	36.9	1	108.5	4	34.2	11	26.4	8	30.0	65	5.3	12	5	338.00	634.6
8349.3	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	10.7	3	0.0	0	11.1	18	0.0	0	0	0.00	0.0
8349.4	102	0	66.64	47.88	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	7.3	1	0.0	0	0.5	1	0.0	0	0	0.00	0.0
8381.1	102	590	66.09	44.70	qmBE	Early thinning	MBE	opalite	1.00	0.0	0	131.6	1	118.1	2	300.0	15	170.3	38	297.2	56	81.1	79	67.0	97	0	0.00	574.0
8382.1	102	590	66.09	44.70	Q*MBE	Mass Reduction	BE	opalite	0.50	0.0	0	206.1	1	115.1	6	598.6	24	120.7	27	276.3	65	69.0	206	82.4	159	0	0.00	6600.0
8383.1	102	588	66.09	44.70	QMBE*1	Mass Reduction	MBe	opalite	0.13	184.2	4	339.0	2	474.4	21	264.4	14	252.7	55	196.8	47	42.9	72	67.7	174	0	0.00	2274.5
8383.2	102	0	66.09	44.70	unanalyzed	N TOO SMALL	too small	other	1.00	110.0	1	0.0	0	10.7	1	0.0	0	9.3	2	0.0	0	6.0	5	0.0	0	0	0.00	0.0
8384.1	102	588	66.09	44.70	qMbE*	Early thinning	BEI	opalite	0.50	0.0	0	133.2	1	72.0	5	171.9	12	131.3	31	123.1	23	99.2	142	48.9	105	0	0.00	1120.6
8384.2	102	0	66.09	44.70	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	6.7	1	0.0	0	6.0	3	0.0	0	3.2	7	0.0	0	0	0.00	0.0
8384.3	102	0	66.09	44.70	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.9	1	0.0	0	0.0	0	0	0.00	0.0
8385.1	102	590	66.09	44.70	QM*Be	Mass Reduction	MBe	opalite	0.25	0.0	0	404.5	2	502.0	22	327.2	16	124.1	30	151.1	39	92.5	232	30.8	59	0	0.00	8000.0
8386.1	102	590	66.09	44.70	Q*mbE	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	0.0	0	62.4	1	23.8	7	63.5	16	12.8	32	24.3	34	3	300.70	780.6
8386.2	102	0	66.09	44.70	unanalyzed	N TOO SMALL	too small	other	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.9	2	0.0	0	0	0.00	17.7
8387.1	102	590	66.09	44.70	Q*MBE	Mass Reduction	MBe	opalite	0.50	0.0	0	225.9	3	13.5	1	253.2	8	24.3	10	60.3	13	16.7	46	15.9	38	0	0.00	13000.0
8388.1	102	590	66.09	44.70	Q*MBE	Early thinning	BEI	opalite	1.00	0.0	0	0.0	0	406.0	16	227.3	11	235.0	60	187.0	47	171.0	418	53.0	96	17	2411.50	3974.7
8389.1	102	590	66.09	44.70	QMBE	Mass Reduction	mBE	opalite	0.06	0.0	0	0.0	0	141.7	5	214.8	11	58.3	16	43.7	14	35.2	94	16.3	37	3	555.80	969.1
8390.1	102	590	66.09	44.70	QMB	Early thinning	BE	opalite	1.00	0.0	0	162.9	1	21.2	1	156.4	8	45.7	16	84.8	22	63.9	154	23.8	46	1	57.90	593.1
8391.1	102	0	66.09	44.70	unanalyzed	Early thinning	BE	opalite	0.50	0.0	0	267.0	2	217.7	11	92.3	6	153.0	39	78.9	18	68.0	166	16.3	42	29	5412.70	7447.1
8392.4	102	590	66.09	44.70	qM*Be	Mass Reduction	MBe	opalite	0.06	513.5	1	141.8	1	276.8	11	303.2	8	117.0	29	26.3	8	64.8	134	18.6	34	10	2024.60	4118.2
8392.5	102	0	66.09	44.70	unanalyzed	N TOO SMALL	too small	basalt	1.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.5	1	0	0.00	0.0
8393.1	102	0	66.09	44.70	unanalyzed	Early thinning	BE	opalite	1.00	0.0	0	0.0	0	6.1	1	102.6	5	11.5	5	45.1	10	15.8	44	12.5	31	7	1092.70	2088.8
8394.1	102	0	66.09	44.70	unanalyzed	Mass Reduction	BE	opalite	1.00	0.0	0	0.0	0	39.0	1	49.5	1	23.9	8	3.1	1	9.2	30	7.1	16	14	1715.20	3011.6
8395.1	102	0	66.09	44.70	unanalyzed	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	47.2	2	10.5	1	13.4	5	5.3	3	9.0	24	2.4	8	0	0.00	352.9
8396.1	102	0	66.09	44.70	unanalyzed	Early thinning	MB	opalite	1.00	457.5	1	288.4	1	115.9	3	133.6	3	121.2	11	33.5	3	42.4	60	0.0	0	4	542.30	1207.5
8397.1	102	590	66.09	44.70	QMBe	Early thinning	BE	opalite	1.00	148.3	1	395.2	2	102.4	3	167.5	5	93.4	15	64.5	10	89.9	150	30.8	48	6	676.70	1395.2
8398.1	102	590	66.09	44.70	qMBe	Early thinning	BE	opalite	1.00	57.0	1	0.0	0	5.5	1	152.5	2	10.8	5	74.6	11	26.8	69	28.1	55	1	430.20	1519.7
9141.1	63	507	139.28	78.35	BEL*	unanalyzed	unanalyzed	opalite	n/a																			
9141.1	63	507	139.28	78.35	MBE*	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table 1. Debitage data: excavation units, lithic inventories, trench samples.

ID	Feature	Unit	N	E	Technological analysis result	Mass analysis result	Weibull analysis result	Raw material	Sample fraction	G0 Flake fragments wt.(g)	n	G0 Flakes w/ platforms wt.(g)	n	G1 Flake fragments wt.(g)	n	G1 Flakes w/ platforms wt.(g)	n	G2 Flake fragments wt.(g)	n	G2 Flakes w/ platforms wt.(g)	n	G3 Flake fragments wt.(g)	n	G3 Flakes w/ platforms wt.(g)	n	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt. (g)
9161.1	63	508	138.48	78.95	mBE	Mass Reduction	MBe	opalite	1.00																			
9161.1	63	508	138.48	78.95	b L	Mass Reduction	MBe	opalite	1.00	0.0	0	0.0	0	0.0	0	66.5	4	15.2	5	21.4	9	9.8	23	6.1	17	0	0.00	34.4
9161.1	63	508	138.48	78.95	mBE	Mass Reduction	MBe	opalite	1.00	0.0	0	0.0	0	0.0	0	66.5	4	15.2	5	21.4	9	9.8	23	6.1	17	0	0.00	34.4
9181.1	63	509	137.28	76.11	mBE	N TOO SMALL	too small	opalite	1.00	0.0	0	0.0	0	0.0	0	0.0	0	105.2	6	1.3	1	8.3	14	9.0	5	1	350.90	357.1
9241.1	106	578	124.02	93.92	MBE	unanalyzed	unanalyzed	opalite	n/a																			

KEY: Q = quarry debris, M = mass reduction, B = blank preparation E = early biface thinning L = late biface thinning

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference	Specimen			Raw	Flakes and flake fragments		G0 Angular debris		>G0 Angular debris
#	#	N	E	material	n	wt.(g)	n	wt.(g)	wt.(g)
5001	1	142.00	28.00	opalite	22	15.5	0	0.0	23.6
5002	1	147.00	25.00	opalite	18	90.6	0	0.0	29.3
5003	1	147.00	30.00	opalite	5	9.0	0	0.0	14.4
5004	1	146.00	33.00	opalite	9	6.8	0	0.0	20.2
5005	1	135.00	26.00	opalite	27	861.0	0	0.0	121.4
5006	1	138.00	26.00	opalite	18	33.4	0	0.0	23.0
5007	1	130.00	38.00	opalite	20	329.1	0	0.0	58.1
5008	1	138.00	37.00	opalite	8	36.0	0	0.0	4.4
5009	1	153.00	23.00	opalite	2	0.5	0	0.0	6.9
5010	1	153.00	26.00	opalite	9	16.3	0	0.0	45.1
5011	1	155.00	31.00	opalite	3	11.2	0	0.0	15.4
5012	1	150.00	38.00	opalite	4	35.0	0	0.0	4.9
5013	1	161.00	24.00	opalite	5	3.9	0	0.0	51.1
5014	1	163.00	27.00	opalite	1	0.1	0	0.0	1.9
5015	1	162.00	33.00	opalite	4	0.6	0	0.0	7.6
5016	1	163.00	38.00	opalite	0	0.0	0	0.0	26.7
5017	1	134.00	5.00	opalite	23	37.5	0	0.0	47.7
5018	1	136.00	9.00	opalite	92	278.2	0	0.0	42.5
5019	1	132.00	14.00	opalite	47	60.8	0	0.0	264.8
5020	1	138.00	19.00	opalite	44	187.1	4	199.1	396.1
5021	1	147.00	10.00	opalite	63	102.4	5	299.8	484.7
5022	1	149.00	17.00	opalite	18	24.6	0	0.0	30.6
5023	1	142.00	9.00	opalite	36	68.7	2	59.6	115.5
5024	1	146.00	2.00	opalite	19	307.6	2	125.2	184.7
5025	1	150.00	1.00	opalite	8	12.5	0	0.0	7.3
5026	1	159.00	5.00	opalite	37	252.0	0	0.0	77.9
5028	1	161.00	6.00	opalite	1	0.4	0	0.0	36.1
5029	1	160.00	15.00	opalite	6	1.2	0	0.0	40.0
5031	1	155.00	16.00	opalite	7	29.9	0	0.0	15.2
5032	1	158.00	12.00	opalite	0	0.0	0	0.0	53.7
5033	1	117.00	20.00	opalite	48	147.4	0	0.0	171.8
5034	1	111.00	26.00	opalite	34	330.1	0	0.0	181.6
5035	1	117.00	32.00	opalite	44	202.1	0	0.0	292.0
5036	1	110.00	36.00	opalite	42	278.5	3	136.5	459.0

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference	Specimen			Raw	Flakes and flake fragments		G0 Angular debris		>G0 Angular debris
#	#	N	E	material	n	wt.(g)	n	wt.(g)	wt.(g)
5037	1	120.00	33.00	opalite	32	21.7	2	186.7	298.0
5038	1	122.00	39.00	opalite	128	595.8	0	0.0	100.3
5039	1	125.00	21.00	opalite	26	23.7	0	0.0	74.0
5040	1	123.00	25.00	opalite	54	190.0	0	0.0	352.6
5041	1	163.00	40.00	opalite	2	1.7	0	0.0	5.1
5042	1	162.00	46.00	opalite	0	0.0	0	0.0	6.3
5045	1	155.00	49.00	opalite	8	8.0	0	0.0	4.7
5046	1	158.00	48.00	opalite	17	22.2	0	0.0	5.2
5047	1	151.00	53.00	opalite	2	5.1	0	15.6	0.0
5048	1	152.00	55.00	opalite	1	0.8	0	0.0	19.6
5049	1	140.00	48.00	opalite	8	15.5	0	0.0	22.0
5050	1	143.00	49.00	opalite	10	20.2	0	0.0	37.0
5051	1	143.00	56.00	opalite	3	14.9	0	0.0	39.6
5052	1	149.00	57.00	opalite	1	1.6	0	0.0	14.4
5053	1	130.00	46.00	opalite	6	15.2	0	0.0	5.8
5054	1	138.00	48.00	opalite	9	6.6	0	0.0	7.3
5055	1	133.00	56.00	opalite	4	28.1	0	0.0	60.7
5056	1	137.00	59.00	opalite	4	3.2	0	0.0	6.4
5057	1	122.00	53.00	opalite	11	28.4	0	0.0	28.5
5058	1	122.00	56.00	opalite	8	12.9	0	0.0	20.4
5059	1	120.00	49.00	opalite	26	383.7	2	391.5	449.7
5060	1	120.00	43.00	opalite	28	300.9	2	287.1	160.7
5061	1	114.00	47.00	opalite	67	262.2	0	0.0	163.2
5062	1	112.00	49.00	opalite	85	282.0	0	0.0	483.3
5063	1	111.00	56.00	opalite	34	67.4	0	0.0	39.9
5064	1	112.00	58.00	opalite	26	22.5	0	0.0	41.3
5065	1	101.00	53.00	opalite	8	77.9	0	0.0	153.9
5066	1	103.00	53.00	opalite	48	298.2	1	284.3	357.1
5067	1	104.00	66.00	opalite	60	772.1	1	143.7	228.2
5068	1	106.00	67.00	opalite	43	238.3	0	0.0	102.4
5069	1	98.00	54.00	opalite	20	87.1	0	0.0	13.3
5070	1	91.00	58.00	opalite	79	181.9	0	0.0	99.5
5071	1	95.00	60.00	opalite	119	348.6	0	0.0	180.2
5072	1	99.00	65.00	opalite	128	463.1	0	0.0	64.2

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5073	1	88.00	50.00	opalite	142	346.5	0	0.0	263.2
5074	1	88.00	56.00	opalite	70	196.1	0	0.0	54.0
5075	1	81.00	65.00	opalite	107	208.1	0	0.0	153.4
5076	1	85.00	69.00	opalite	34	92.1	0	0.0	57.9
5077	1	85.00	70.00	opalite	171	268.9	0	0.0	108.4
5078	1	83.00	72.00	opalite	57	689.7	0	0.0	208.2
5081	1	97.00	73.00	opalite	66	99.1	0	0.0	65.2
5082	1	96.00	71.00	opalite	56	119.8	0	0.0	67.1
5084	1	109.00	70.00	opalite	18	37.0	0	0.0	10.7
5085	1	107.00	82.00	opalite	9	9.7	0	0.0	26.3
5086	1	107.00	89.00	opalite	19	17.5	0	0.0	9.1
5088	1	95.00	89.00	opalite	72	101.6	0	0.0	21.0
5089	1	113.00	60.00	opalite	16	55.5	0	0.0	27.1
5090	1	118.00	67.00	opalite	7	2.4	0	0.0	2.9
5091	1	122.00	63.00	opalite	2	6.6	0	0.0	0.0
5092	1	128.00	60.00	opalite	3	7.3	0	0.0	3.2
5094	1	122.00	79.00	opalite	13	38.4	0	0.0	1.5
5096	1	114.00	79.00	opalite	23	57.7	0	0.0	11.8
5097	1	93.00	92.00	opalite	41	231.7	2	60.8	100.8
5098	1	95.00	95.00	opalite	30	52.8	0	0.0	19.4
5099	1	92.00	105.00	opalite	4	6.5	0	0.0	2.0
5100	1	99.00	102.00	opalite	6	11.7	0	0.0	16.7
5101	1	76.00	115.00	opalite	49	262.1	0	0.0	12.1
5102	1	72.00	117.00	opalite	8	10.3	0	0.0	3.0
5103	1	75.00	125.00	opalite	5	1.9	0	0.0	2.7
5104	1	78.00	124.00	opalite	10	28.8	0	0.0	4.1
5105	1	84.00	115.00	opalite	3	1.3	0	0.0	7.5
5106	1	86.00	119.00	opalite	3	9.1	0	0.0	19.2
5107	1	81.00	127.00	opalite	4	1.2	0	0.0	3.9
5108	1	86.00	124.00	opalite	1	6.9	0	0.0	14.4
5109	1	70.00	91.00	opalite	14	114.9	0	0.0	34.1
5111	1	83.00	99.00	opalite	28	65.1	0	0.0	36.7
5113	1	73.00	101.00	opalite	34	326.1	3	126.5	168.8
5114	1	72.00	109.00	opalite	9	35.7	0	0.0	33.7

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5115	1	82.00	107.00	opalite	17	141.0	1	27.6	28.3
5116	1	83.00	109.00	opalite	22	36.8	0	0.0	4.4
5117	1	50.00	98.00	opalite	13	22.7	0	0.0	29.2
5118	1	51.00	98.00	opalite	15	21.7	0	0.0	81.5
5119	1	60.00	95.00	opalite	23	86.7	1	10.9	41.3
5120	1	62.00	99.00	opalite	26	50.8	0	0.0	21.6
5121	1	50.00	103.00	opalite	19	49.0	0	0.0	14.7
5122	1	59.00	105.00	opalite	0	0.0	1	494.6	511.2
5123	1	63.00	104.00	opalite	18	99.3	0	0.0	54.7
5124	1	68.00	106.00	opalite	43	97.6	0	0.0	32.7
5125	1	56.00	117.00	opalite	31	125.7	4	300.5	417.2
5131	1	68.00	124.00	opalite	19	28.3	0	0.0	8.5
5132	1	69.00	125.00	opalite	12	21.2	0	0.0	10.6
5133	1	31.00	95.00	opalite	13	13.1	0	0.0	56.7
5134	1	36.00	91.00	opalite	9	10.3	0	0.0	15.2
5135	1	44.00	92.00	opalite	49	93.7	0	0.0	141.0
5136	1	40.00	99.00	opalite	37	56.3	0	0.0	25.1
5137	1	34.00	100.00	opalite	6	25.5	0	0.0	43.1
5138	1	36.00	108.00	opalite	67	217.8	1	44.3	181.5
5139	1	44.00	105.00	opalite	31	19.7	0	0.0	52.9
5140	1	45.00	105.00	opalite	51	75.5	1	47.2	99.2
5141	1	42.00	50.00	opalite	31	83.2	0	0.0	47.6
5142	1	47.00	53.00	opalite	14	15.0	0	0.0	91.6
5143	1	47.00	64.00	opalite	19	26.0	0	0.0	24.3
5144	1	47.00	68.00	opalite	7	12.2	0	0.0	69.7
5144	2	47.00	68.00	jasper	2	6.2	0	0.0	0.0
5145	1	57.00	55.00	opalite	56	184.3	1	29.4	229.7
5146	1	58.00	55.00	opalite	29	53.5	2	142.6	337.8
5147	1	54.00	60.00	opalite	8	9.3	0	0.0	83.4
5148	1	51.00	68.00	opalite	21	53.9	0	0.0	92.3
5149	1	62.00	52.00	opalite	43	170.6	5	270.3	466.0
5150	1	68.00	51.00	opalite	62	337.4	2	82.5	337.2
5151	1	64.00	63.00	opalite	28	132.8	0	0.0	184.8
5152	1	64.00	65.00	opalite	68	247.6	1	23.9	233.3

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5153	1	73.00	51.00	opalite	84	305.4	0	0.0	75.2
5154	1	78.00	59.00	opalite	107	211.1	0	0.0	358.3
5155	1	78.00	69.00	opalite	129	211.9	0	0.0	116.1
5156	1	79.00	61.00	opalite	99	384.2	1	30.1	131.0
5157	1	79.00	70.00	opalite	181	416.5	0	0.0	223.0
5158	1	75.00	72.00	opalite	57	314.4	4	255.9	395.3
5159	1	78.00	84.00	opalite	70	165.0	0	0.0	194.4
5160	1	74.00	86.00	opalite	43	244.1	3	122.9	330.7
5161	1	61.00	84.00	opalite	43	81.0	0	0.0	194.4
5162	1	62.00	89.00	opalite	24	31.4	0	0.0	45.1
5163	1	68.00	73.00	opalite	154	237.0	0	0.0	120.7
5164	1	67.00	74.00	opalite	80	180.0	0	0.0	166.0
5165	1	44.00	76.00	opalite	16	91.3	0	0.0	27.6
5166	1	43.00	78.00	opalite	31	49.0	1	51.1	137.4
5167	1	43.00	84.00	opalite	39	73.7	0	0.0	182.4
5168	1	44.00	84.00	opalite	45	154.4	0	0.0	190.5
5169	1	56.00	77.00	opalite	20	62.2	0	0.0	63.9
5170	1	51.00	72.00	opalite	11	15.6	0	0.0	14.7
5171	1	55.00	83.00	opalite	16	20.1	0	0.0	70.0
5172	1	57.00	82.00	opalite	15	13.0	0	0.0	154.4
5173	1	23.00	54.00	opalite	20	68.1	0	0.0	144.0
5174	1	21.00	56.00	opalite	5	11.8	0	0.0	137.4
5175	1	35.00	52.00	opalite	10	61.8	1	461.8	575.3
5176	1	38.00	53.00	opalite	26	169.6	3	631.2	665.5
5177	1	39.00	63.00	opalite	48	497.1	0	0.0	102.7
5178	1	36.00	64.00	opalite	28	895.2	0	0.0	466.6
5179	1	25.00	61.00	opalite	11	41.0	0	0.0	115.8
5180	1	22.00	62.00	opalite	12	341.6	0	0.0	148.1
5181	1	29.00	70.00	opalite	44	617.2	0	0.0	462.1
5182	1	23.00	77.00	opalite	8	11.8	0	0.0	23.8
5183	1	37.00	75.00	opalite	17	59.9	0	0.0	108.6
5184	1	35.00	78.00	opalite	35	21.0	0	0.0	49.0
5185	1	38.00	85.00	opalite	21	46.3	0	0.0	60.4
5186	1	31.00	84.00	opalite	29	81.1	0	0.0	52.6

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5187	1	28.00	83.00	opalite	19	65.7	0	0.0	56.2
5188	1	21.00	89.00	opalite	28	65.8	0	0.0	46.1
5189	1	25.00	90.00	opalite	14	34.0	0	0.0	40.4
5190	1	29.00	99.00	opalite	7	8.0	0	0.0	79.4
5191	1	23.00	104.00	opalite	0	0.0	0	0.0	10.9
5192	1	25.00	106.00	opalite	6	6.1	0	0.0	60.7
5193	1	23.00	114.00	opalite	7	6.7	0	0.0	81.5
5194	1	28.00	119.00	opalite	17	61.0	0	0.0	90.0
5195	1	23.00	128.00	opalite	16	67.9	0	0.0	112.5
5196	1	29.00	127.00	opalite	37	96.5	0	0.0	46.4
5197	1	38.00	110.00	opalite	30	172.6	0	0.0	339.3
5198	1	33.00	115.00	opalite	45	167.9	0	0.0	313.6
5199	1	45.00	119.00	opalite	81	222.3	0	0.0	91.9
5200	1	46.00	119.00	opalite	167	384.5	0	0.0	195.1
5201	1	102.00	102.00	opalite	5	8.5	0	0.0	2.5
5202	1	102.00	107.00	opalite	10	20.8	0	0.0	15.8
5203	1	104.00	92.00	opalite	7	26.3	0	0.0	8.3
5204	1	106.00	92.00	opalite	5	36.0	0	0.0	6.5
5205	1	90.00	111.00	opalite	7	3.0	0	0.0	4.5
5206	1	94.00	111.00	opalite	0	0.0	0	0.0	2.4
5207	1	101.00	117.00	opalite	1	0.2	0	0.0	0.0
5208	1	104.00	116.00	opalite	3	0.8	0	0.0	0.0
5209	1	108.00	125.00	opalite	1	5.8	0	0.0	0.0
5210	1	109.00	121.00	opalite	3	8.5	0	0.0	0.0
5211	1	97.00	121.00	opalite	6	2.7	0	0.0	0.0
5212	1	97.00	124.00	opalite	4	2.8	0	0.0	0.0
5216	1	146.00	67.00	opalite	2	1.8	0	0.0	0.0
5217	1	140.00	77.00	opalite	1	0.4	0	0.0	7.9
5218	1	141.00	78.00	opalite	3	4.0	0	0.0	4.8
5219	1	133.00	77.00	opalite	4	8.0	0	0.0	8.4
5220	1	137.00	74.00	opalite	7	11.0	0	0.0	9.0
5222	1	154.00	65.00	opalite	2	3.2	0	0.0	1.1
5223	1	163.00	63.00	opalite	1	1.7	0	0.0	0.0
5227	1	157.00	79.00	opalite	1	1.2	0	0.0	0.0

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5228	1	153.00	77.00	opalite	11	33.6	0	0.0	19.3
5229	1	113.00	82.00	opalite	10	21.7	0	0.0	5.1
5230	1	116.00	80.00	opalite	7	4.1	0	0.0	0.0
5231	1	129.00	85.00	opalite	11	21.4	0	0.0	6.0
5232	1	128.00	89.00	opalite	7	4.4	0	0.0	0.0
5233	1	128.00	94.00	opalite	4	3.1	0	0.0	3.0
5234	1	127.00	96.00	opalite	8	26.9	0	0.0	1.8
5235	1	117.00	98.00	opalite	8	13.1	0	0.0	58.7
5236	1	113.00	97.00	opalite	13	23.8	0	0.0	20.4
5237	1	136.00	81.00	opalite	2	0.8	0	0.0	0.0
5238	1	137.00	88.00	opalite	1	0.6	0	0.0	10.6
5239	1	134.00	93.00	opalite	1	0.7	0	0.0	0.0
5240	1	132.00	98.00	opalite	3	1.8	0	0.0	0.5
5243	1	147.00	81.00	opalite	0	0.0	0	0.0	33.9
5244	1	141.00	85.00	opalite	3	1.0	0	0.0	0.0
5246	1	156.00	86.00	opalite	1	2.4	0	0.0	0.0
5250	1	167.00	91.00	opalite	1	2.6	0	0.0	6.4
5251	1	164.00	88.00	opalite	1	1.2	0	0.0	1.2
5252	1	166.00	86.00	opalite	1	5.5	0	0.0	0.0
5256	1	165.00	119.00	opalite	1	1.1	0	0.0	0.0
5258	1	150.00	118.00	opalite	2	1.6	0	0.0	0.0
5259	1	156.00	106.00	opalite	2	14.2	0	0.0	14.0
5261	1	148.00	104.00	opalite	1	0.4	0	0.0	0.8
5265	1	131.00	111.00	opalite	2	7.5	0	0.0	0.0
5266	1	133.00	119.00	opalite	2	1.7	0	0.0	0.0
5267	1	138.00	102.00	opalite	1	5.2	0	0.0	0.0
5268	1	133.00	100.00	opalite	5	14.9	0	0.0	5.5
5269	1	126.00	108.00	opalite	3	4.0	0	0.0	0.0
5270	1	125.00	106.00	opalite	2	0.8	0	0.0	0.0
5271	1	128.00	114.00	opalite	2	4.3	0	0.0	0.0
5272	1	127.00	116.00	opalite	2	2.5	0	0.0	0.0
5275	1	118.00	104.00	opalite	4	7.0	0	0.0	0.3
5276	1	110.00	104.00	opalite	2	1.2	0	0.0	0.0
5277	1	41.00	9.00	opalite	4	24.4	0	0.0	35.2

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5278	1	45.00	9.00	opalite	4	24.4	0	0.0	34.9
5279	1	50.00	8.00	opalite	6	62.1	0	0.0	0.0
5280	1	58.00	8.00	opalite	17	101.7	0	0.0	38.6
5281	1	60.00	3.00	opalite	4	21.2	0	0.0	11.6
5282	1	69.00	4.00	opalite	13	124.0	0	0.0	41.4
5283	1	112.00	122.00	opalite	3	7.6	0	0.0	0.0
5285	1	124.00	123.00	opalite	1	1.2	0	0.0	0.0
5286	1	123.00	122.00	opalite	1	3.6	0	0.0	0.0
5287	1	137.00	122.00	opalite	1	3.4	0	0.0	1.2
5288	1	139.00	129.00	opalite	1	0.3	0	0.0	6.2
5289	1	141.00	127.00	opalite	5	7.5	0	0.0	1.5
5293	1	166.00	124.00	opalite	1	5.1	0	0.0	0.0
5294	1	163.00	126.00	opalite	0	0.0	0	0.0	1.3
5295	1	165.00	139.00	opalite	0	0.0	0	0.0	4.3
5296	1	160.00	135.00	opalite	3	4.0	0	0.0	0.0
5297	1	156.00	136.00	opalite	0	0.0	0	0.0	2.8
5298	1	150.00	131.00	opalite	1	2.4	0	0.0	0.0
5300	1	153.00	143.00	opalite	1	2.0	0	0.0	0.0
5301	1	41.00	125.00	opalite	74	96.9	0	0.0	136.2
5302	1	45.00	122.00	opalite	92	229.0	0	0.0	92.0
5302	2	45.00	122.00	other	1	1.0	0	0.0	0.0
5303	1	33.00	126.00	opalite	53	126.1	0	0.0	142.0
5304	1	38.00	128.00	opalite	70	120.1	0	0.0	248.2
5305	1	70.00	4.00	opalite	11	23.7	0	0.0	83.9
5306	1	71.00	0.00	opalite	33	109.0	0	0.0	244.6
5307	1	87.00	1.00	opalite	6	3.2	0	0.0	72.7
5308	1	85.00	6.00	opalite	11	23.6	1	36.5	113.0
5309	1	72.00	11.00	opalite	35	104.4	0	0.0	116.2
5310	1	71.00	12.00	opalite	42	98.4	0	0.0	145.1
5311	1	85.00	14.00	opalite	24	576.8	10	1232.9	1583.5
5312	1	87.00	15.00	opalite	26	318.7	0	0.0	664.2
5313	1	91.00	2.00	opalite	6	3.7	0	0.0	318.7
5314	1	99.00	4.00	opalite	5	14.7	0	0.0	57.3
5315	1	101.00	4.00	opalite	4	1.8	0	0.0	18.1

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5316	1	100.00	7.00	opalite	7	20.6	0	0.0	42.7
5317	1	101.00	14.00	opalite	14	48.4	0	0.0	27.7
5318	1	104.00	16.00	opalite	34	155.4	0	0.0	76.1
5319	1	90.00	12.00	opalite	14	27.0	0	0.0	34.9
5320	1	91.00	19.00	opalite	50	91.8	0	0.0	85.2
5321	1	111.00	3.00	opalite	16	17.4	0	0.0	34.8
5322	1	119.00	9.00	opalite	17	36.4	0	0.0	15.3
5323	1	120.00	1.00	opalite	28	85.0	0	0.0	31.0
5324	1	121.00	0.00	opalite	10	7.0	0	0.0	44.4
5325	1	110.00	18.00	opalite	62	172.3	0	0.0	211.3
5326	1	118.00	16.00	opalite	33	60.1	0	0.0	160.9
5327	1	122.00	19.00	opalite	21	24.5	0	0.0	136.1
5328	1	124.00	19.00	opalite	26	43.5	0	0.0	90.3
5329	1	72.00	20.00	opalite	15	23.6	0	0.0	18.0
5330	1	79.00	23.00	opalite	21	60.4	0	0.0	9.0
5331	1	88.00	29.00	opalite	34	203.7	1	17.3	106.8
5332	1	89.00	29.00	opalite	23	95.0	3	233.9	297.3
5333	1	75.00	30.00	opalite	36	55.7	1	49.1	61.5
5334	1	77.00	35.00	opalite	30	153.0	2	44.0	79.8
5335	1	80.00	35.00	opalite	10	11.4	2	42.7	48.2
5336	1	89.00	33.00	opalite	35	154.4	0	0.0	73.7
5337	1	97.00	20.00	opalite	25	64.1	0	0.0	16.6
5338	1	99.00	26.00	opalite	50	167.9	0	0.0	12.1
5339	1	106.00	24.00	opalite	14	153.0	0	0.0	0.0
5340	1	109.00	27.00	opalite	47	97.0	1	73.7	82.2
5341	1	96.00	34.00	opalite	95	195.2	0	0.0	98.4
5342	1	96.00	37.00	opalite	96	453.0	0	0.0	82.5
5343	1	100.00	36.00	opalite	19	315.5	0	0.0	0.0
5344	1	102.00	39.00	opalite	97	381.2	0	0.0	25.0
5345	1	71.00	44.00	opalite	45	78.3	0	0.0	33.1
5346	1	79.00	41.00	opalite	51	245.6	3	46.5	95.0
5347	1	85.00	43.00	opalite	23	58.8	0	0.0	0.0
5348	1	87.00	42.00	opalite	90	188.6	0	0.0	9.7
5349	1	92.00	44.00	opalite	38	82.7	2	251.0	258.0

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5350	1	97.00	48.00	opalite	107	662.4	0	0.0	6.8
5351	1	104.00	41.00	opalite	106	351.2	2	114.6	121.6
5352	1	109.00	48.00	opalite	41	383.0	0	0.0	256.5
5353	1	8.00	30.00	opalite	6	11.8	1	165.5	195.0
5354	1	7.00	37.00	opalite	39	69.1	2	139.8	183.9
5355	1	15.00	33.00	opalite	3	64.3	0	0.0	32.2
5356	1	16.00	36.00	opalite	4	2.2	0	0.0	1.8
5357	1	13.00	48.00	opalite	3	14.6	0	0.0	6.9
5358	1	11.00	48.00	opalite	16	92.5	0	0.0	0.0
5359	1	5.00	41.00	opalite	18	95.5	2	238.7	473.7
5360	1	2.00	47.00	opalite	8	55.0	0	0.0	17.9
5361	1	24.00	38.00	opalite	6	16.8	0	0.0	29.6
5362	1	24.00	39.00	opalite	10	35.5	0	0.0	2.6
5363	1	31.00	32.00	opalite	2	27.6	0	0.0	35.0
5364	1	37.00	32.00	opalite	5	6.1	0	0.0	28.0
5365	1	24.00	46.00	opalite	13	39.8	0	0.0	13.1
5366	1	23.00	48.00	opalite	16	108.4	0	0.0	20.2
5367	1	33.00	43.00	opalite	3	9.5	0	0.0	0.0
5368	1	32.00	46.00	opalite	5	5.4	0	0.0	14.6
5369	1	44.00	31.00	opalite	2	10.0	0	0.0	10.6
5370	1	43.00	39.00	opalite	3	10.8	1	34.5	85.9
5371	1	52.00	36.00	opalite	3	42.6	0	0.0	18.2
5372	1	59.00	33.00	opalite	34	64.2	0	0.0	87.1
5373	1	44.00	41.00	opalite	1	1.2	0	0.0	1.1
5374	1	40.00	49.00	opalite	31	150.9	1	55.1	69.4
5375	1	56.00	46.00	opalite	7	156.0	0	0.0	13.4
5376	1	53.00	42.00	opalite	11	32.1	0	0.0	159.2
5377	1	66.00	35.00	opalite	18	43.7	0	0.0	10.2
5378	1	62.00	38.00	opalite	37	81.1	0	0.0	11.1
5379	1	61.00	47.00	opalite	24	182.9	0	0.0	2.1
5380	1	65.00	49.00	opalite	25	82.8	0	0.0	52.9
5383	1	23.00	21.00	opalite	1	5.7	0	0.0	0.0
5384	1	24.00	25.00	opalite	1	7.0	0	0.0	69.3
5385	1	32.00	11.00	opalite	0	0.0	0	0.0	65.4

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5386	1	30.00	12.00	opalite	1	4.1	0	0.0	0.0
5387	1	38.00	22.00	opalite	3	1.1	0	0.0	22.2
5388	1	37.00	23.00	opalite	1	15.1	0	0.0	0.0
5389	1	48.00	15.00	opalite	9	29.2	0	0.0	38.5
5390	1	46.00	18.00	opalite	6	20.2	0	0.0	19.6
5391	1	42.00	29.00	opalite	5	6.3	0	0.0	25.7
5392	1	42.00	20.00	opalite	4	28.2	0	0.0	0.0
5393	1	58.00	11.00	opalite	6	20.2	0	0.0	7.2
5394	1	55.00	11.00	opalite	7	84.6	0	0.0	10.0
5395	1	68.00	15.00	opalite	5	30.9	0	0.0	0.0
5396	1	69.00	18.00	opalite	2	1.4	0	0.0	12.8
5397	1	51.00	20.00	opalite	8	53.1	0	0.0	30.9
5398	1	52.00	24.00	opalite	13	48.6	0	0.0	35.3
5399	1	66.00	22.00	opalite	12	23.1	0	0.0	42.3
5400	1	67.00	23.00	opalite	0	0.0	0	0.0	18.6
5401	1	147.00	134.00	opalite	0	0.0	0	0.0	0.8
5402	1	140.00	137.00	opalite	1	1.2	0	0.0	0.0
5403	1	135.00	130.00	opalite	3	3.3	0	0.0	0.0
5404	1	133.00	136.00	opalite	0	0.0	0	0.0	29.1
5405	1	144.00	140.00	opalite	0	0.0	0	0.0	9.4
5408	1	132.00	147.00	opalite	2	13.8	0	0.0	0.6
5409	1	126.00	137.00	opalite	0	0.0	0	0.0	14.2
5410	1	126.00	138.00	opalite	2	1.2	0	0.0	1.5
5411	1	117.00	139.00	opalite	10	39.2	0	0.0	10.5
5412	1	113.00	137.00	opalite	2	0.6	0	0.0	2.0
5413	1	129.00	142.00	opalite	1	0.7	0	0.0	0.0
5414	1	123.00	149.00	opalite	0	0.0	0	0.0	12.0
5415	1	111.00	141.00	opalite	2	3.5	0	0.0	0.0
5416	1	111.00	148.00	opalite	2	1.7	0	0.0	0.0
5418	1	101.00	137.00	opalite	4	9.0	0	0.0	0.0
5419	1	99.00	135.00	opalite	13	23.3	0	0.0	0.0
5420	1	92.00	131.00	opalite	3	4.9	0	0.0	0.0
5421	1	108.00	143.00	opalite	1	0.8	0	0.0	0.0
5422	1	109.00	147.00	opalite	0	0.0	0	0.0	1.1

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5423	1	98.00	144.00	opalite	4	10.5	0	0.0	0.0
5424	1	95.00	146.00	opalite	3	2.9	0	0.0	0.0
5425	1	88.00	138.00	opalite	1	0.4	0	0.0	0.0
5426	1	82.00	132.00	opalite	1	29.7	0	0.0	0.0
5427	1	74.00	135.00	opalite	2	1.0	0	0.0	0.0
5428	1	71.00	136.00	opalite	4	4.9	0	0.0	2.4
5429	1	88.00	143.00	opalite	4	7.5	0	0.0	1.0
5430	1	84.00	148.00	opalite	2	0.8	0	0.0	0.6
5431	1	78.00	146.00	opalite	4	4.8	0	0.0	0.0
5432	1	73.00	146.00	opalite	3	6.6	0	0.0	3.1
5433	1	61.00	131.00	opalite	7	4.6	0	0.0	1.4
5434	1	61.00	138.00	opalite	1	2.9	0	0.0	0.0
5435	1	56.00	131.00	opalite	6	21.8	0	0.0	8.9
5436	1	55.00	135.00	opalite	8	13.4	0	0.0	2.6
5437	1	68.00	141.00	opalite	0	0.0	0	0.0	2.8
5438	1	62.00	146.00	opalite	2	2.3	0	0.0	0.0
5439	1	57.00	147.00	opalite	2	2.6	0	0.0	0.7
5440	1	50.00	149.00	opalite	3	5.3	0	0.0	0.0
5443	1	36.00	132.00	opalite	39	86.9	0	0.0	149.9
5444	1	33.00	138.00	opalite	34	69.7	1	51.1	145.3
5445	1	47.00	148.00	opalite	7	16.3	0	0.0	10.6
5447	1	34.00	147.00	opalite	10	25.1	0	0.0	25.8
5449	1	48.00	150.00	opalite	7	7.4	0	0.0	0.0
5450	1	40.00	157.00	opalite	2	3.5	0	0.0	8.0
5453	1	68.00	156.00	opalite	0	0.0	0	0.0	4.8
5456	1	53.00	159.00	opalite	2	26.2	0	0.0	3.9
5457	1	68.00	166.00	opalite	2	16.1	0	0.0	54.5
5458	1	65.00	165.00	opalite	19	24.2	0	0.0	9.9
5459	1	59.00	169.00	opalite	3	8.0	0	0.0	0.0
5460	1	55.00	168.00	opalite	3	4.9	0	0.0	0.0
5461	1	81.00	151.00	opalite	1	3.4	0	0.0	0.0
5462	1	81.00	153.00	opalite	2	2.0	0	0.0	0.0
5463	1	79.00	157.00	opalite	3	5.2	0	0.0	0.0
5464	1	75.00	155.00	opalite	3	9.3	0	0.0	0.0

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5465	1	88.00	168.00	opalite	1	1.7	0	0.0	0.0
5466	1	80.00	166.00	opalite	4	5.0	0	0.0	0.0
5467	1	77.00	169.00	opalite	4	12.7	0	0.0	5.4
5468	1	71.00	162.00	opalite	2	6.0	0	0.0	0.0
5470	1	105.00	156.00	opalite	4	5.5	0	0.0	0.0
5471	1	99.00	155.00	opalite	2	7.6	0	0.0	0.0
5472	1	90.00	153.00	opalite	5	5.9	0	0.0	0.0
5473	1	106.00	165.00	opalite	0	0.0	0	0.0	26.7
5474	1	102.00	160.00	opalite	2	1.7	0	0.0	0.0
5475	1	95.00	160.00	opalite	2	5.3	0	0.0	0.0
5476	1	94.00	160.00	opalite	2	11.7	0	0.0	0.0
5477	1	128.00	153.00	opalite	2	2.6	0	0.0	0.0
5481	1	119.00	166.00	opalite	1	1.3	0	0.0	0.7
5483	1	113.00	175.00	opalite	2	12.8	0	0.0	0.0
5484	1	112.00	173.00	opalite	1	5.3	0	0.0	0.0
5486	1	102.00	179.00	opalite	3	2.4	0	0.0	0.0
5488	1	91.00	172.00	opalite	12	52.7	0	0.0	4.2
5489	1	87.00	178.00	opalite	17	125.9	0	0.0	36.6
5490	1	83.00	171.00	opalite	2	5.0	0	0.0	0.0
5491	1	78.00	171.00	opalite	2	1.3	0	0.0	0.0
5492	1	77.00	175.00	opalite	3	19.1	0	0.0	0.0
5493	1	68.00	178.00	opalite	5	24.2	0	0.0	5.0
5494	1	60.00	172.00	opalite	7	14.8	0	0.0	0.0
5495	1	51.00	170.00	opalite	2	10.8	0	0.0	0.0
5496	1	50.00	171.00	opalite	1	6.4	0	0.0	2.4
5497	1	17.00	98.00	opalite	10	27.1	0	0.0	0.0
5498	1	14.00	98.00	opalite	6	12.0	0	0.0	2.7
5499	1	16.00	79.00	opalite	4	5.8	0	0.0	3.8
5500	1	14.00	76.00	opalite	8	9.7	0	0.0	0.2
5501	1	8.00	70.00	opalite	4	11.8	0	0.0	0.0
5502	1	7.00	76.00	opalite	9	10.9	0	0.0	0.7
5503	1	18.00	86.00	opalite	37	186.3	0	0.0	34.4
5504	1	14.00	84.00	opalite	15	13.7	0	0.0	1.2
5505	1	2.00	80.00	opalite	3	9.0	0	0.0	0.0

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5506	1	3.00	87.00	opalite	7	23.0	0	0.0	10.1
5507	1	19.00	53.00	opalite	1	0.3	0	0.0	3.1
5508	1	18.00	56.00	opalite	6	33.6	0	0.0	5.5
5509	1	9.00	53.00	opalite	38	70.6	0	0.0	65.8
5510	1	1.00	58.00	opalite	7	6.0	0	0.0	0.7
5511	1	12.00	61.00	opalite	15	23.8	0	0.0	6.4
5512	1	10.00	60.00	opalite	8	54.4	0	0.0	0.0
5513	1	3.00	65.00	opalite	4	8.0	0	0.0	0.3
5514	1	2.00	64.00	opalite	11	7.1	0	0.0	2.2
5516	1	167.00	146.00	opalite	1	0.6	0	0.0	0.0
5518	1	167.00	151.00	opalite	7	23.4	0	0.0	0.0
5519	1	157.00	155.00	opalite	2	14.5	0	0.0	0.0
5520	1	154.00	158.00	opalite	9	29.3	0	0.0	2.3
5521	1	149.00	150.00	opalite	2	9.1	0	0.0	0.0
5522	1	144.00	157.00	opalite	3	1.2	0	0.0	0.0
5523	1	139.00	154.00	opalite	2	9.2	0	0.0	0.0
5524	1	134.00	158.00	opalite	2	3.2	0	0.0	0.0
5525	1	131.00	163.00	opalite	2	2.2	0	0.0	0.0
5526	1	137.00	164.00	opalite	3	0.7	0	0.0	0.0
5528	1	125.00	167.00	opalite	2	1.9	0	0.0	0.0
5529	1	123.00	175.00	opalite	3	6.5	0	0.0	0.0
5530	1	127.00	178.00	opalite	2	2.2	0	0.0	0.0
5531	1	48.00	163.00	opalite	2	22.8	0	0.0	0.0
5532	1	45.00	169.00	opalite	4	14.8	0	0.0	0.0
5533	1	41.00	177.00	opalite	7	11.0	0	0.0	0.0
5534	1	49.00	178.00	opalite	3	2.4	0	0.0	0.0
5535	1	38.00	164.00	opalite	6	12.1	0	0.0	0.0
5536	1	34.00	168.00	opalite	4	16.0	0	0.0	0.0
5537	1	25.00	137.00	opalite	47	107.8	0	0.0	18.7
5538	1	22.00	139.00	opalite	26	63.9	0	0.0	8.3
5539	1	20.00	142.00	opalite	6	6.3	0	0.0	0.0
5540	1	24.00	149.00	opalite	42	64.5	0	0.0	42.6
5545	1	13.00	135.00	opalite	13	20.3	0	0.0	22.5
5546	1	18.00	135.00	opalite	11	10.3	0	0.0	1.9

Table A.2 Debitage data: 25cm by 25 cm systematic random surface scrapes.

Reference #	Specimen #	N	E	Raw material	Flakes and flake fragments n	Flakes and flake fragments wt.(g)	G0 Angular debris n	G0 Angular debris wt.(g)	>G0 Angular debris wt.(g)
5547	1	10.00	121.00	opalite	23	38.6	0	0.0	17.0
5548	1	18.00	121.00	opalite	19	24.5	0	0.0	27.8
5549	1	11.00	110.00	opalite	21	22.6	0	0.0	10.7
5550	1	11.00	110.00	opalite	10	5.3	0	0.0	14.6
5551	1	15.00	107.00	opalite	5	1.7	0	0.0	0.0
5552	1	17.00	100.00	opalite	5	22.3	0	0.0	0.0
5553	1	4.00	96.00	opalite	15	25.7	0	0.0	0.0
5554	1	3.00	92.00	opalite	4	0.9	0	0.0	0.3
5557	1	16.00	10.00	opalite	2	1.3	0	0.0	0.0
5562	1	37.00	7.00	opalite	2	0.9	0	0.0	0.0

Appendix B

List of Illustrated Artifacts

	Figure No.	Reference No.	Specimen No.
Chapter 4	4.1	9141	001
	4.2	6961	001
	4.3 a.	6221	001
	b.	6081	001
	4.4 a.	6221	001
	b.	6221	001
	4.5 a.	6201	001
	b.	6221	001
	c.	9141	001
Chapter 5	5.1 a.	2599	011
	b.	01	099
	5.2 a.	3029	012
	b.	3027	004
	c.	01	081
	5.3 a.	01	062
	b.	01	083
	c.	01	090
	d.	01	082
	e.	01	097 (2 pieces refit)
	5.5 a.	3059	001
	b.	2599	009
	c.	2599	014
	d.	2599	050
	5.6 a.	3097	002
	b.	3012	005
	c.	3032	004
	d.	3029	003
	5.7 a.	3048	001
	b.	2599	080
	c.	6001	002
	5.8 a.	01	011
	b.	3081	003
	c.	8342	001
	d.	3050	005
	5.9 a.	01	110
	b.	01	111
	c.	8301	005
	d.	4007	002
	e.	8392	008

	Figure No.	Reference No.	Specimen No.
	5.10 a.	4083	002
	b.	2599	018
	c.	3065	001
	d.	7721	002
	5.11 a.	3063	001
	b.	5548	002
	c.	01	084
	d.	8041	004
	e.	01	112
	5.12 a.	2599	313
	b.	4463	005
	5.13 a.	01	044
	b.	4022	002
Chapter 6	6.1 a.	01	015
	b.	2599	225
	c.	2599	170
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	6.4 a.	2599	101
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	c.	2599	361

Appendix C

Technical Analyses

BETA ANALYTIC INC.

MURRY A. TAMERS, PH.D.
JERRY J. STIPP, PH.D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A.

RECEIVED
MAR 19 1991

March 14, 1991

Mr. Dave N. Schmitt
Intermountain Research
Drawer A
Silver City, Nevada 89428

Dear Mr. Schmitt:

Please find enclosed the results on the nine charcoal samples recently submitted for radiocarbon dating analyses. We hope these dates will be useful in your research.

Your charcoals were pretreated by first examining for rootlets. The samples were then given a hot acid wash to eliminate carbonates. They were repeatedly rinsed to neutrality and subsequently given a hot alkali soaking to take out humic acids. After rinsing to neutrality, another acid wash followed and another rinsing to neutrality. The following benzene syntheses and counting proceeded normally. All of the portions sent for each sample were used for these analyses.

Seven of the samples were small, as indicated on the date report sheet. They were given extended counting time (four times the normal amount) to reduce the statistical errors as much as practical. I should mention that the supplementary fee for the small sample service always includes giving special priority status for the chemical treatments so that we can still meet the promised delivery time.

We are enclosing our invoice. If there are any questions or if you would like to confer on the dates, my direct telephone number is listed below. Please don't hesitate to call us if we can be of help.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / BITNET: XNRBET22@SERVAX

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dave N. Schmitt
Intermountain Research

DATE RECEIVED: February 19, 1991
DATE REPORTED: March 14, 1991

SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	
Beta-43152	2599-159-6 (0.82 gram carbon)	3890 +/- 70 BP	(charcoal) Trench 3,
Beta-43153	2599-103-12	270 +/- 80 BP	(charcoal) Trench 2,
Beta-43154	2599-104-13 (0.84 gram carbon)	490 +/- 70 BP	(charcoal) Trench 2,
Beta-43155	2599-106-14 (0.65 gram carbon)	560 +/- 60 BP	(charcoal) T2
Beta-43156	2599-111-18	220 +/- 70 BP	(charcoal) bottom T 2
Beta-43157	2599-209-26 (0.52 gram carbon)	810 +/- 80 BP	(charcoal) bottom T 4
Beta-43158	2599-178-49 (0.32 gram carbon)	920 +/- 110 BP	(charcoal) T8, E wall
Beta-43159	2599-220-53 (0.58 gram carbon)	4090 +/- 100 BP	(charcoal) T5 E end floor
Beta-43160	2599-223-56 (0.28 gram carbon)	1420 +/- 130 BP	(charcoal) T10 E wa

Note: the seven small samples were given extended counting time.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

MURRY A. TAMERS, PH.D.
JERRY J. STIPP, PH.D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A.

February 8, 1991

Mr. Dave N. Schmitt
Intermountain Research
Drawer A
Silver City, Nevada 89428

Dear Mr. Schmitt:

Please find enclosed the results on the twenty-four charcoal samples recently submitted for radiocarbon dating analyses. We hope these dates will be useful in your studies.

Your charcoals were pretreated the same as the other materials of this sort submitted previously. They were first examined for rootlets. The samples were then given our acid, alkali, acid soakings to get out carbonates and humic acids. The following benzene syntheses and counting proceeded normally. Beta-42495 was small and this caused the larger than usual statistical error.

We are enclosing our invoice. If there are any questions or if you would like to confer on the dates, please call us.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

P.S. I'm including some sample data sheets for future samples and a copy of our new brochure for your files.

TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / BITNET: XNRBET22@SERVAX

BETA ANALYTIC INC.
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P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dave N. Schmitt
Intermountain Research

DATE RECEIVED: January 18, 1991
DATE REPORTED: February 8, 1991
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	
Beta-42474	2599-160-7	3810 +/- 60 BP	(charcoal)
Beta-42475	2599-161-8	3830 +/- 80 BP	(charcoal)
Beta-42476	2599-162-9	3670 +/- 90 BP	(charcoal)
Beta-42477	2599-107-15	310 +/- 70 BP	(charcoal)
Beta-42478	2599-109-16	370 +/- 50 BP	(charcoal)
Beta-42479	2599-110-17	170 +/- 60 BP	(charcoal)
Beta-42480	2599-112-19	390 +/- 60 BP	(charcoal)
Beta-42481	2599-113-20	230 +/- 70 BP	(charcoal)
Beta-42482	2599-201-21	720 +/- 60 BP	(charcoal)
Beta-42483	2599-205-22	550 +/- 80 BP	(charcoal)
Beta-42484	2599-207-24	620 +/- 90 BP	(charcoal)
Beta-42485	2599-211-28	190 +/- 50 BP	(charcoal)
Beta-42486	2599-213-30	690 +/- 90 BP	(charcoal)
Beta-42487	8001-1-31	330 +/- 50 BP	(charcoal)

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.
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UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: _____

_____

_____

_____

DATE RECEIVED: _____

DATE REPORTED: _____

SUBMITTER'S
PURCHASE ORDER # _____

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	
Beta-42488	8041-1-33	410 +/- 60 BP	(charcoal)
Beta-42489	8081-1-35	280 +/- 50 BP	(charcoal)
Beta-42490	8161-1-40	310 +/- 60 BP	(charcoal)
Beta-42491	8201-1-42	150 +/- 70 BP	(charcoal)
Beta-42492	2599-165-44	570 +/- 60 BP	(charcoal)
Beta-42493	2599-176-47	500 +/- 50 BP	(charcoal)
Beta-42494	2599-179-50	510 +/- 60 BP	(charcoal)
Beta-42495	2599-224-57	1090 +/- 130 BP	(charcoal)
Beta-42496	2599-114-61	50 +/- 50 BP	(charcoal)
Beta-42497	2599-180-62	520 +/- 70 BP	(charcoal)

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

JERRY J. STIPP, PH. D.
MURRY A. TAMERS, PH. D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A.

Mr. Steven G. Botkin
Intermountain Research
Drawer A
Silver City, NV 89428

September 17, 1990

Dear Mr. Botkin:

Please find enclosed our result on the charcoal sample (3032-36-2599-168) that you recently sent for TIME-GUIDE radiocarbon dating analysis. The date was phoned to you at 10AM this morning. The unused material of pouch 'B' is also returned herein as requested.

The sample contained a minor amount of rootlet contamination. After washing free and discarding all adhering mineral matter the charcoal was lightly crushed for surface area and all remaining rootlets were removed by hand-picking. The charcoal was then treated with soakings in hot acid and alkali solutions to remove any carbonate or humic acid contaminants. After final rinsing to neutrality the clean charcoal was gently dried, synthesized and counted for radiocarbon content. The sample was of very good quality and quantity, and all analytical steps proceeded normally.

We have enclosed our invoice. Would you please forward this to the appropriate office for payment. As always, please call us at any time you have questions or would like to discuss the date.

Sincerely,

Jerry J. Stipp

PS: also subtly enclosed is a genuine Beta field cap for your complete protection...and general good luck.

TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / BITNET: XNRBET22@SERVAX

BETA ANALYTIC INC.
(305) 667-5167
UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Steven G. Botkin
Intermountain Research
Silver City, NV

DATE RECEIVED: September 15, 1990 (10AM)
DATE REPORTED: September 17, 1990 (10AM)
SUBMITTER'S PURCHASE ORDER #

TIME-GUIDE Basis

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ			
Beta-39485	3032-36-2599-168	3,890	+/-	60	Charcoal

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

July 22, 1991

Ms. Kathryn Ataman
Intermountain Research
Drawer 'A'
Silver City, NV 89428

Dear Ms. Ataman:

Enclosed below is a table presenting x-ray fluorescence data generated from the analysis of six artifacts from site 26Ek3032 in the Tosawihi quarries area, Elko County, Nevada. The analyses were conducted pursuant to your letter request of July 18, 1991.

X-ray fluorescence analysis conditions and artifact-to-source assignment procedures for these six samples were identical to those I reported to Dr. Elston in my letter of February 14, 1991.

Trace Element Concentrations

Cat. Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Obsidian Source (Chemical Type)
Loc. 36, 3063-1	80 ±7	18 ±4	375 ±5	2 ±3	82 ±3	74 ±5	17 ±3	0 ±24	Paradise Valley
Loc. 36, 8041-4	74 ±6	24 ±3	368 ±5	2 ±3	80 ±2	74 ±5	13 ±3	0 ±13	Paradise Valley
Loc. 36, 01-112	70 ±6	19 ±3	212 ±5	41 ±3	66 ±2	401 ±5	45 ±3	1117 ±14	Browns Bench
Loc. 23, 3001-1	54 ±6	20 ±3	249 ±5	26 ±3	68 ±2	367 ±5	46 ±3	625 ±13	Browns Bench
Loc. 138, 53-1	78 ±6	15 ±4	179 ±5	64 ±3	71 ±2	556 ±6	53 ±3	1228 ±14	Browns Bench
Loc. 141, 01-1	68 ±5	20 ±3	361 ±5	0 ±3	74 ±2	74 ±5	11 ±3	0 ±13	Paradise Valley

All trace element values in parts per million (ppm); ± = pooled expression (in ppm) of x-ray counting uncertainty and regression fitting error at 200 and 300* seconds livetime.

Trace element data in the table document that three of these samples match the geochemical signature of parent obsidians of the Paradise Valley geochemical type, and three correspond with the trace element profiles of Browns Bench volcanic glass. In my letter of February 14, I remarked that Browns Bench obsidian is somewhat variable in trace element composition because it was formed in a large ash-flow tuff sheet. Such sheets can produce artifact-quality glasses that vary in geochemical composition both horizontally and vertically.

I hope these data will be of assistance in your analysis of the Tosawihi materials. Please contact me at my laboratory (Phone: [916] 364-1074) if I can provide further assistance.

Sincerely,

Richard Hughes

Richard E. Hughes, Ph.D.

SONOMA STATE UNIVERSITY
ACADEMIC FOUNDATION, INC.

ANTHROPOLOGICAL STUDIES CENTER
CULTURAL RESOURCES FACILITY
707 664-2381

Dr. Kathryn Ataman
Intermountain Rseearch
Drawer A
Silver City, Nevada 89428

August 16, 1991

Dear Dr. Ataman:

This letter reports our analysis of hydration bands on six obsidian items from site 26EK3032. This work was completed as requested in your letter dated July 24, 1991.

The analysis was completed at the Sonoma State University Obsidian Hydration Laboratory, an adjunct of the Anthropological Studies Center, Department of Anthropology. Procedures used by our hydration lab for thin section preparation and hydration band measurement are described below.

Each specimen was examined in order to find two or more surfaces that would yield edges which would be perpendicular to the microslide when preparation of the thin section was completed. Two small parallel cuts were made at an appropriate location along the edge of each specimen with a 4 inch diameter circular saw blade mounted on a lapidary trimsaw. The cuts resulted in the isolation of a small sample with a thicknesses of approximately one millimeter. Each sample was removed from its specimen and mounted with Lakeside Cement onto permanently etched petrographic microslide.

The thickness of the samples was reduced by manual grinding with a slurry of #500 silicon carbide abrasive on a glass plate. The grinding was completed in two steps. The first grinding was terminated when the sample's thickness was reduced by approximate 1/2, thus eliminating any micro-chips created by the saw blade during the cutting process. The slides were then reheated, which liquified the Lakeside Cement, and the samples inverted. The newly exposed surfaces were then ground until the proper thickness was attained.

The correct thin section thickness was determined by the "touch" technique. A finger was rubbed across the slide, onto the sample, and the difference (sample thickness) was "felt." The second technique employed for arriving at proper thin section thickness is termed the "transparency" test. The microslide was held up to a strong source of light and the translucency of the thin section observed. The sample was sufficiently reduced in thickness when the thin section readily allowed the passage of light.

A protective coverslip was affixed over the thin sections when all grinding was completed. The completed microslides are curated at our hydration lab under File No. 91-H1044.

1801 East Cotati Avenue Rohnert Park, California 94928

The hydration bands were measured with a strainfree 40 power objective and a Bausch and Lomb 12.5 power filar micrometer eyepiece on a Nikon petrographic microscope. Six measurements were taken at several locations along the edge of the thin section. The mean of the measurements was calculated and listed on the enclosed table with other information. These hydration measurements have a range of +/- 0.2 due to normal limitations of the equipment.

One specimen (23-3001-35), as marked on the table by the abbreviation "DH" under the "Mean" column, has diffuse hydration which is not measureable.

If you have questions or comments about this hydration work, please don't hesitate to contact us.

Cordially,

Thomas M. Origer

Thomas M. Origer, Director
Obsidian Hydration Laboratory

NV-26EK3032 Submitted by: Kathryn Ataman - Intermountain Research August 1991

Lab#	Catalog#	Description	Provenience	Remarks	Measurements (microns)	Mean	Source
01	23-3001-35	Biface fragment	surface	none		DH	BB (x)
02	36-3063-1	Rosegate point	surface	none	1.4 1.4 1.4 1.6 1.6 1.7	1.5	PV (x)
03	36-8041-4	Gatecliff series	surface	none	2.5 2.5 2.5 2.5 2.6 2.6	2.5	PV (x)
04	36-01-112	Biface fragment	surface	none	10.1 10.3 10.3 10.3 10.4 10.4	10.3	BB (x)
05	138-53-1	Point stem	surface	none	11.0 11.1 11.1 11.2 11.3 11.3	11.2	BB (x)
06	141-01-1	Preform?	surface	none	4.1 4.2 4.2 4.3 4.3 4.3	4.2	PV (x)

Lab Accession No.: 91-H1044 Technician: Thomas M. Origer

Archaeological Investigations At Tosawihi, A Great Basin Quarry

Part 7: 26EK5040,
A Middle Archaic Reduction Station and Campsite

Kathryn Ataman, Margaret Bullock, Daniel P. Dugas, and Robert G. Elston

prepared for
BLM Elko Resource Area
on behalf of
Newmont Exploration, Ltd.
P.O. Box 669
Carlin, Nevada 89822-0669

BLM CR Use Permit No. N-58661

prepared by
Intermountain Research
P.O. Drawer A
Silver City, Nevada 89428

March 1995
Revised September 1995

ABSTRACT

Archaeological excavations at 26Ek5040, in north central Nevada, revealed a workshop/campsite where prehistoric inhabitants concentrated on the manufacture of bifaces made of high quality opalite toolstone abundant in the nearby Tosawihi Quarries. 26Ek5040 lies within the "Tosawihi Production Sphere" (Leach and Botkin 1992), a more than 125 square kilometer area around the quarries within which most prehistoric activity focused on tool manufacture. The site is notable principally for its chronological context. In contrast to the bulk of occupation of the Tosawihi Quarries, where most sites contain mixed Middle and Late Archaic deposits, and where use intensified in the Late Archaic, 26Ek5040 dates primarily to the Middle Archaic. Excavations at 26Ek5040 suggest that biface technology became more standardized from the Middle to the Late Archaic. In earlier times, visits to the area may have been of longer duration or composed of larger groups than in the Late Archaic. In contrast with the Late Archaic pattern, finished bifaces were exported in addition to partially finished tools. Analyses of obsidian from 26Ek5040 suggest the possibility of a territorial boundary along the Humboldt River south of Tosawihi which may have controlled access to the quarries over a long period of time.

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Acknowledgements

Seventh in a series reporting archaeological research at the Tosawihi Quarries, the work described herein was performed under contract to Newmont Exploration, Ltd.; Rick Lisle served as our liaison with Newmont; we thank him for his assistance. Kathryn Ataman served as Principal Investigator, designing and supervising the research. Margaret Bullock served as crew chief. Geomorphological investigations were conducted by Dan Dugas and site mapping by Bryan Cooperrider. The field crew consisted of Janette Benjamin, Bryan Cooperrider, Jim Carter, Tim Hunt, Susan McCabe, and Molly O'Halloran.

Robert G. Elston provided editorial support. Graphics and maps were prepared by Molly O'Halloran. Artifact photographics were crafted by Janette Benjamin. Report production was accomplished by Kathy Nickerson.

INTRODUCTION

A decade of minerals exploration and development on BLM-administered lands within the Ivanhoe Mining District of Elko County, Nevada (Figure 1), has produced a considerable body of research concerning the cultural resources of this region. The prehistory of the area is tied closely to the exploitation and manipulation of opalite toolstone from the Tosawihi Quarries (Figure 2), which are notable among Great Basin archaeological sites in general, and among quarry sites in particular, for their sheer extent and abundance of archaeological material. While artifacts that point to residential occupation are relatively rare at quarry localities, evidence of non-quarrying land use is apparent at Tosawihi. Evidence of Pre-Archaic hunting in the heart of the Quarries and multi-component campsites on their periphery attest to at least periodic non-quarrying use of the area. Rockshelters and other localities within the Quarries are potential informants of problem domains other than those associated with prehistoric lithic procurement.

The present report is the seventh volume in a series reporting archaeological investigations in the vicinity of Tosawihi Quarries. All have been undertaken in association with The Ivanhoe Project, first proposed by Ivanhoe Gold Company and now continued by Newmont Gold Corporation.

History of Investigations

Development of the pit, processing plant, and ancillary facilities of the Ivanhoe/Hollister Mine encompassed areas to the west and east of the 800+ acre Tosawihi Quarries 26Ek3032, i.e., the Western and Eastern Peripheries (Figure 3). The Silver Cloud Road, which links the mine and ancillary facilities to roads along Antelope Creek leading to Battle Mountain, was upgraded to handle traffic associated with mine development and, in 1991, a previously unsurveyed segment of Silver Cloud Road, traversing BLM-administered land (Elko District), sustained unauthorized heavy equipment blading. At the request of Ivanhoe Gold Company, Intermountain Research inventoried the segment of road where blading had occurred in order to assess effects to significant cultural resources (IMR Project 637-004; BLM CrNV-1-1449).

Fifteen previously unrecorded sites were discovered by the inventory. Of these, fourteen were considered ineligible for nomination to the National Register of Historic Places. However, one (26Ek5040) demonstrated potential for intact subsurface cultural deposits and potential to contribute to an understanding of the Tosawihi Quarries vicinity. Site testing was recommended.

Under the stipulations of an agreement between the BLM Elko District Office and Ivanhoe Mining Company, Intermountain Research conducted an archaeological evaluation of 26Ek5040 in April 1992 (IMR Project 638-5040). Based on results of this evaluation (Ataman et al. 1992), BLM determined the site eligible for National Register consideration and the Nevada State Historic Preservation Officer concurred. The same agreement committed Ivanhoe Gold Company to mitigate the effects of blading on the site, an obligation subsequently assumed by Newmont.

The following report documents the excavation and analysis of 26Ek5040. The report describes the environmental setting of the site and surrounding area, reviews regional ethnographic information, summarizes previous archaeological investigations conducted in the immediate area, describes results of the data recovery, and reviews the findings in a regional context. Much of the background material presented herein is derived from *An Archaeological Evaluation of Site 26Ek5040* (Ataman et al. 1992) and the data recovery plan (Intermountain Research 1994) developed to guide the work.

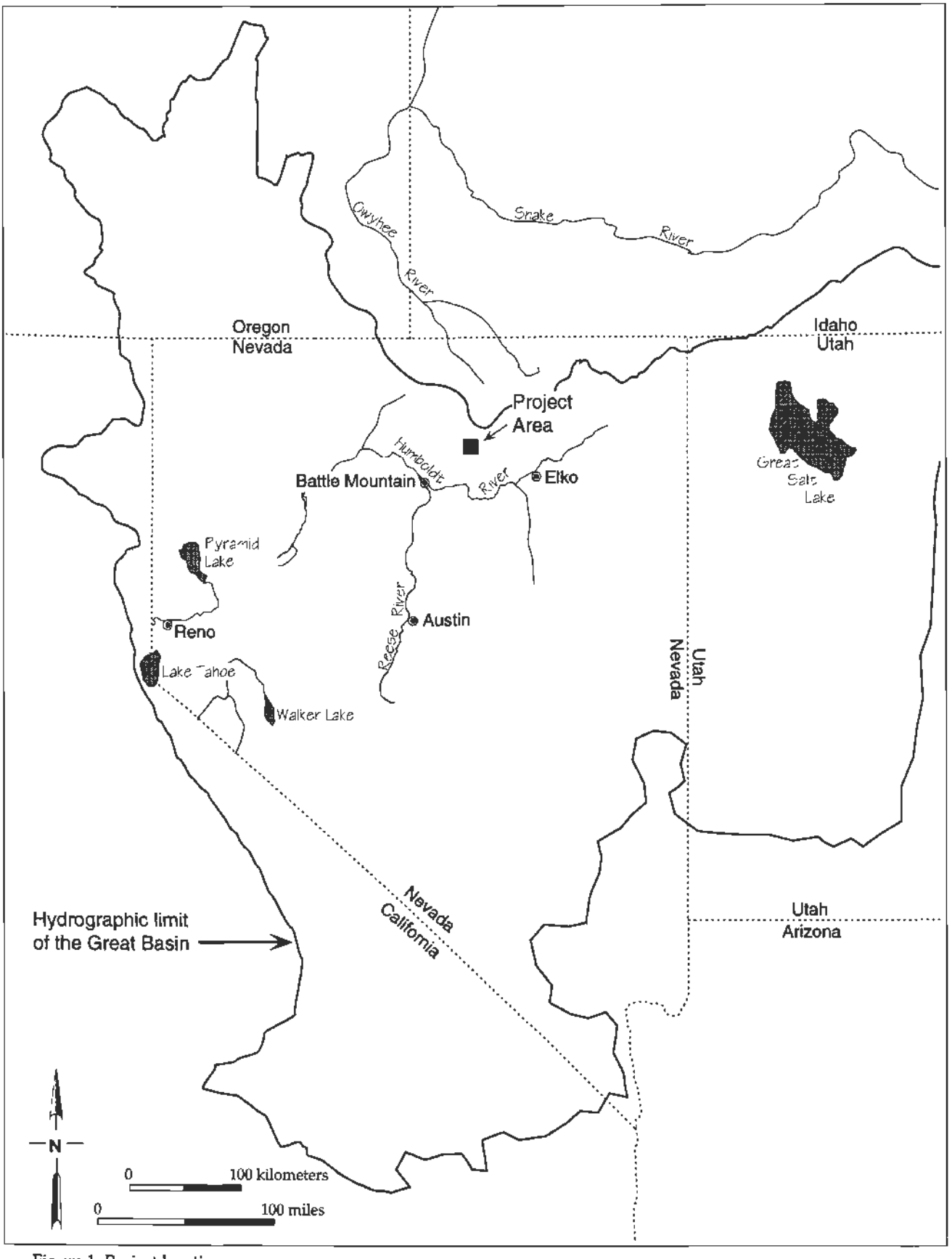


Figure 1. Project location map.

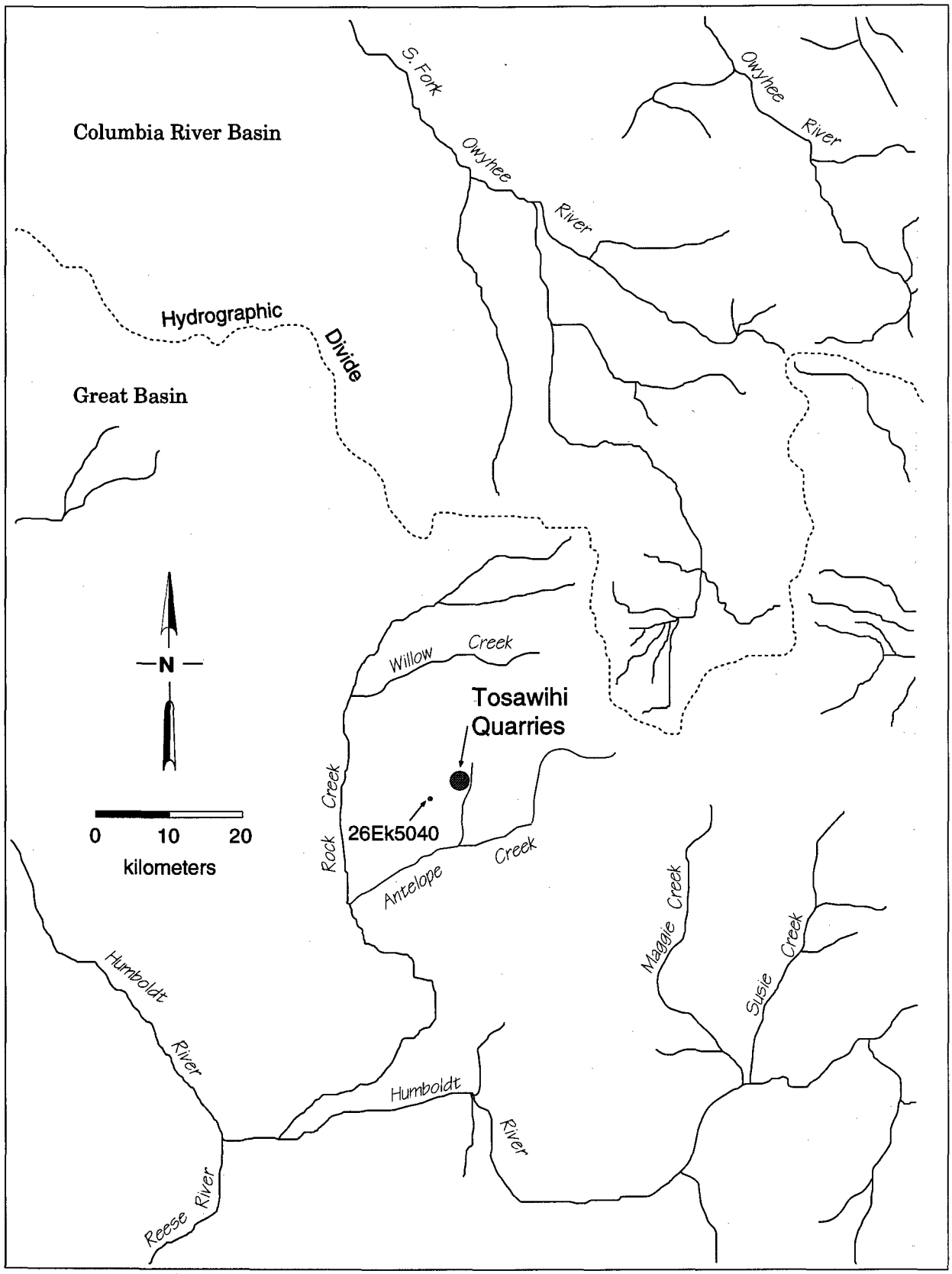


Figure 2. Tosawihi Quarries (26Ek3032) and 26Ek5040 in their regional setting.

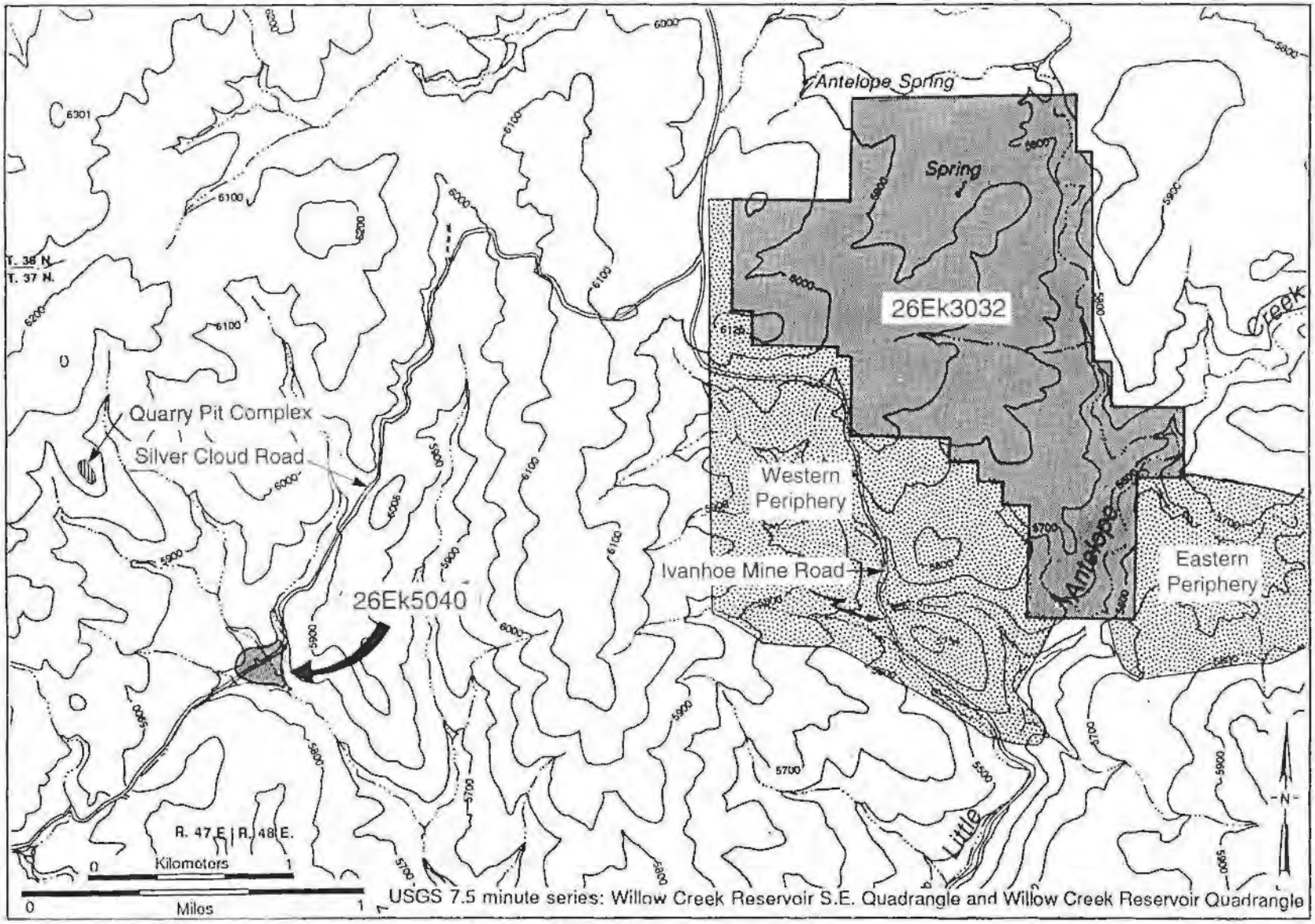


Figure 3. Site 26Ek5040 in relation to the Tosawihi Quarries (26Ek3032).

Chapter 1

RESEARCH OBJECTIVES AND CONTEXTS

Kathryn Ataman, Editor

26Ek5040 lies in the northern extreme of the Sheep Creek Range, a mid-elevation upland (4500-7500 ft amsl) that rises from the floodplain of the Humboldt River and abuts the higher north-south sweep of the Tuscarora Mountains. Environmental attributes of the region, including its geology, topography, hydrology, flora, and fauna, have been summarized variously by Raven (1987, 1992), Budy, Elston, and Raven (1989), and Leach and Botkin (1992); they are not reiterated here save as they pertain to the immediate setting of 26Ek5040.

The following descriptions of physical and cultural settings are taken directly from Raven (1992), with minor modification.

Physical Setting

The site covers an area of just under 33,000 m^2 occupying a group of alluvial terraces cut by three small confluent ephemeral stream channels in uneven terrain at 5500 to 6300 ft amsl (Figures 4, 5). Basalts and rhyolites dominate local bedrock, although zones of silicification have been noted nearby (Leach and Botkin 1992). Three channels drain small canyons immediately upslope (west and north); their confluences fall within and adjacent the site vicinity, from which runoff follows a single channel down to Antelope Creek some 7.5 km southeast. Although the confluence of drainages may have rendered the locus of 26Ek5040 somewhat more attractive than most of the otherwise poorly watered vicinity, the site lies at the base of a watershed no larger than 3.5 km^2. Runoff is rapid, and significant flows in any channel probably occur only during snow melt or coincident with substantial thunder showers. Two km southeast of the site a mapped spring feeds into the principal runoff channel, and approximately 1 km southeast in the same channel an unmapped spring/seep was active into mid-June after the very dry winter of 1993/1994. No other water sources are mapped in the surrounding 50 km^2, although a low area in the site itself and another drainage to the west of the site, dammed for livestock, contain water into the summer months.

Vegetation in the site vicinity is characteristic of the northern reach of the Sheep Creek Range; trees are absent, and the shrub community is an intricate mosaic of tall sage (*Artemisia tridentata*) and low sage (*A. arbuscula*). The on-site stand of tall sage is particularly dense and robust (crown cover was estimated at 60%), a reflection of the well-drained, relatively deep loams at the base of the canyons. Fingers and patches of low sage are interspersed among the tall sage on surrounding slopes. Native perennial bunchgrasses include Great Basin wildrye (*Elymus cinereus*), bluebunch wheatgrass (*Agropyron spicatum*), squirreltail (*Sitanion hystrix*), and Idaho fescue (*Festuca idahoensis*). Their current sparseness is the product of modern livestock grazing; we expect them to have been considerably more abundant in prehistoric times. In the spring of 1994, after a season of restricted access to cattle, wild rye was abundant in the area around the site. Phlox (*Leptodactylon* sp.), buckwheat (*Eriogonum* spp.), and lupine (*Lupinus* sp.) occur sporadically in favorable microhabitats. The thin rocky soils of the adjacent ridges appear to be good habitat for bitterroot (*Lewisia rediviva*), an ethnographically attested food species, although none was observed in the field.

Wildlife noted during fieldwork included burrowing rodents, cottontail rabbits (*Sylvilagus nuttallii*), coyotes (*Canis latrans*), hawks, songbirds, lizards, and ticks (*Dermacentor* sp?). Relict

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

Note:

One or more pages have been removed from this part of the report due to sensitivity of specific archaeological site location information. Qualified persons may contact the Nevada Bureau of Land Management, Elko Field Office, to inquire about obtaining additional information.

burrows attest the recent presence of badgers (*Taxidea taxus*) and a family of four was observed along the Silver Cloud Road 1-2 km northeast of the site. Mule deer (*Odocoileus hemionus*) were not observed in the site vicinity in either the 1992 or 1994 spring excavations seasons, but archaeological field crews have observed them frequently over the past five years on the higher slopes and ridges 1-2 km to the east. Antelope (*Antilocapra americana*), frequent visitors to the broad, open valleys and tablelands lying a few km northeast, were occasionally observed visiting a cattle pond along the Silver Cloud Road 3-4 km southwest of the site.



Figure 5. Overview of 26Ek5040, looking southwest.

Cultural Setting

A century and a half ago, virtually the entire Great Basin was inhabited by peoples speaking various languages of the Numic branch of the Uto-Aztecan linguistic family (Miller 1966). Among the largest of the Numic subgroups, the Western Shoshone occupied an enormous territory covering about half the present-day state of Nevada as well as smaller portions of Utah, California, and Idaho (Figure 6). Ethnographic accounts of Western Shoshone lifeways were compiled and synthesized during the present century, chiefly by J.H. Steward (1937, 1938, 1939, 1941, 1970); useful summaries of the work of Steward and other ethnographers have been compiled by Janetski (1981) and Thomas, Pendleton, and Cappannari (1986).

26Ek5040 lies in the northwestern extreme of Western Shoshone territory (cf. Figure 3), in a region ascribed by Steward (cf. esp. 1938) to the *Tosawihi* ('White Knives') Shoshone of the upper Humboldt River drainage. Harris (1940) reconstructed many details of aboriginal Tosawihi life in his study of subsequent acculturation of that group, and Raven (1992) recently summarized data gleaned from early travellers' reports and more formal ethnographic observations. The following sketch deals only with those aspects likely to be significant for understanding the archaeological record of 26Ek5040.

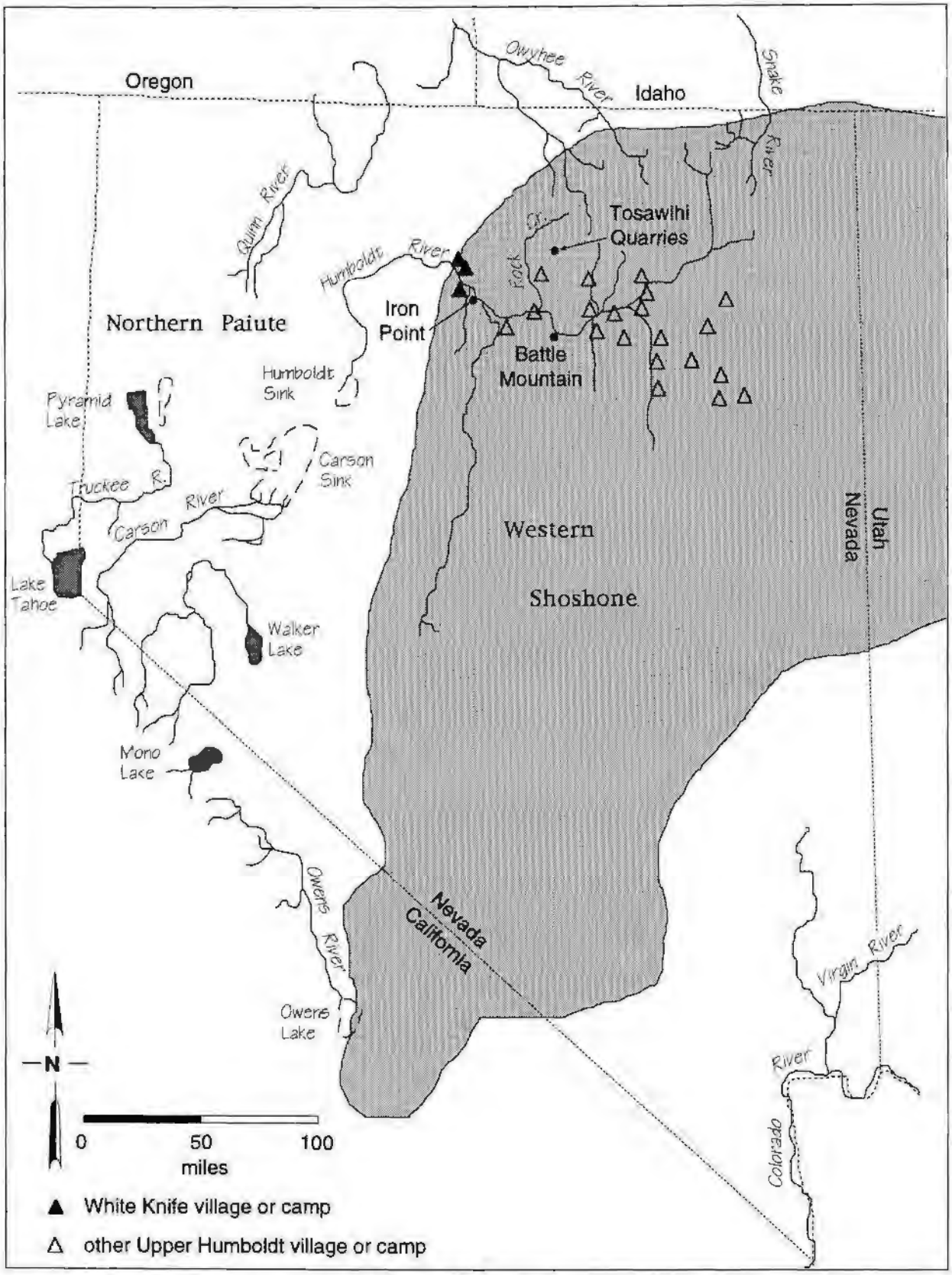


Figure 6. Western Shoshone Territory (after Steward 1937, 1938).

The Tosawihi wintered along the Humboldt River, by most accounts in small, multi-family camps in the vicinity of Battle Mountain. Most of the dry season was given over to dispersed foraging in higher country and considerable mobility over an extensive range—south toward Austin for pinyon nuts, north to the Snake River Plain for salmon, to Iron Point and back to Battle Mountain for festivals. The hills above Rock Creek were reported by Steward (1938:162) to be an especially favored foraging zone. Its attractions probably were enhanced by its proximity to vast fields of opalite toolstone, the exploitation of which the local group owed its name. 26Ek5040 lies within this favored area.

The Tosawihi shared a boundary with the Northern Paiute (Steward 1937, 1938), with whom by most accounts they interacted amiably. It is unlikely that a strict territorial boundary was observed or defended. Given the mobility of most northern Great Basin foraging peoples, in fact, it is probable that Northern Paiutes sometimes visited Rock Creek, the opalite quarries, and perhaps even 26Ek5040. Since the material culture of both Paiute and Shoshone was simple, limited to a relatively few technologically and stylistically equivalent categories of thing, there can be little hope of discriminating on the basis of the archaeological record which group was present at any particular time.

The prehistory of the region is known from a variety of sources, including research at Valmy to the southwest (Elston et al. 1981), at Rossi Mines to the southeast (Rusco et al. 1982), and along the southern reach of Rock Creek (Clay and Hemphill 1986). Long term, detailed investigations in the Tosawihi area, including surveys (Budy 1988; Elston, Raven, and Budy 1987; Raven 1988; Leach and Botkin 1992) and extensive excavations (Elston 1989; Elston and Raven 1992a, 1992b) have disclosed a 10,000 year history of human visitation, the later several millennia of which focused largely on the procurement of opalite as toolstone. The archaeological record suggests particular intensification of use over the past 1500 years. While the Tosawihi Quarries lie only 3 km east of the site (cf. Figure 3), 26Ek5040 falls well within the much larger *Tosawihi production sphere*, estimated at just under 800 km^2 (Leach and Botkin 1992), in which Tosawihi opalite continued to be processed and transported and, local geology permitting, quarried (though less intensively). A quarry pit complex, for example, occupies a ridgecrest only 1 km northwest of 26Ek5040 (cf. Figure 4).

A stratified, random sample survey of the Tosawihi vicinity (Leach and Botkin 1992) resulted in the archaeological inventory of 280 m x 280 m quadrats in the neighborhood of 26Ek5040. Of 23 quadrats surveyed within the 1800 ha surrounding the site (Figure 7), only two contain no prehistoric cultural materials. Most quadrats (n=21) contain at least sparse to moderate density lithic scatters reflecting a preponderance of middle to late stages of biface reduction; five also contain milling stones (usually only one specimen), two contain quarrying features, and one apparently is a residential site with a relatively diverse stone tool assemblage. A second residential site was recorded outside any survey quadrats, adjacent a spring.

Clearly, most parts of the local landscape were visited prehistorically, and although the bulk of the archaeological record (small reduction and tool maintenance stations) signals ephemeral, short-term use, considerable locational, functional, and material diversity is expressed in a small area. Most *kinds* of place (including ridge crests, knoll tops, slopes, terraces, and drainage margins) were used, numerous categories of activity (including temporary residence, quarrying, hunting, plant food procurement and processing, lithic production, and tool maintenance) were performed, and a variety of lithic materials (including Tosawihi opalite, jasper, and basalt, all probably of local origin, as well as imported obsidian) were employed.

Interestingly, time-marking artifacts noted so far in the 1800 ha surrounding the site consist only of Great Basin Stemmed, Gatecliff, and Elko projectile points, and a possible crescent (Leach and Botkin 1992), a pattern which, if it survives subsequent research, contrasts sharply with the temporal profile of the Tosawihi Quarries where Late Archaic time markers are more common (Elston 1989; Elston and Raven 1992a, 1992b).

TOSAWIHI QUARRIES:
ARCHAEOLOGICAL INVESTIGATIONS AND ETHNOGRAPHIC STUDIES IN NEVADA

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Research Goals in the Context of Previous Research

Research conducted so far in the Tosawihi vicinity has been guided by an evolving suite of problem domains, theoretical models, hypotheses, and empirical questions. The overall framework of inquiry has undergone considerable refinement and refocusing in light of the ongoing accumulation and analysis of data (cf. especially Elston 1988, 1989; Elston, Raven, and Budy 1987; Elston and Raven 1992a, 1992b; Leach and Botkin 1992), but central to all investigations has been concern with understanding the economics and strategies of toolstone procurement. Since the extraction of toolstone was the principal goal of prehistoric visits over several millennia, understanding the prehistory of the area demanded inquiry into how viable stone sources were discovered and evaluated, how raw toolstone was removed from the ground, how and to what extent it was processed in the field prior to transport, and how the products and by-products of extraction and production were manifest in the archaeological record. Additional critical questions involved the spatial structure of task segmentation, the organization of support measures (such as the procurement of food), and the seasonal and geographic integration of toolstone procurement into larger economic, technological, and social patterns.

Prior to testing, several attributes of 26Ek5040 suggested that the site might shed important light on various of these questions. While not constituting a locus of toolstone extraction itself, the site lies relatively near the main body of the Tosawihi Quarries (26Ek3032) as well as lesser, but closer, exploited sources of opalite. It is, however, sufficiently distant from these sources (2 km and 1 km, respectively; cf. Figure 3) that spatial considerations are likely to have come into play in the composition of the archaeological record. After toolstone was extracted at Tosawihi, a large proportion was made into bifaces. Biface manufacture can be divided into stages; at Tosawihi, different stages tend to be segregated in space. Early stages of reduction (through early Stage 3) were usually performed near stone sources, though often somewhat removed from the actual locus of quarrying; bifaces were exported from the greater Tosawihi vicinity, however, at mid-to-late Stage three, subsequent to heat-treatment (a process that improves the flaking quality of the stone; cf. Ataman, Carambelas, and Elston 1992; Bloomer, Ataman, and Ingbar 1992). This implies that the final stages of reduction, including heat-treatment, were performed farther from quarries, probably at camp sites located closer to subsistence resources (water and food). Reduction stages reflected in bifaces and debitage at 26Ek5040, therefore, should situate the site along that portion of the reduction continuum lying between extraction of raw material and final export of toolstone packages from Tosawihi, thereby further clarifying the role of distance in structuring the Tosawihi production sphere.

The chronology of human presence in the hills around the site is poorly understood at present; time-sensitive artifacts observed in survey contexts (Great Basin Stemmed, Gatecliff, Elko, and a possible 'crescent' of Tosawihi opalite) seem to reflect only the Pre-Archaic, Early, and Middle Archaic periods, although exploitation of the nearby Tosawihi Quarries underwent considerable intensification in the Late Archaic (Ataman et. al 1992). Since Late Archaic time markers have not yet been detected in the 1800 ha surrounding 26Ek5040 (Leach and Botkin 1992), the region, as well as the subject site, may inform on earlier land-use patterns in the Tosawihi hinterlands. If this is so, careful consideration of the opalite fraction of the artifact and debitage assemblage, as well as of its relation to the exploitation of other lithic materials, may help clarify strategic and economic changes in toolstone extraction, processing, and transport.

Results of Testing

Archaeological test excavations conducted at 26Ek5040 in 1992 produced data used to evaluate the eligibility of the site for inclusion in the National Register of Historic Places as well as to formulate the goals of the present research. Despite the absence of an on-site usable toolstone source, test data

confirmed the site location as a component of the production zone of the Tosawihi Quarries (Leach and Botkin 1992); that is, the primary activities represented at the site are connected to the acquisition and processing, but not primarily the use, of locally available lithic raw material. As such, information available at this site, and that derived from previous work at Tosawihi, is inextricably linked. In addition, limited chronological data recovered from the site suggested that indeed the primary occupation of the site was probably centered on the Middle Archaic, thus providing opportunity for contrast with previous work. The depth of cultural deposits encountered in the test also allowed the possibility for *in situ* changes in technology and biface production strategies. Thus the test demonstrated that 26Ek5040 had the potential to confirm and extend analytical and theoretical observations used in planning and developing previous research (Elston 1988; Elston, Raven, and Budy 1987; Elston and Raven 1992a, 1992b) as well as to address new questions identified in the course of our work there (Ataman et al. 1992). The following chapters describe the data recovery phase of the project; test data are included as indicated.

Chapter 2

RESEARCH METHODS

Margaret Bullock

Data recovery methods employed at 26Ek5040 were designed to recover information relevant to site-specific research questions and to questions regarding the place of 26Ek5040 in the larger context of the Tosawihi Quarries (Ataman et al. 1992; Elston and Raven 1992b). Fieldwork included contour mapping, intensive surface reconnaissance and systematic collection, lithic feature inventory, excavation of all surface and subsurface features, and judgmental sampling of landforms for subsurface deposits with backhoe trenches, excavation units, and mechanical scraping.

Field and Laboratory Methods

We tested 26Ek5040 in the spring of 1992. Site boundaries encompass approximately 3.3 hectares; within this area 25 surface lithic features were identified and 125 surface artifacts were collected. During testing, a sample of eight features and two non-feature areas, stratified by landform, was chosen for excavation. Testing included surface reconnaissance and collection, and stratigraphic examination of drainage cuts and excavation units (Ataman et al. 1992).

Data recovery in 1994 began with systematic surface survey to relocate the features identified during testing and to evaluate previously identified site boundaries. As a consequence, the boundaries were altered slightly; seven additional surface features (Figure 8) and 279 more surface artifacts were found (Figure 9). Several methods of excavation explored cultural deposits (Table 1, Figure 10). All surface features which had not been excavated during testing were explored with blocks of 1 x 1 m surface scrapes to a depth of 4 centimeters. The number of scrapes in each block varied judgmentally by feature, according to feature size, composition, and content. Those units with potential for subsurface deposits were continued as excavation units (EU) in arbitrary 10 cm levels from an established datum, usually until culturally sterile deposits were encountered. Clearly delimited stratigraphy was difficult to see during excavation, but when encountered, samples from each stratum within arbitrary levels were delineated through the use of unique lot numbers. A total of 72 scrapes and 16 EUs (64 EU levels) were excavated in surface feature contexts (cf. Table 1). All soil and cultural material was screened through 1/4 in mesh; artifacts were collected and bagged by provenience, then returned to the laboratory for processing.

Table 1. Number of Units Excavated per Context in 1994.

	Scrapes	*EU levels	Mechanical Scrapes
Surface Feature	72	64	
Subsurface Feature	12		
Nonfeature Contexts	10	35	7
Total	82	111	7

*EU=Excavation unit

Ten additional surface scrapes, six of which were continued as EUs, were placed in non-feature areas (cf. Figure 10) to aid examination of the extent of subsurface cultural deposits. In order to

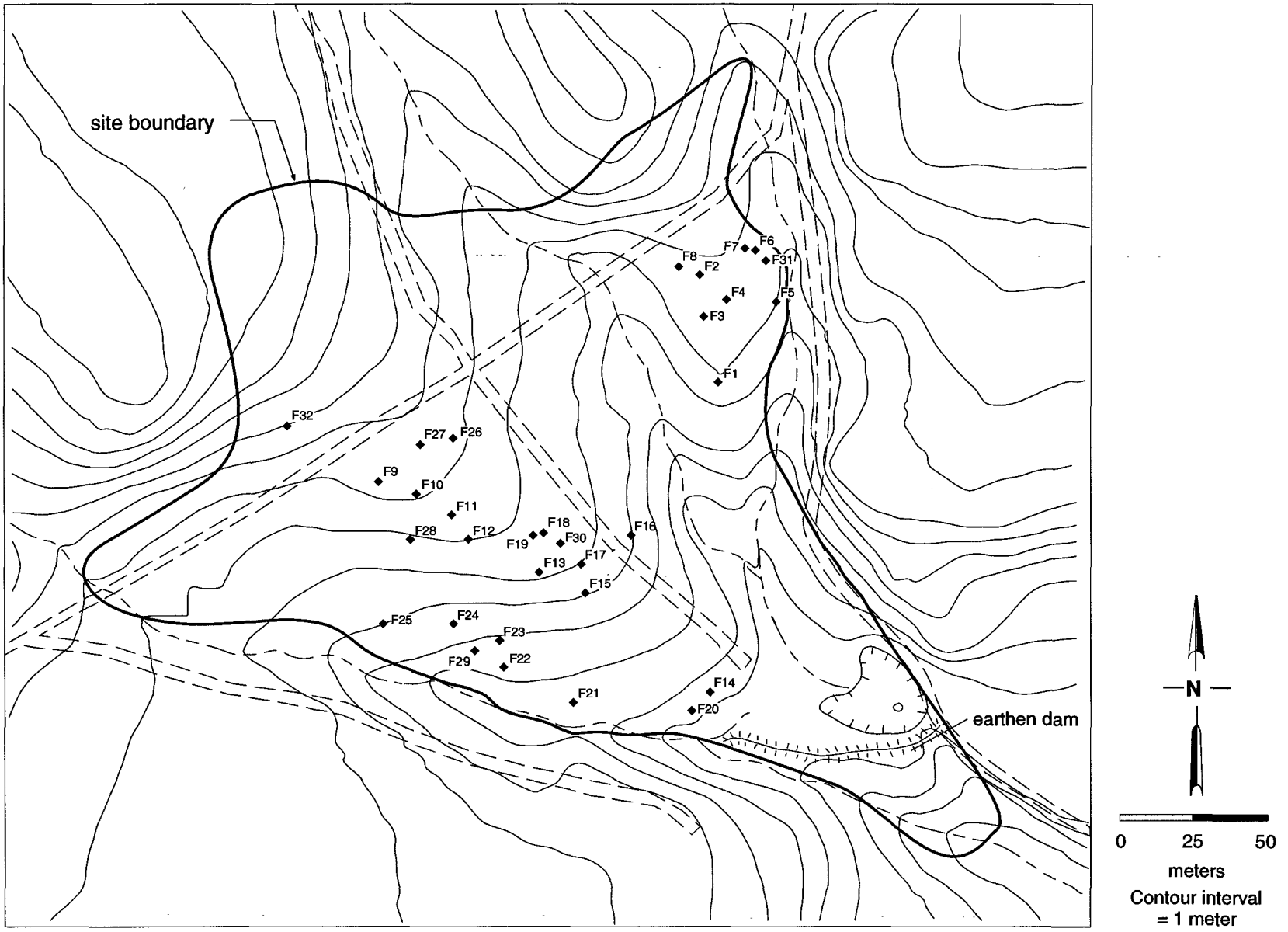


Figure 8. Distribution of features at 26Ek5040.

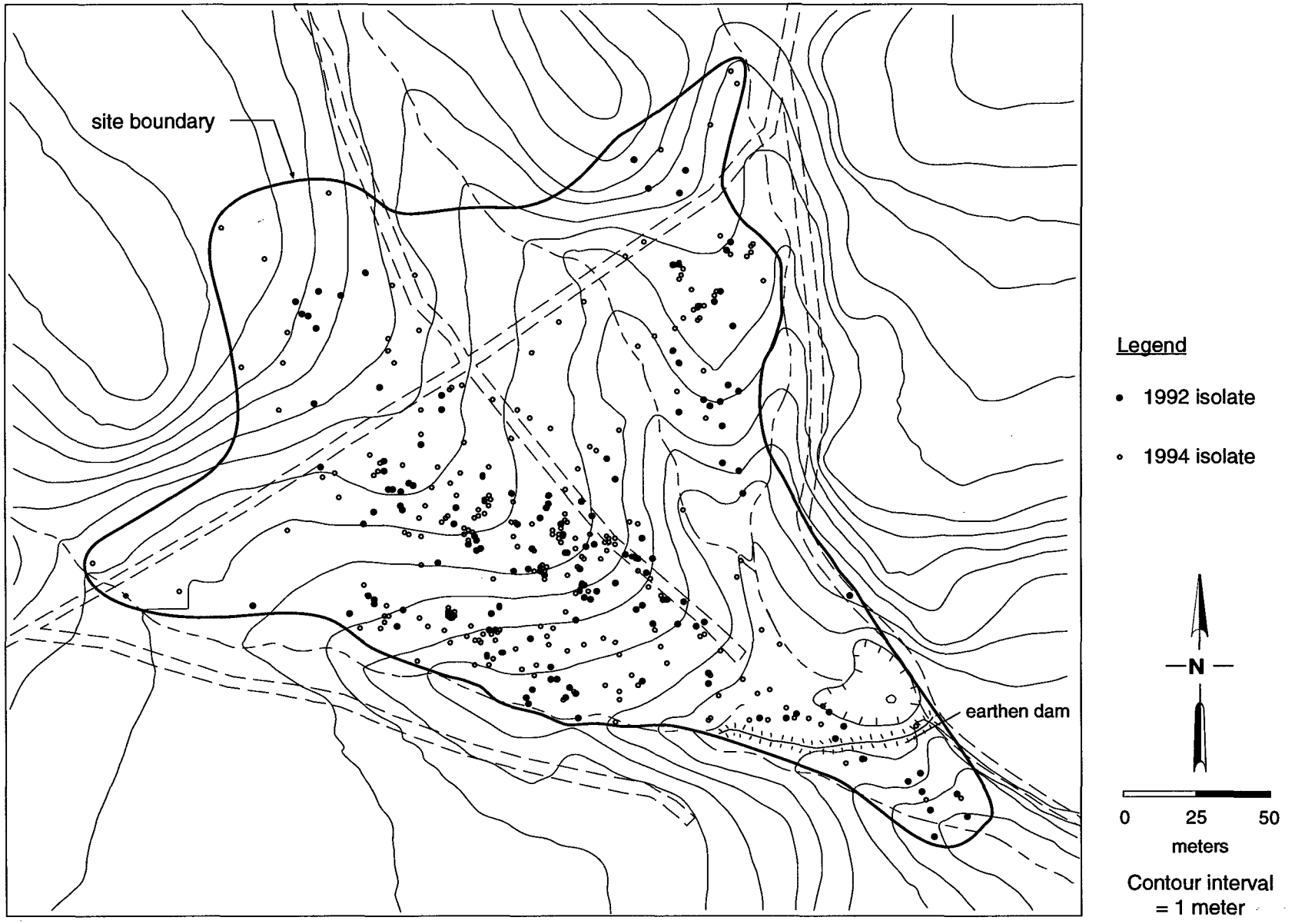


Figure 9. Distribution of surface isolates at 26Ek5040.

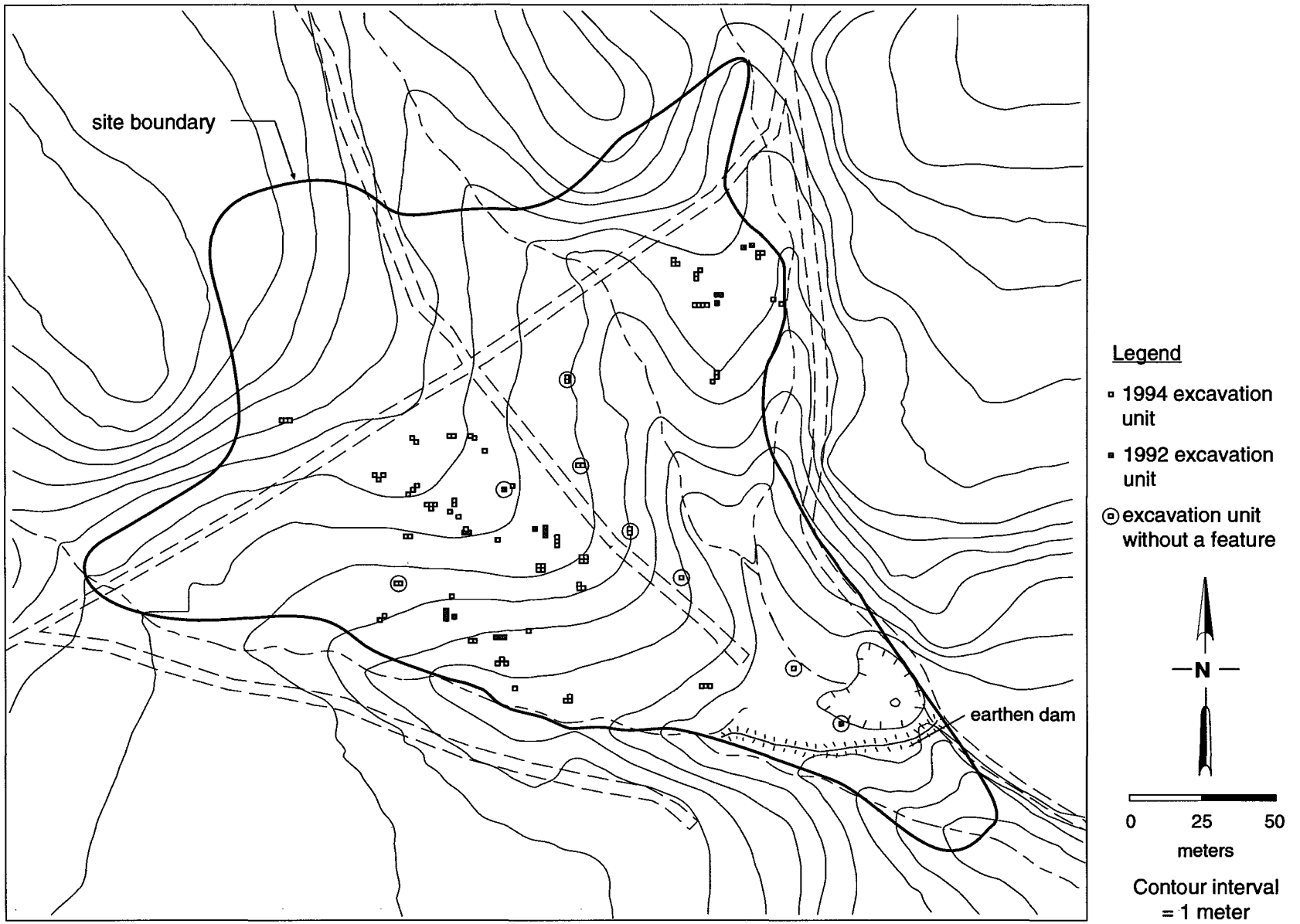


Figure 10. Location of excavation units at 26Ek5040.

facilitate comparison with returns from the surface feature units, each was begun as a 4 cm surface scrape (Level 1) then excavation proceeded from Level 2 in 10 cm arbitrary levels from a datum. Screening and artifact collection procedures were identical to those described above.

Other means used to explore site deposits included soil coring using a handheld soil probe with a 3.5 cm diameter barrel, backhoe trenching, and mechanical scraping (Figures 11, 12). Twenty soil cores and nine backhoe trenches (Figure 13) explored site depositional history; these were placed to test a variety of landforms. Cores, trenches, and excavation units were described and profiled by the project geoarchaeologist. Detailed discussion of his findings appears in Chapter 3.

Once all excavation was completed, seven areas of variable size (Figure 14) were mechanically scraped to a depth of approximately 10 cm below surface, a method that has proved useful for locating subsurface features such as hearths in previous excavations in the Tosawihi quarries (Schmitt et al. 1992:43). A number of roughly circular fire blackened areas at 26Ek5040 were revealed by this method, but most appeared to be recent sagebrush root burns. The six that looked most promising were bisected with an excavation unit and soil samples collected; descriptions of these features follow in Chapter 3. All excavations were backfilled to grade upon conclusion of the field phase of the project.

Once transported to the laboratory, collections were cleaned, sorted, labeled, and cataloged. Each distinctive artifact or lot of artifacts was assigned a catalog number comprised of site number, reference number, and specimen number. Numbers were applied directly to artifacts using indelible white or black ink covered with clear lacquer. Debitage samples were scanned to identify tools (which were given their own unique numbers) and then cataloged in lots. A computer catalog was created, which includes in addition to provenience, the class, type, material, count and weight of each item or sample.

Artifact Analysis

Certain standard analytical methods are applied consistently throughout the Great Basin to describe and classify particular kinds of artifacts. Our analysis follows procedures developed by Thomas (1981) for projectile points and by Ataman (1992a) for flake tools. Measured attributes of projectile points appear in Appendix F. Groundstone analysis follows Mikkelsen (1989, 1993) and Adams (1989) as modified by Bullock (1994a); hammerstone analysis follows previous Tosawihi usage (Schmitt 1992a).

Biface manufacturing stages used here are those outlined by Callahan (1979) as modified in our previous analyses at Tosawihi (Bloomer, Ataman and Ingbar 1992; Ataman 1992b). In this descriptive system, Stage 1 represents a selected blank before it has been reduced and Stage 2 the edge prepared blank. By Stage 3 primary thinning has been accomplished, while secondary thinning is used to indicate Stage 4. We have used Stage 5 to represent a biface on which finishing has been initiated, that is, basal shaping, edge straightening, or pressure flaking detail. Stages 2, 3, 4, and 5 are further subdivided; Stages 2, 4, and 5 are divided into early and late, and Stage 3 into early, middle, and late. Because Tosawihi opalite is variously colored and because some colors are particular to specific quarry localities, the colors of bifaces were also recorded.

Debitage Analysis

Prior to size grading, each sample of opalite or local chert debitage was evaluated for presence of heat-treatment (expressed as a percentage) and proportion (by weight) of white opalite to other colors. Each debitage sample then was size graded through nested screens of 2 in., 1 in., 1/2 in., 1/4 in., and 1/8



Figure 11. A view of Trench F from the west.



Figure 12. Use of backhoe for surface scraping.

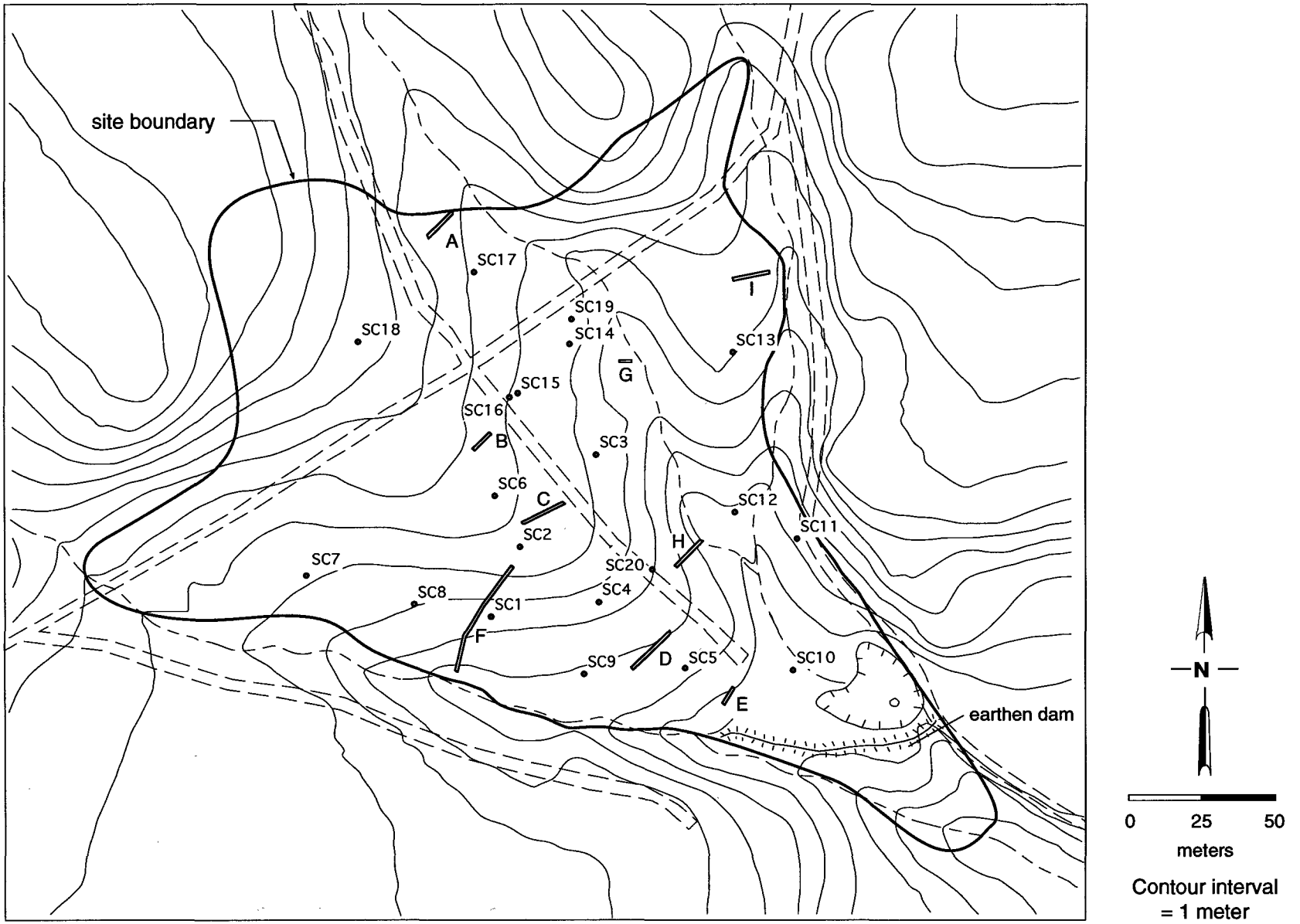


Figure 13. Location of soil cores and backhoe trenches at 26Ek5040.

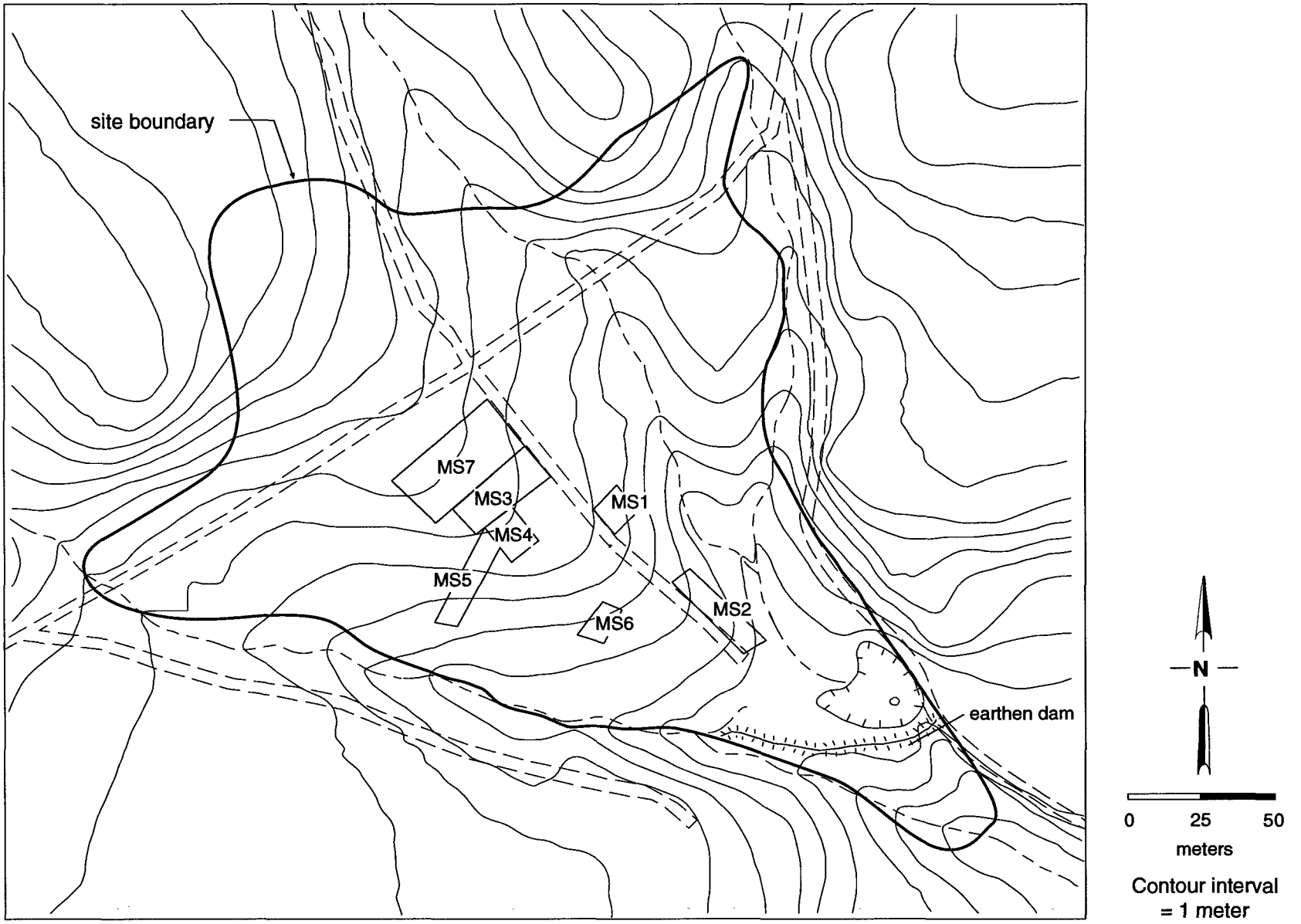


Figure 14. Location of mechanical scrapes at 26Ek5040.

in. mesh, with the portion collected in each screen bagged and weighed separately. These procedures are intended to identify variation in debitage density, composition, lithic source, and degree of heat treatment both horizontally and vertically across the site. Opalitic and basaltic cherts were treated differently during cataloging. Although combined by level in the color and heat treatment analyses, these were considered as separate samples in the debitage analysis.

Once size grading was completed, debitage samples were scanned for technological characterization. Previous work at Tosawihi has shown that the range of technological variation present in recovered debitage samples is limited, with the primary focus on biface production. Evidence for some projectile point manufacture often is recovered from non-quarry sites and, in addition, evidence of flake core technology (primarily confined to basalt and obsidian collections) is also present. Therefore, the descriptions that follow of changes in heat-treatment, color, or technology are for biface debitage; other technologies are described as encountered.

The technological characterization used herein follows that described by Ingbar, Ataman, and Moore (1992:51-59). In this scheme, samples are examined and characterized as a lot rather than as individual flakes. Testing has shown that several types of reduction previously noted at Tosawihi, particularly early stages seen most frequently at true quarry sites, are not represented strongly at 26Ek5040, i.e., quarrying, mass reduction, and blank preparation/initial edging (Ataman et al. 1992). In the present study, therefore, the scheme was simplified and only core reduction, edge or blank preparation, early and late stages of biface thinning, pressure flaking (or retouching), or indeterminate reduction (when the sample was too small to characterize accurately) were noted. Any given sample can be characterized by five categories of debitage: core reduction (C), edge or blank preparation (B), early thinning (E), late thinning (L), or retouching (R). If one of these categories is represented by only small amounts of debitage, a lowercase letter denotes that fact. If a category is represented abundantly but does not dominate the sample, a capital letter is used; a dominant category is denoted by an underscored capital letter. There are, then, four possible attribute states for any given category: blank (category is not represented in the sample), lowercase, uppercase, or emphasized uppercase; these can be combined as appropriate to characterize a sample.

A large quantity of small debitage was noted during excavation of Unit Q8, Levels 4 and 5 (Feature 11). Two samples (Q8-4-2.1, Q8-5-2.1) of this flake concentration were collected and analyzed since concentrations of this sort may signal a heat-treatment hearth or in-situ reduction locale. Samples were washed through a series of nested screens (4 mm, 2 mm, 1 mm, 500 microns) and each fraction was analyzed for the types of flakes present. Results are reported in Chapter 3.

Other Analyses

Obsidian, charcoal, tephra, and botanical samples were sent to specialists for analysis. Obsidian hydration rind measurements were collected by Thomas Origer of the Sonoma State University Academic Foundation, Inc., and x-ray fluorescence sourcing analysis was conducted by Richard Hughes at Geochemical Research Laboratory. A total of forty-nine obsidian artifacts (10 tools, 39 pieces of debitage) were analyzed. Reports of results from both analyses are appended (A and B) hereto.

Charcoal samples from two hearth features were sent to Beta Analytic for radiocarbon dating (see Appendix C). Sample 26Ek5040-AM1-3-6.1 returned a date of 850±200 B.P. (Beta-74722); the second sample (26Ek5040-Q5-2-3.4) contained insufficient carbon for dating and was not processed. In addition to these samples from feature contexts, a soil sample was submitted for dating of the organic fraction. This sample (Beta-71239) returned a date of 4380±90 B.P.

A sample of what appeared to be volcanic ash from Trench F was sent to Franklin Foit, Jr. of Washington State University for identification (see Appendix D). Results are discussed in Chapter 3.

The residue from the flotation of ten soil samples from six units was sent to Nancy Stenholm of Botana Lab for botanical analysis. The flotation method used employed a screen-bottom (1.4 mm mesh), three-gallon bucket and a low pressure water spray. The light fraction of each sample (the materials which rose to the surface of the bucket) was decanted into cheesecloth. The material remaining in the 1.4 mm screen in the bottom of the bucket constituted the heavy fraction. Samples were air dried and then sent on to Botana Lab. Results are reported in Appendix G.

Curation

Artifacts were bagged by artifact class, then by reference and specimen numbers in .002 or .004 mil plastic bags. Each ziplock bag contains a paper provenience tag and an artifact lot. The bags are packed in one cubic foot cardboard boxes. Each box is labeled with project number, box number, site number, and a brief list of contents. These are to be curated at the Nevada State Museum, Carson City, where previous Tosawihi collections are stored. Copies of the catalog, of field notes and photos, of projectile point keying forms and other analytical data, and of the final report accompany the artifacts.

Chapter 3

SITE STRUCTURE

Margaret Bullock, Daniel P. Dugas, Robert G. Elston, and Kathryn Ataman

This chapter describes the physical structure of 26Ek5040, how artifacts are distributed within that structure, and how structural information can be used to make inferences about human activity in this place.

Physical Setting

26Ek5040 is situated on a group of alluvial terraces cut by three small, confluent, ephemeral stream channels (cf. Figure 5). The terraces lie in a roughly triangular-shaped area below low hills of andesite and rhyolitic tuff bedrock mantled by colluvium. The ephemeral drainages have isolated northern and southern interfluves (low ridges) within the site. In general, at the northwestern end of the site, the ridges have fairly low relief with rounded crests between moderately incised drainage channels. At the southeastern end of the site, the drainages are cutting progressively headward and the interfluves appear more dissected. Three terrace surfaces occur on the interfluve landforms (Figure 15); much smaller, intermittent terraces also appear within the ephemeral channels but are too localized to correlate or map. Areal delineation of the three main terrace surfaces is based on their morphology and topographic position relative to the modern drainage.

Most of the site area is comprised of the Terrace 1 surface (cf. Figure 15). Located just above the modern drainage channels, Terrace 1 girdles the southern ridge from the southwest end, around the southeastern tip, and back to the northwestern flank. A lobe of Terrace 1 is also present on the northern ridge at its southeastern tip. Terrace 2 occupies the intermediate topographic position on the ridges; girdling the southwestern and northeastern flanks of the southern ridge, and comprising much of the northern ridge surface area. The Terrace 3 surface occurs along the ridge crests and is best demarcated by exposed or near-surface bedrock that apparently underwent pre-Holocene fluvial erosion prior to burial. The sediments and soils which underlie the three terrace surfaces are described below.

Stratigraphic Sequence

Several backhoe trenches (cf. Appendix H, Figures H.11 and H.13) , soil cores (cf. Figure 13, Appendix I), excavation unit exposures (cf. Figure 10), and a large "gully section" exposure below the earthen dam (Figure 16) disclosed important stratigraphic relationships. Correlation between these exposures revealed at least 26 stratigraphic units, representing sediments (coarse and fine grained alluvium, eolian silts, volcanic ash), the horizons of five paleosols, and the modern soil (Figure 17, Table 2). The most comprehensive and illustrative exposure of typical site stratigraphy was seen in Trench F (Figure 18).

Before proceeding with the site stratigraphy description, it should be noted that as excavation proceeded and strata were exposed, a stratum number was assigned to each depositional layer (parent material) and soil horizon as it was recognized and described. Stratum number assignments, however, are not strictly sequential, due either to the addition of some stratum numbers at later stages of the field endeavor or because soil horizon development may occur within sediments at some time after they are initially deposited (yet they occupy coincident positions in the stratigraphic profile). Therefore,

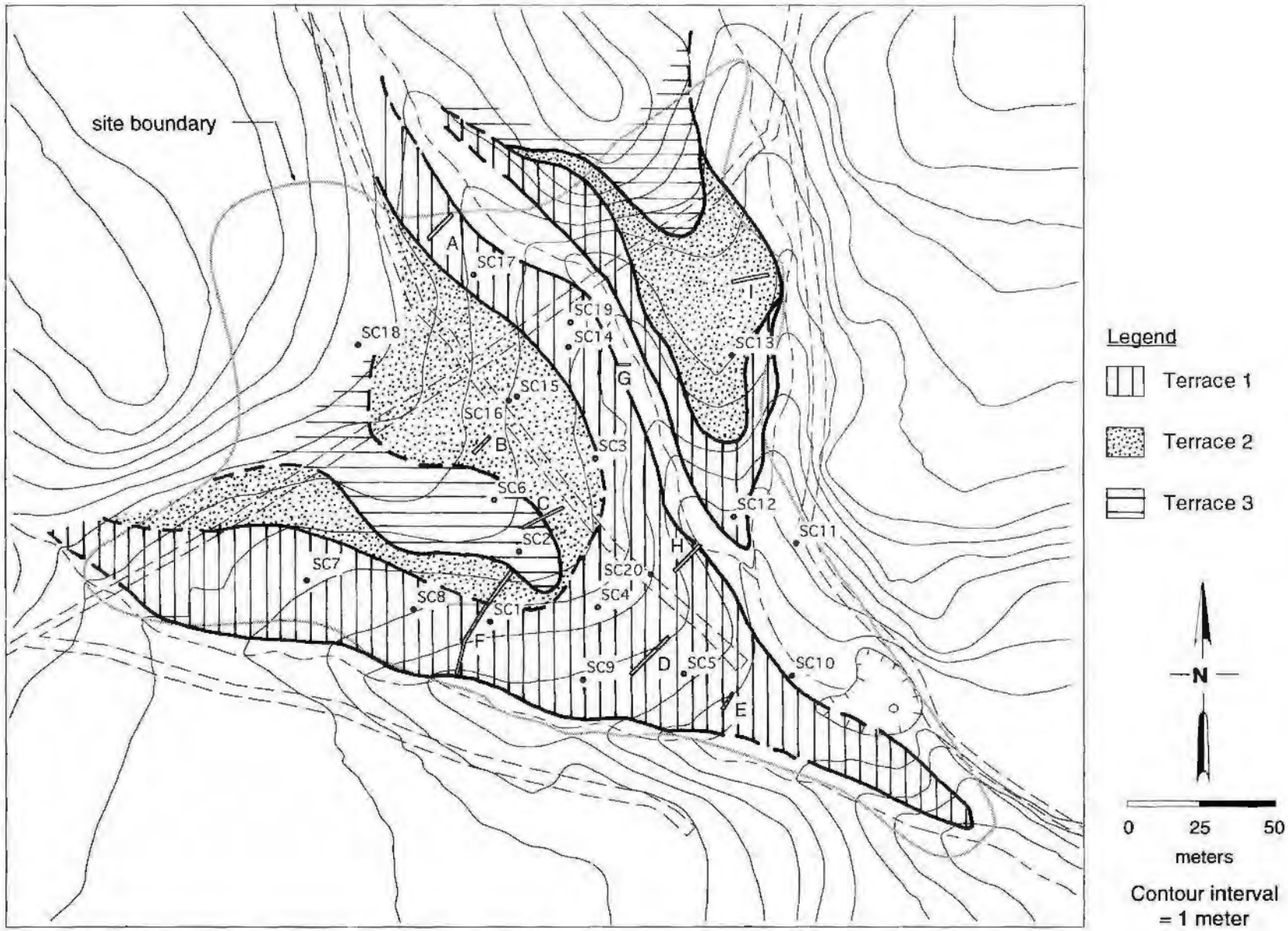


Figure 15. Site map of 26Ek5040 showing terrace surfaces.

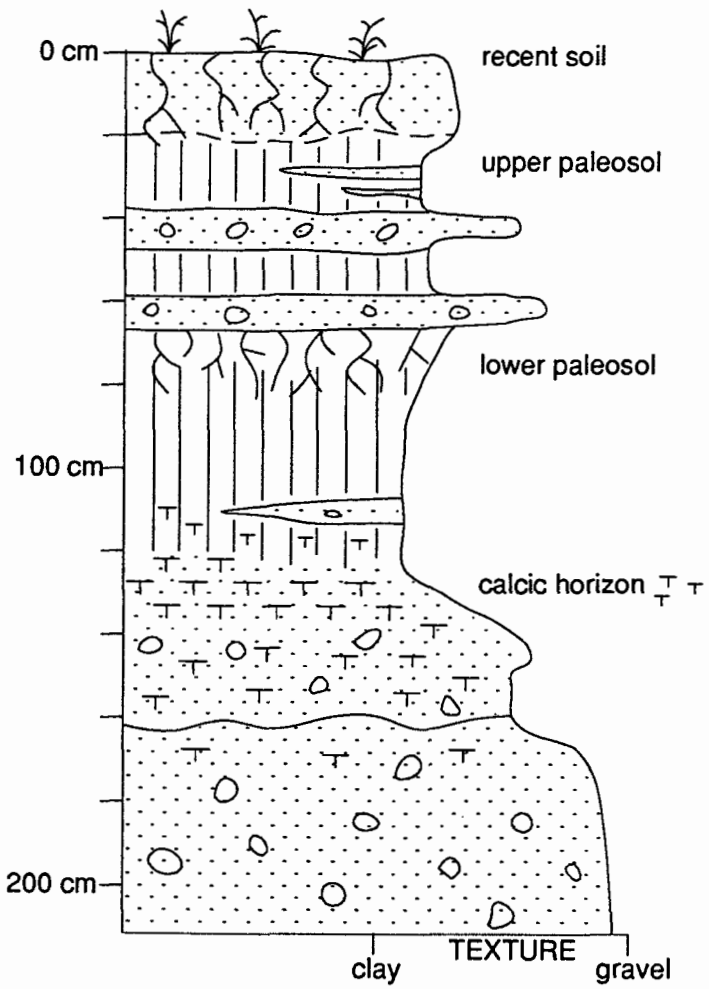


Figure 16. Stratigraphic profile of gully section.

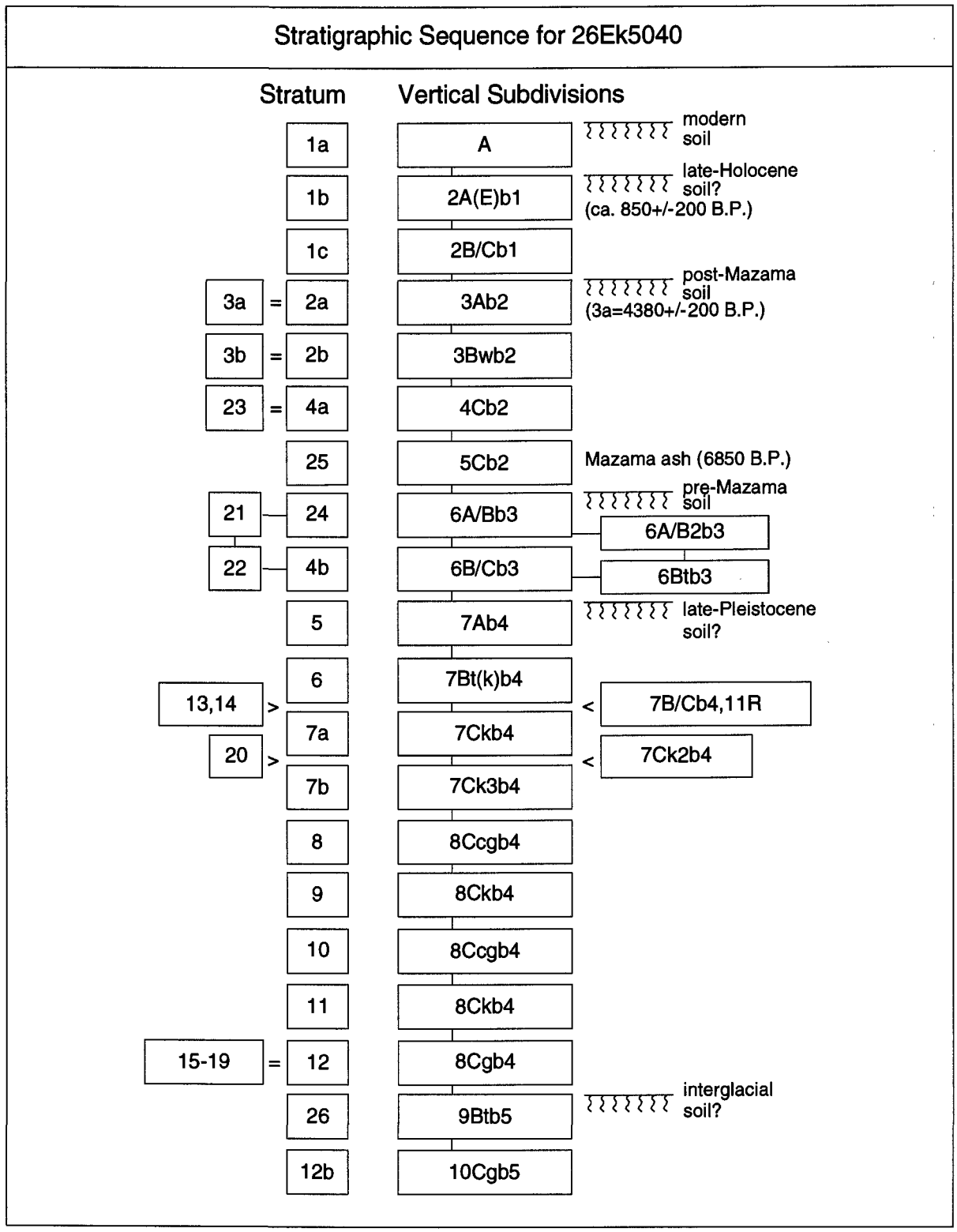


Figure 17. Stratigraphic sequence showing strata and equivalent vertical subdivisions.

using stratum numbers for both sedimentary units and soil horizons may not represent a true *temporal* sequence of stratigraphic events in the profile. Because of this lack of temporal clarity, a stratigraphic numbering system separate from the stratum numbers assigned during excavation is also presented here, using vertical subdivision designators (Soil Survey Staff 1975, 1990) (Figure 17 and Table 2). Vertical subdivision designators allow for separate depositional sedimentary layers and soil horizons to be described simultaneously while still allowing them to be indicated as distinct stratigraphic phenomena in the same descriptive system. A concordant, master soil stratigraphic sequence that reconciles the sedimentary sequence with the soil sequence is given in Figure 17 and Table 2 using vertical subdivision designators. Proceeding from left to right at each vertical subdivision, the first number (e.g., 1a, 1b, 2a, etc.) refers to each parent material consecutively encountered from the surface downward; capitalized letters refer to standard master soil horizons (A, typically organic-rich, surficial soil horizons; B, pedogenically-altered subsurface soil horizons; and C, non-pedogenic subsurface horizons). A master designation with a virgule, such as A/C, refers to a horizon with characteristics of both A and C. The master horizon E refers to a zone slightly leached of silicate clay, iron, and aluminum. Lower case letters which follow master horizon letters refer to subordinate horizon distinctions, such as c for accumulation of concretions (in this case manganese), g for gleying (a reduction of iron by water saturation), k for accumulation of carbonates, t for accumulation of silicate clay, and w for development of color or structure in a B horizon, but with no illuvial accumulation of materials. Where numbers follow either master or subordinate horizon letters, these refer to additional divisions of the horizon due to evident changes in structure, color, or texture that otherwise would not qualify them to be separated by some other element of the vertical subdivision name. Finally, the b at the end of the subdivision name designates portions of buried soils within the stratigraphic sequence. The b is followed by a number that refers to which consecutive buried soil the stratum is part of in a sequence from the surface downward.

Table 2. Descriptions of Stratigraphic Units at 26Ek5040.

Stratum No.	**Soil Horizon**	**Description**
1a	**A**	Very dark grayish brown (10YR 3/2 moist), dark grayish brown (10YR 4/2 dry); moderately-sorted very fine silt loam; moderate fine subangular platy to granular; slightly hard; friable, slightly sticky, nonplastic; noneffervescent; many fine roots, few very fine simple pores; boundary gradual and smooth. Modern soil surface of eolian silt with slopewash sediments.
1b	**2A(E)b1**	Similar to Stratum 1a except for slightly higher color value (5/2 dry) and firmer consistence. Stratum 1b appears to be a separate depositional unit from 1a and part of a former soil surface.
1c	**2B/Cb1**	Dark reddish brown (5YR 3/2 dry), sandy alluvial gravel unit lying directly above Stratum 2. Exposed only in `gully section'.
2a	**3Ab2**	Dark brown (7.5YR 3/4 moist), brown (10YR 5/3 dry); moderately-sorted very fine silty clay loam; very weak fine angular blocky; slightly hard to hard, very friable, slightly sticky, slightly plastic; noneffervescent; few to common thin argillan films; common fine to medium roots, common fine to medium simple open and closed pores; boundary clear and smooth. Parent material of eolian silt and slopewash sediments. Part of modern B horizon and possibly part of a buried A horizon.
2b	**3Bwb2**	Dark brown (7.5YR 3/4 moist), brown (10YR 5/3 dry); moderately-sorted very fine silty clay loam; moderate fine to medium angular to subangular blocky; slightly hard to hard, very friable, slightly sticky, slightly plastic; noneffervescent; few to common thin argillan films; common fine to medium roots, common fine to medium simple open and closed pores; boundary clear and smooth. Parent material of eolian silt and slopewash sediments. Part of modern B horizon and possibly part of a buried B horizon. May be equivalent to Stratum 23 in some portions of site.
3a	**3Ab2**	Dark reddish brown to yellowish brown (5YR 3/4 to 10YR 4/6 moist), brown (7.5YR 5/4 dry); poorly-sorted sandy clay loam; moderate fine to medium subangular blocky to prismatic; hard to very hard, firm, sticky, plastic; noneffervescent; few to common thin argillan films; very few fine roots, common fine simple open pores; boundary clear and wavy. Alluvium parent material. `Upper paleosol' of `gully section'. Dated by soil carbon average mean residence time to 4380 ± 90 B.P. (Beta-71239). Probable equivalent of Stratum 2 in other areas of site.
3b	**3Bwb2**	Similar to Stratum 3a. Transitional to Stratum 4a.

Table 2, continued.

Stratum No.	Soil Horizon	Description
4a	**4Cb2**	Reddish brown (5YR 4/4 moist), yellowish red (5YR 4/6 dry); poorly-sorted gravelly very coarse to fine sandy clay loam; weak fine subangular blocky to structureless; hard, friable, slightly sticky, slightly plastic; noneffervescent; few fine roots, few fine simple closed pores; boundary clear and irregular. Parent material of soil clasts and gravel slopewash sediments. Transitional soil horizon above Stratum 25 ash, typically containing gravel and reworked soil clasts. May be equivalent to Stratum 23 in some parts of site
4b	**6B/C2b3**	Dark brown (10YR 3/3 moist), dark reddish gray (5YR 4/2 dry), with pinkish gray (7.5YR 7/2 moist) spotty mottling; moderately-sorted coarse to fine sandy clay loam with angular gravel; strong fine subrounded granular (durinodes?); very hard, friable, sticky, plastic; noneffervescent; thin to moderately thick skeltan and silan films; very few fine roots, very few very fine simple pores; boundary clear and smooth to wavy. Parent material of alluvial and slopewash sands and silts with abundant clay. In Trench F: underlies Stratum 21 then merges with 21/22 to the northeast. Possible buried mollic surface horizon of the Strata 5/6 soil, or durinodes from an extremely eroded soil?
5	**7Ab4**	Black (5YR 2.5/1 moist), black to dark reddish brown (5YR 2.5/1 to 3/3 dry); slightly gravelly well-sorted very fine silty clay; strong fine angular blocky to prismatic; very hard, very firm, sticky, plastic; noneffervescent; common moderately thick argillan films and bridges; very few very fine roots; very few very fine simple pores; boundary abrupt and smooth. Organic-rich (?) upper portion of `lower paleosol' of `gully section'. Grades into Stratum 6; Stratum 5 to 6 contact is difficult to detect in most soil cores.
6	**7Bt(k)b4**	Yellowish red (5YR 4/6 moist) to strong brown (7.5YR 4/6 moist) to dark yellowish brown (10YR 3/4 moist)(colors varying according to degree of oxidation relative to local groundwater levels), dry colors only slightly higher in values, with yellowish red (5YR 4/6 moist) to strong brown (7.5YR 4/6 moist) mottling; slightly gravelly well-sorted very fine silty clay; strong medium angular to subangular prismatic; very hard, very firm, sticky, plastic; slightly effervescent (stage I) to locally very strongly effervescent (stage III); common moderately thick argillan and calcan films and bridges; very few very fine roots, very few very fine simple closed pores; boundary clear and smooth. Subsoil of `lower paleosol' in `gully section'.
7	**7Ckb4**	Yellowish red (5YR 4/6 moist), reddish brown (5YR 4/4 dry) with very pale brown (10YR 7/4 moist) carbonate mottles and stringers; clay loam with rare to common moderately-sorted medium to fine gravel; weak medium angular blocky; very hard, very firm, slightly sticky, slightly plastic; slightly to strongly effervescent (stage I to II); few thin argillan films, common moderately thick calcan films and pore fillings; no roots; very few fine simple closed pores; boundary abrupt to gradual and smooth. Parent material of fine alluvium with gravel lenses. C horizon of `lower paleosol'. 7b is similar to Stratum 7a except for a slightly higher color values.
8	**8Ccgb4**	Black (5YR 2.5/1 moist), dark reddish brown (5YR 2.5/2 dry); moderately-sorted, sandy loam; weak very fine angular blocky; hard, friable, nonsticky, nonplastic; noneffervescent; many moderately thick mangan films, pore fillings and brings; very few very fine roots, very few very fine simple open pores; boundary abrupt and smooth. This stratum is a series of manganese staining layers. It is probably a water table fluctuation feature and post-dates other soil formation features.
9	**8Ckb4**	Dark brown (7.5YR 4/4 moist), brown to light brown (7.5YR 4/5 to 6/4 dry), with very pale brown (10YR 7/3 moist) mottling of carbonate stringers and patches; gravelly moderately well-sorted medium to fine sandy clay loam; weak fine angular blocky/prismatic to massive; hard, firm, sticky, slightly plastic; very strongly effervescent (stage IV); many moderately thick calcan films, pore fillings and bridges, some possible thin argillans and silans; very few very fine roots, common fine simple open and closed pores; boundary clear and smooth to wavy. Parent material of moderately well-sorted medium to fine alluvial sand. Carbonate-rich Ck horizon of `lower paleosol' in `gully section'.
10	**8Ccgb4**	Same as Stratum 8. Includes 10a, b, and c.
11	**8Ckb4**	Same as Stratum 9.
12a	**8Cgb4**	Dark brown (7.5YR 4/4 moist), brown to light brown (7.5YR 5/4 to 6/4 dry); gravelly moderately-sorted medium to fine sandy clay loam; weak fine angular blocky/prismatic to massive; hard, friable, sticky, slightly plastic; slightly effervescent; very few thin calcan films and pore fillings very few very fine roots, common fine simple open pores; boundary abrupt and smooth. Parent material of sandy gravel alluvium. Gravel-rich C/R horizon of `gully section'. Stratum 12b is similar to Stratum 12 but is separated from it by Stratum 26 and designated 10Cgb5.
13	**7B/Cb4**	Reddish brown (5YR 4/4 moist), yellowish red (5YR 4/6 dry); silty clay with abundant angular bedrock clasts; weathered bedrock float zone of Stratum 5/6 and Stratum 1/2 materials mixed with bedrock clasts.
14	**11R**	White to yellow (10YR 8/2 to 7/6 dry); rhyolitic tuff bedrock with cherty fine-bedding alternating with chalky to welded ash-fall beds.
15	**8Cgb4**	Dark brown (7.5YR 4/4 moist), brown to light brown (7.5YR 4/5 to 6/4 dry), with very pale brown (10YR 7/3 moist) mottling of carbonate stringers and patches; gravelly moderately well-sorted medium to fine sandy clay loam; weak fine angular blocky/prismatic to massive; hard, firm, sticky, slightly plastic; slightly effervescent; few thin calcan films and pore fillings, some possible thin argillans; very few very fine roots, common fine simple open and closed pores; boundary clear and smooth to wavy. Parent material of moderately well-sorted medium to fine alluvial sand. Equivalent to Stratum 12.

Table 2, continued.

Stratum No.	Soil Horizon	Description
16	**8Cgb4**	Similar to Stratum 15 except for more gravelly. Equivalent to Stratum 12.
17	**8Cgb4**	Same as Stratum 15. Equivalent to Stratum 12.
18	**8Cgb4**	Similar to Stratum 15 except for more gravelly. Equivalent to Stratum 12.
19	**8Cgb4**	Same as Stratum 15. Equivalent to Stratum 12.
20	**7Ck2b4**	Dark reddish brown (5YR 3/4 moist), yellowish red (5YR 4/6 dry); poorly-sorted gravel to fine sand; structureless; slightly hard, very friable, nonsticky, nonplastic; noneffervescent; no roots or pores; clear and smooth boundary. Parent material of poorly-sorted, subrounded to subangular gravel (<3 cm) and very coarse to fine sand alluvium with some silt matrix. Gravels of tuff and andesitic basalt lithology. Gravel lens within Stratum 6/7 of Trench F.
21	**6A/B2b3**	Very dark brown (10YR 2/2 moist), dark reddish brown (5YR 3/4 dry); silty clay loam with rare to common moderately-sorted medium to fine gravel; moderate to strong fine subangular prismatic; very hard, very firm, sticky, plastic; noneffervescent; few thin argillan and skeltan films and pore fillings; few fine roots, common fine simple open pores; boundary gradual and smooth. Parent material probably of fine alluvium and eolian silts. Pre-Mazama soil with slightly darker upper portion (Stratum 21). Found only in Trench F.
22	**6Btb3**	Very dark brown (10YR 2/2 moist), dark reddish brown (5YR 3/4 dry); silty clay loam; moderate fine granular to very fine subangular blocky; hard, firm, sticky, plastic; noneffervescent; very few thin argillan films; very few fine roots, few fine simple open pores; boundary clear and smooth. Lower portion of pre-Mazama (Stratum 21/22) soil.
23	**4Cb2**	Dark reddish brown to reddish brown (5YR 3/4 to 4/4 moist), reddish brown (5YR 4/3 dry); gravelly poorly-sorted coarse to fine sandy clay loam; moderate to strong medium subangular blocky; hard to very hard, friable to firm, very sticky, plastic; noneffervescent; common moderately thick argillan films, pore fillings and bridges; common fine roots, common fine simple and dendritic open pores; boundary abrupt and smooth. This layer may represent slopewash intervals of reddish sediment derived from erosion of strata 5/6 or 21 materials.
24	**6A/Bb3**	Dark reddish brown to reddish brown (5YR 3/4 to 4/4 moist), reddish brown (5YR 4/3 dry); gravelly poorly-sorted coarse to fine sandy clay loam; moderate to strong medium subangular blocky; hard to very hard, friable to firm, very sticky, plastic; noneffervescent; common moderately thick argillan films, pore fillings and bridges; common fine roots, common fine simple and dendritic open pores; boundary abrupt and smooth. Similar to Stratum 23. This layer may represent slopewash intervals of reddish sediment derived from erosion of strata 5/6 or 21 materials.
25	**4Cb2**	Dark yellowish brown (10YR 3/4 moist), pale brown to light yellowish brown (10YR 6/3 to 6/4 dry); moderately-sorted fine to very fine loam; moderate medium angular blocky to massive; hard, firm, slightly sticky, slightly plastic; non- to very slightly effervescent; common fine pores, common very fine to fine simple and dendritic open pores, abundant fine to coarse insect and rodent burrows; boundary clear and smooth. Soil and insect reworked Mazama ash (6850 B.P.). Occurs below Stratum 2 in several trench exposures and soil cores across site.
26	**9Btb5**	Olive (5Y 4/4 moist), olive (5Y 5/4 dry), with very distinct yellowish red (5YR 4/6 moist) root mottling and root traces; clay loam; strong medium subangular prismatic to blocky; very hard, very firm, sticky, plastic; slightly effervescent; common moderately thick argillan films and pore fillings; very few fine roots, few very fine simple opens and closed pores; boundary abrupt and smooth. Parent material of fine alluvium. Gleyed paleosol near base of `gully section'.

These master and subordinate soil horizon designators allow for sequential labeling of both soil horizons and sediment units, which, as noted above, may occupy coincident positions in the stratigraphic profile because soil horizons develop in sediments as well as on them. For example, Stratum 2b and the underlying Stratum 4a were not sequentially numbered in the field, but in the soil stratigraphic series they are, as 3Bwb2 and 4Cb2, respectively; and they both possess horizons of the b2 paleosol. Stratum 2b is composed of the third parent material (3) encountered from the surface (one of eleven recognized) and is an incipient illuvial soil horizon (Bw) within the second buried soil at the site (b2). Stratum 4a, therefore, is developed in the fourth parent material type below the surface (4), is part of a weakly pedogenically-affected soil horizon (C), but is also part of the second buried soil profile (b2). It should also be noted that, depending upon the stratigraphic exposure considered, one or more of the vertical subdivisions in the master stratigraphic series may be absent or only poorly expressed. Using Figure 17 and Table 2 as guides, the master stratigraphic sequence can be described as follows.

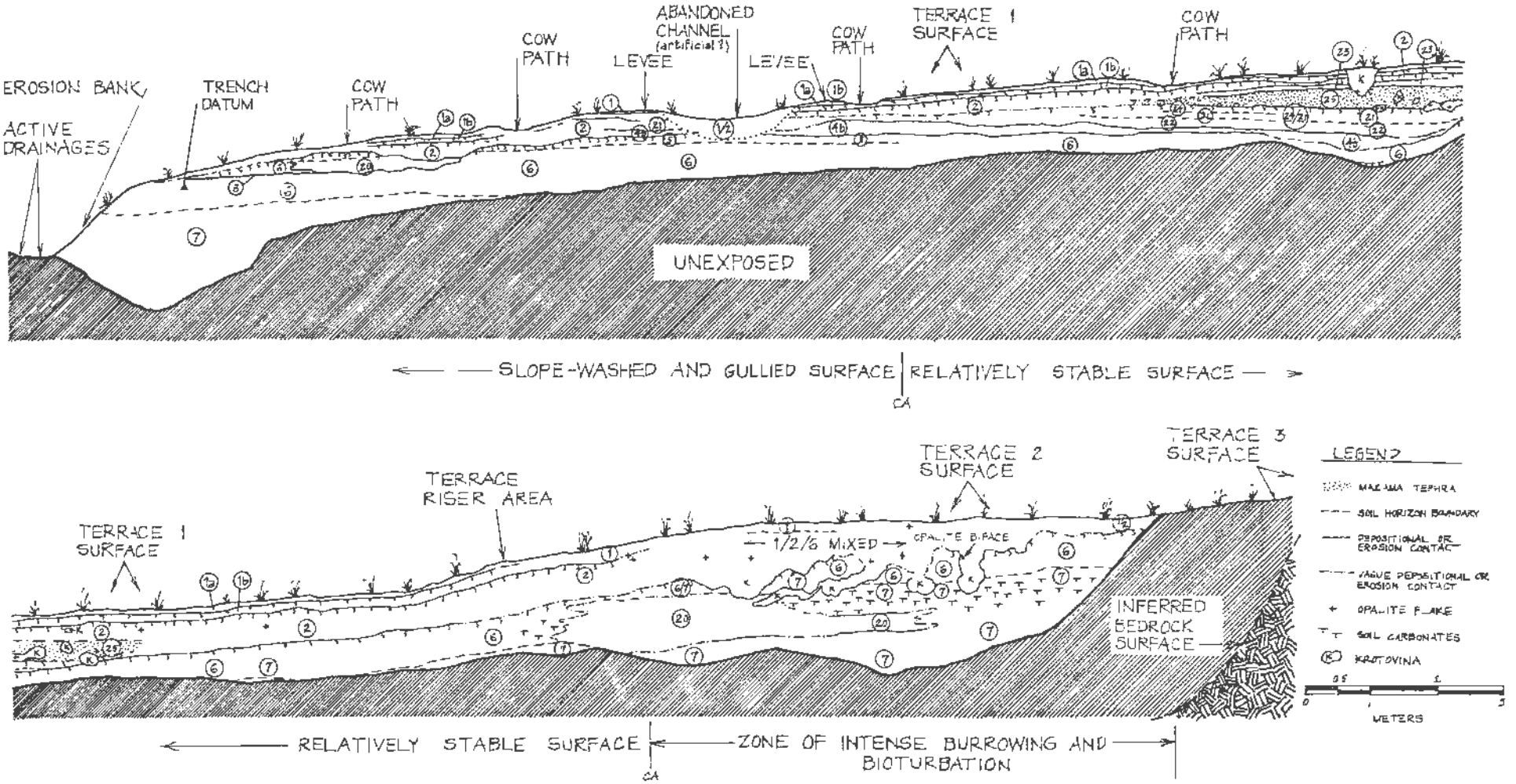


Figure 18. Trench F stratigraphic profile; west wall.

Stratum 1a (A) is the dark grayish brown eolian and slopewashed silt loam surface component of the site. A limiting date for the deposition of Stratum 1a is given by a hearth (cf. Figure 23) found at the surface of 1b in Trench B (Appendix H), which has been dated at 850±200 B.P. (Appendix C).

Stratum 1b (2A/Eb1) is part of both a buried (b1) soil and the modern soil. Notable changes in the vertical distribution of lithic material qualities and types, occurring in several excavation units (N1, AF1, AH2, AJ1, AI1, AL1, AM1, and AN1) near the surface of Stratum 1b (see below) probably are related to the depositional break between Stratum 1a and Stratum 1b.

Stratum 1c (2B/Cb1) is a dark reddish brown, sandy alluvial gravel buried (b1) soil horizon, exposed only in the gully section (cf. Figure 16) below the earthen dam. It probably correlates with Stratum 1b.

Stratum 2a (3Ab2) is a dark brown, moderately-sorted, very fine silty clay loam which marks the buried surface of the b2 paleosol. In places, it is also part of the B horizon of the modern soil.

Stratum 2b (3Bwb2), a dark brown, moderately-sorted, very fine silty clay loam, is the buried B horizon of the b2 paleosol as well as part of the modern soil B horizon.

Stratum 3a (3Ab2) and **Stratum 3b (3Bwb2)** are dark reddish brown to yellowish brown, poorly-sorted, sandy clay loams that are equivalent to Stratum 2, but confined to the gully section (cf. Figure 16); they are derived from alluvium parent material rather than from eolian or slopewashed silts. Stratum 3a is part of the b2 paleosol in the gully section and has been radiocarbon dated by soil carbon average mean residence time to 4380±90 B.P. (Beta-71239)(Appendix C).

Next in the soil stratigraphic sequence, **Stratum 23 (4Cb2)** is a dark reddish brown to reddish brown, poorly-sorted, coarse to fine sandy clay loam with gravel. This layer is comprised of clay-rich slopewashed sediments derived from erosion of strata 5/6 and 21 materials.

Stratum 4a (4Cb2), underlying either Stratum 2b or Stratum 23, is a reddish brown to yellowish red, gravelly, poorly-sorted, very coarse to fine sandy clay loam. As with Stratum 23, it is derived from eroded soil clasts and gravelly slopewash sediments. It is a transitional soil horizon to the Stratum 25 ash layer. A mixed combination of Stratum 4a and Stratum 25 occurs directly below Stratum 2 in several trench exposures and soil cores across the site.

Stratum 25 (4Cb2) is a pale brown to yellowish brown, moderately-sorted, fine to very fine loam composed of mixed silt and volcanic Mazama ash (6850 B.P., Appendix D). It typically appears throughout the site as a turbated and pedogenic mixture of ash and eolian silt, often difficult to recognize as a separate stratum. The best preservation of Mazama ash (Stratum 25) is limited to the area below Terrace 1 above the southern drainage where it is distinctly more ashy in appearance (see Trench F, Figure 18). While Stratum 25 and Stratum 4b contained archaeological materials in some excavation units (AG1, AH2, P1, Y1), these sediments are extensively turbated by insect burrowing and an assumed Mazama or pre-Mazama age for accompanying artifacts is only speculative.

Stratum 24 (6A/Bb3) is a dark reddish brown to reddish brown, poorly-sorted, coarse to fine sandy clay loam with common gravel. This layer may represent intervals of reddish sediment slopewash derived from erosion of strata 5/6 or 21 materials.

Stratum 21 (6A/B2b3) and **Stratum 22 (6Btb3)** are both dark reddish brown silty clay loams that occur between strata 24 and 4b. They represent the pre-Mazama b3 paleosol, found only in the Trench F exposure (cf. Figure 18) and adjacent soil cores.

Stratum 4b (6B/Cb3) is a dark brown, gravelly, moderately-sorted, coarse to fine sandy clay loam with pinkish gray (7.5YR 7/2 moist) spotty mottling. In Trench F (cf. Figure 18), Stratum 4b is part of the b3 buried soil which underlies Stratum 21 and possibly part of a cummulic mollic surface horizon or an extremely eroded duric debris derived from the b4 paleosol.

Stratum 5 (7Ab4), a black to dark reddish brown, slightly gravelly, well-sorted, very fine silty clay, comprises the organic-rich upper portion of the Pleistocene-age(?)(Soil Survey Staff 1980), b4 lower paleosol in the gully section.

Stratum 6 (7Bt(k)b4) is the subsoil of the b4 paleosol and is a yellowish red to strong brown to dark yellowish brown (colors varying according to degree of oxidation relative to local groundwater levels), slightly gravelly, well-sorted, very fine silty clay. Stratum 5 grades into Stratum 6, and the actual contact is difficult to detect in most soil cores.

In Trench C (cf. Appendix H), **Stratum 13 (7B/Cb4)** and **Stratum 14 (11R)** represent the weathering float zone below Stratum 5/6 and Stratum 1/2 materials; appearing as reddish brown silty clays with abundant angular weathered bedrock clasts, and white to yellow, rhyolitic tuff bedrock with cherty fine-bedding alternating with chalky to welded ash-fall beds. This float zone dominates the highest portions of much of the Terrace 2 and Terrace 3 areas of the site.

Stratum 7a (Ckb4) and **Stratum 7b (7Ckb4)** are yellowish red and reddish brown clay loams with very pale brown carbonate mottles and stringers. They are part of the C horizon of the lower b4 paleosol in the gully section.

Stratum 20 (7Ck2b4), a dark reddish brown to yellowish red, poorly-sorted, gravel to fine sand, occurs between Stratum 7a and Stratum 7b in a portion of Trench F (cf. Figure 18).

Stratum 8 (8Ccgb4), a black to dark reddish brown, moderately-sorted, sandy loam, occurs as a series of manganese staining layers throughout the site. It is probably a feature of water table fluctuation and post-dates most other soil horizons (cf. Trench F, Figure 18; Figure 16; and trenches D and E, Appendix H).

Stratum 10 (8Ccgb4) is similar to Stratum 8.

Stratum 9 (8Ckb4) is a carbonate-rich Ck horizon of b4 lower paleosol in the gully section. It is a dark brown to light brown, gravelly, moderately well-sorted medium to fine sandy clay loam with very pale brown carbonate stringers and mottled patches. Stratum 11 (8Cckb4) is similar to Stratum 9.

Stratum 12a (8Cgb4) is a dark brown to light brown, gravelly, moderately-sorted, medium to fine sandy clay loam and is part of the gravel-rich C/R buried b4 soil of the gully section (cf. Figure 16). Strata 15 through 19 (8Cgb4), which are equivalent to Stratum 12a, are dark brown, to light brown gravelly, moderately well-sorted, medium to fine sandy clay loams found variously throughout the site.

Stratum 26 (9Btb5) is an olive colored clay loam with very distinct yellowish red root mottling and root traces. This is the gleyed b5 paleosol found near the base of gully section.

Stratum 12b (10Cgb5) is similar to Stratum 12a but is part of the b5 paleosol.

In summary, the master stratigraphic section represents this sequence: deposition of tuff bedrock and early Terrace 3 formation; deposition of gravelly alluvium and sandy clay parent materials 10 and 9; formation of the b5 soil (9Btb5 and 10Cgb5); deposition of alluvial parent materials 8 and 7;

formation of the b4 paleosol (7Ab4, 7Btkb4, 7B/Cb4, 7Ckb4, 7Ck2b4, 7Ck3b4, 8Ccgb4, 8Ckb4, 8Ccgb4, and 8Ckb4); erosion of the Terrace 2(?) landform, deposition of parent material 3, and the beginning of Terrace 1 accretion; formation of the b3 soil (6ABb3, 6A/B2b3, 6Btb3, and 6B/Cb3); deposition of Mazama ash (parent material 5); erosion of Terrace 1 landform and deposition of parent material 4; deposition of parent material 3; formation of the b2 paleosol (3Ab2, 3Bwb2, 4Cb2, and 5Cb2); deposition of lower parent material 1 (Strata 1b and 1c); formation of the b1 buried soil (2A/Eb1 and 2B/Cb1); deposition of upper parent material 1 (Stratum 1a); and formation of the modern soil (A) and recent stream channel erosion.

The minimum ages for soil formation episodes recognized here (at ca. 7000 B.P., ca. 4380 B.P., ca. 850 B.P., and recent soil), are very similar to those recognized at Susie Creek, Nevada (at ca. 7500 B.P., ca. 3500 B.P., ca. 1000 B.P, and recent) (Niles 1994) and in southeastern Oregon (at ca. 8000 B.P., ca. 4700 B.P., ca. 1000 B.P., and recent)(Dugas and Bullock 1993; Dugas 1994). These similarities may represent a regional tendency toward soil formation at similar times, or at least the cessation of soil formation by sediment burial at similar times.

Site Formation Processes

In general, stream alluviation and erosion appear to have been the dominant geomorphic processes during the Pleistocene. During the Holocene, eolian silt and ash accretion, colluvial slopewash, and bioturbation become more important site formation processes. Soil textural variation, due to a combination of locally intense bioturbation (cf. Figure 18, north end of Trench F), movement of fines by slopewash and wind activity, and clay shrink/swell, are perhaps one of the most noticeable site sediment characteristics. Generally, the soil texture of the soil surface ranges between Holocene-age, granular-structured, eolian silts of Strata 1 and 2; and clay-rich exposures of mixed surface silts and b4, b2, and b1 paleosol materials (Strata 1b, 1c, 2, 4a, 5, 6, 7, and 25). Sediments appear to have been eroded most extensively from the surfaces of Terrace 2 and Terrace 3, then redeposited on the Terrace 1 surface. The most intense mixing, by pedogenesis and bioturbation of sediments, has occurred on the slopes occupied by Terrace 2 and the transition zone between Terrace 2 and Terrace 3. This was most clearly observed in Trench F at its northern end (cf. Figure 18). Fortunately, in terms of archaeological recovery, much of this mixing appears to have affected sediments below Stratum 2. In terms of surface erosion, portions of Terrace 1 adjacent the drainages are the areas most heavily affected by gullying and surface wash. This has resulted in the disturbance of several archaeological features along the southern edge of the site.

In order to better define the potential extent and depth of artifact-bearing sediments, an isopach map was constructed (Figure 19) showing the distribution and thickness of Holocene-age sediments and soils which overlie the b4 Pleistocene-age paleosol. Typically, the thickest areas of Holocene fill occur below the Terrace 1 surface (cf. Figure 18 also), especially along the southern flank of the south ridge. Deep sediments also appear below the Terrace 2 surface on the northern flank of the south ridge.

The isopach map was constructed coincident with data recovery excavations, recognizing that excavation unit placement would, in part, be based on early recognition of the varying thicknesses of archaeologically-significant, Holocene sediments. Comparison of the isopach map and terrace extent also serves to illustrate the dynamic nature of the geomorphic processes which have affected the history of site formation. The deeper Holocene fill areas (cf. Figure 19) northwest and southeast of Trench B (cf. Figure 13), for example, suggest that the northern stream channel may have traversed the site at this point in the past to join the southern ridge in the areas of Unit Y1 (cf. Figure 10) rather than at the extreme southeast end of the site. This channel cutting has, in the process, isolated a small, shallowly buried, bedrock knoll (Figure 19, and Trench C in Appendix H) in the area of blocks R, T, and V (cf. Figure 10).

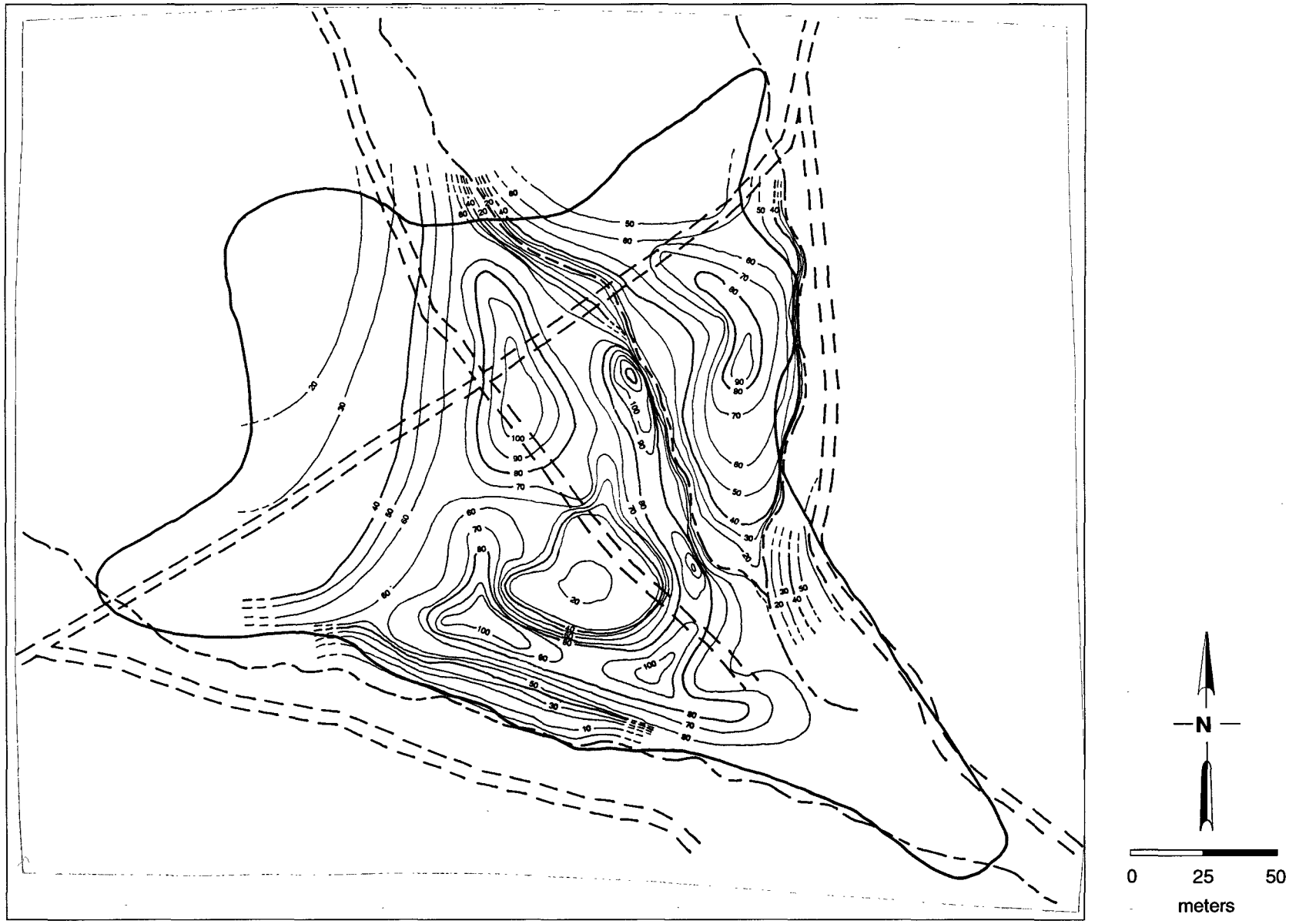


Figure 19. Isopach map of 26Ek5040 from ground surface to stratum 5/6 surface showing thickness of Holocene fill; contour interval is ten centimeters.

The geomorphology and stratigraphy discussed above illustrate the complex character of the formation processes and resultant setting of 26Ek5040. At least three depositional events alternating with four individual soil episodes within the Holocene (including the modern soil) has fostered preservation of occupation surfaces and archaeological features, and the combination of terrace surfaces and multiple sediment and soil layers has allowed for several artifact contexts to exist.

Surface Features

Although not all surfaces within the bounds of 26EK5040 were covered with a continuous scatter of debitage, large areas did exhibit debitage at relatively low density. At 26Ek5040, bounded areas where debitage density exceeded the local low density background were defined as features. Clusters of debitage of a common (i.e., one) toolstone material, were also treated as features. We recognize that defining features in this way should favor those that are most recent, or located in places most protected from cultural, biological, and geological processes. In the fullness of time, surface features are likely to be dissipated or buried. Features 2 and 3 for example, were noticeably less dense during excavations in June 1994 than described in 1992. But features that are visible now may represent loci of individual acts of toolstone reduction, and thus contain more specific information on technological processes and their distribution across the site than samples of the background scatter.

Surface cultural features on site 26Ek5040 form three clusters (cf. Figure 8). The northern cluster is on the crest of the northernmost interfluvial ridge, the central group is on the crest of the southern ridge, and the southern group is along the south flank of the southern ridge overlooking the intermittent stream. The northern feature group is located wholly on Terrace 2, while the southern group is only on Terrace 1. Members of the central feature group, however, are found on all three terraces. Since preliminary analysis of features by geomorphic position failed to demonstrate significant patterning, the following discussion refers to features in terms of spatial groups. Observations of surface feature composition, size, and density recorded before excavation are provided in Table 3; excavation data are provided in Table 4 and Table 5.

Northern Group

The northern group comprises nine features (1 through 8, and 31) located on a relatively flat portion of the northern ridge. Eight features are tightly clustered in an area about 25 by 40 m; Feature 1 lies somewhat isolated on the edge of the flat about 20 m south of the main group. Features 4, 6, and 7 were tested in 1992 (Ataman et al. 1992). Features in this group were the smallest in area (mean 22.6±29.3 m^2). Surface debitage in most (n=8) features of this group appeared dominated by opalite, although the proportion of obsidian in Feature 3 was estimated at forty percent (cf. Table 3). Surface debitage density varied among features from 10 to 100 flakes per square meter (cf. Table 3). Formed flaked artifacts were not common in surface features of this group (0.3 per feature); only a scraper, a biface, and an Elko point (cf. Table 3) were recovered, and groundstone artifacts were limited to two metate or mano fragments not in surface features. In the opalite samples recovered from surface scrapes, mean fraction of heat treated debitage in the northern group was 56.97±16.7 percent; mean fraction of colored chert was 18.41±14.6 percent. There is a narrower segment of the reduction sequence present in the 57 opalite debitage samples from surface contexts in this feature group, compared to the central and southern groups. Less core reduction and less retouch/finishing are present perhaps attributable to the smaller sample size of the northern group.

Table 3. Surface Feature Data Summary.

Feature #	Units	Size (m^2)	Material (%)	Maximum Density (flakes/m^2)	Tools	Description
North Group						
1	J1-J3	9.4	100% OP	10		Diffuse scatter, biface thinning flakes dominate; denser in 1992.
2	K1-K3	9.4	100% OP	10		Small diffuse scatter of blank preparation and thinning flakes; more distinct in 1992.
3	L1-L4	99	60% OP; 40% OB	8--obsidian; 30+--opalite	Opalite scraper; Obsidian Elko	Sparse scatter of obsidian debitage within opalite scatter overlaping with WSW edge of Feature 4.
4	1992 Test	24	98% OP; 2% OB	80	1 biface	Discrete dense scatter of opalite debitage; mid-stage thinning.
5	M1-M2	39.3	100% OP	40		Large opalite biface thinning debitage present. Appears to be eroding out of hill. Obsidian flake collected from surface.
6	1992 Test	10.5	90% OP; 10% OB	40		Small, med. & large debitage; mid/late biface thinning; little heat-treatment; obsidian mostly pressure flakes.
7	1992 Test	1.8	100% OP	100+		Dense scatter of mostly small to medium debitage; mid-stage reduction; some heat treatment.
8	N1-N3	21.2	99% OP; 1 % OB	100		Concentration of thinning flakes; may represent a single reduction event.
31	AE1-AE3	3.5	100% OP	75		Small, dense, white opalite scatter of thinning flakes.
Central Group						
9	O1-O3	11	99%OP; 1% BA	50	4 bifaces; 1 flake tool	Diffuse scatter of late stage opalite thinning flakes.
10	P1-P3	314	99% OP; 1% OB	50		Long narrow scatter with dense and diffuse areas. Primarily late stage debitage.

Table 3, continued.

Feature #	Units	Size (m^2)	Material (%)	Maximum Density (flakes/m^2)	Tools	Description
11	Q1-Q8	55	100% OP	40	1 pc. groundstone, 1 scratched stone, FCR	Diffuse scatter of multi-colored opalite thinning flakes. Some cobble reduction. Numerous FCR.
12	AN1	6.2	100% OP	Not given	1 biface, 1 Gatecliff point	Scattered around feature surface. Excavated in 1992. Dense, small scatter of opalite thinning debitage.
13	R1-R4	189	99% OP; 1% OB	50	6 bifaces	Large diffuse scatter of predominantly white opalite. Mostly middle stage reduction.
15	T1-T3	353	99% OP; 1% OB	100	3 bifaces	Large, dense late stage opalite scatter. Small cluster of tin cans on NE edge.
16	U1-U2	15.7	99% OP; 1 % OB	15	1 flake tool, 1 biface	Small diffuse concentration within a moderate density scatter. Predominantly white opalite thinning flakes. Feature is on slope--disturbed?
17	V1-V4	28.3	99% OP; 1% OB	75	3 bifaces	Small, dense opalite scatter of thinning flakes. Obsidian flake collected from surface.
18	1992 Test	13.5	100% OP	50	1 scraper, several tin cans	Small. med. & large debitage of various materials; mid/late stage reduction; some heat treatment.
19	1992 Test	2.2	100% OP	30	1 biface, 2 cans	single FCR with associated lithic scatter and historic cans F18).
20	Historic scatter, not excavated					19 cans, 4 glass frags.dump along drainange; includes coffee and milk cans.
26	Z1-Z2	28.3	95% OP; 1% OB; 1% BA	75		Mlulticolored and white opalite flakes. Primarily large, late thinning flakes.
27	AA1-AA2	31	100% OP	30	1 biface	Small scatter of white and multicolored opalites. Primarily mid to late reduction in range of sizes.
30	AD1-AD3	19	99%OP; 1%OB	70	3 biface	Dense scatter of large thinning flakes of white and colored opalites. Obsidian flake collected from surface.
32	AF1-AF3	31.4	100% OP	20		Small scatter consisting almost entirely of late stage biface thinning flakes. May be a single reduction episode.

Table 3, continued.

Feature #	Units	Size (m^2)	Material (%)	Maximum Density (flakes/m^2)	Tools	Description
South Group						
14	S1-S3	19	99% OP; 1% OB	20	1 biface	White opalite scatter. Mostly thinning flakes. Obsidian flake collected from surface.
21	W1-W3	47	100% OP	40	2 bifaces	Locally dense, fairly discrete scatter of opalite thinning flakes. Possible single reduction event.
22	X1-X4	283	100% OP	60	1 preform, 1 point fragment, 4 bifaces, 1 hammerstone	Large, fairly sparse scatter of mostly white opalite thinning flakes with some core reduction. Amorphous boundaries.
23	1992 Test	5.2	100% OP	80	3 bifaces	Two dense loci within a sparse scatter; small, discrete; mostly white, large, med & small debitage; mid-stage reduction, some heat treatment; effects of slope wash evident
24	1992 Test	36	100% OP	150	8 bifaces, 1 flake tool, 1 Gatecliff point, 1 grndst. frag, 1 ob. flake	Two dense loci within a sparse scatter; mostly white with some yellow & pink; early middle and late reduction; some heat treatment.
25	Y1-Y2	31.5	100% OP	100	5 bifaces	Multiple reduction stages present including several small single reduction events. Several colors of opalite present.
28	AB1-AB2	14.1	100% OP	25	1 biface, 1 obsidian projectile point	Small lithic scatter of primarily white opalite with some other colors. Mostly late thinning, some pressure flakes.
29	AC1-AC2	1.6	50% OP; 50% BA	10	Elko point	Very small flake cluster at head of small runoff channel. Basalt may be from single reduction episode. Basalt flakes are cobble reduction, opalite are thinning.

OP=Opalite; BA=Basalt; OB=Obsidian

Table 4. Debitage Samples from Surface Scrapes.

Group	Feature	Excavation Unit	% Heat treatment	% Color	Opalite Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
Northern	1	J1-1	30	7.2	bE*LR	0	15.6	54.4	28.4	1.5	
		J2-1	70	2	E l	0	0	16.5	81.7	1.8	
		J3-1	60	20.6	bl	0	0	47	46.5	6.5	Obsidian--0.58%
	2	K1-1	35	13.1	elr	0	0	54.6	43.4	1.9	Obsidian--1.9%
		K2-1	40	75.8		0	49.4	20.6	10.6	0	
		K3-1	30	13/6	bEL	0	0	40.2	56.5	3.3	
	3	L1-1	70	9.2	belR	0	36.5	29	27.9	6.5	Obsidian--0.5%
		L2-1	55	13.4	clR*	0	0	39.7	49.4	10.9	Obsidian--0.51%
		L3-1	70	17.6	E lR	0	0	53.9	37.2	8.9	Obsidian--0.24%
		L4-1	70	7.8	celR	0	0	53.2	34.5	12.3	Obsidian--0.9%
	5	M1-1	55	2.9	BEL	0	36.5	41.3	21.5	0.7	
		M2-1	60	14	bEL*r	0	0	56.9	40.2	2.8	
	8	N1-1	70	0	cBElr	0	24.8	49.5	24.4	1.3	Outre passe flake
		N2-1	80	1.8	cBEL*r	0	12.2	56.2	30	1.6	
		N3-1	85	4.5	cBEL*r	0	17.8	52.3	28.1	1.8	
	31	AE1-1	40	1.4	bE*lr	0	46	41.9	11.6	0.5	
		AE2-1	50	0.9	bE*lr	4.4	38.2	42.5	14.5	0.4	
		AE3-1	55	3	bE*lr	0	59.6	25.8	13.9	0.6	
Central	9	O1-1	80	20	beLR	0	0	40.2	58.4	1.3	
		O2-1	80	20.1	cbElR	0	0	48.2	50.7	1.1	
		O3-1	75	33.6	CBELr	0	12.6	39.8	46	1.7	Basalt--0.16%
	10	P1-1	80	16.9	cBElr	0	8.7	38.5	51.5	1.2	
		P2-1	85	18.5	R	0	0	52.3	45.9	1.8	Obsidian--0.22%
		P3-1	75	8.8	r	0	32.7	29.7	35.9	1.7	
	11	Q1-1	70	43.5	cBELr	0	25.3	37.3	35.6	1.8	Obsidian--0.07%
		Q2-1	50	47.8	cBElr	0	19.3	53.8	25.6	1.3	
		Q3-1	40	44	cbE*lr	0	25.4	37.2	36.3	1.1	

Table 4, continued.

Group	Feature	Excavation Unit	% Heat treatment	% Color	Opalite Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
	11, cont.										
		Q4-1	60	21.6	cbE*Lr	0	29.9	41.9	26.7	1.3	Obsidian--0.08%
		Q5-1	60	31.7	cBELr	0	0	58.3	39.4	2.2	Obsidian--0.31%
		Q6-1	75	24.4	bElr	0	4.3	45.9	47.4	2.3	Obsidian--0.26%
		Q7-1	65	37.2	bELr	0	0	49.1	47.9	2.9	
		Q8-1	65	35.3	B*ELR	0	16	37	45.4	1.6	Obsidian--0.15%
	12	AN1-1	85	13.2	BE*LR	0	21.3	38.7	37.6	2.3	Obsidian--0.05%; Bipolar flake
	13	R1-1	65	30.2	CBeLr	0	14.2	41.2	42	2.6	Obsidian--0.11%; Basalt--0.69%; Some burning
		R2-1	75	43	cbELr	14.9	7.4	35.3	40.4	2.1	
		R3-1	65	27.7	cbElr	0	0	56.3	40.9	2.8	Obsidian--0.11%
		R4-1	50	38.4	CbElr	0	16.6	39.2	43.1	1	Some burning
	15	T1-1	65	10.6	cbElr	0	13.1	57.9	28.1	0.9	Some burned pieces
		T2-1	65	4.6	cbELr	0	13.2	54.5	31.6	0.6	
		T3-1	60	11.7	cbELr	0	11.8	58.3	29	0.8	Some burned pieces
	16	U1-1	40	27.2	cbEl	0	0.01	59	38	3	
		U2-1	60	12.4	cbElr	0	21.8	33.2	43.6	1.4	
	17	V1-1	75	17.6	cbElr	0	15.8	61	36.9	1.1	Some burned pieces
		V2-1	60	16.4	cbElr	0	18.8	47.4	32.6	1.1	Obsidian--0.05%
		V3-1	60	15.4	cBE*L	0	20.8	41.5	36.7	0.9	Obsidian--0.13%
		V4-1	70	15.9	cbE*lr	0	14.4	48.7	35.4	1.5	Obsidian--0.02%
	26	Z1-1	60	32.4	cbEL	0	0	31.2	65.8	3	Obsidian--0.06%
		Z2-1	60	16.4	cBElr	0	13.8	33.1	51.5	1.5	Burning present
	27	AA1-1	80	30.6	cBElr	0	39.4	34.8	25.2	0.5	Heat failed pieces
		AA2-1	80	13.7	bE*Lr	0	11.7	16.4	69.1	2.7	Obsidian--0.07%; Basalt--0.01%; Burning
	28	AB1-1	60	27	bE*lr	0	7.6	57.1	34	1.3	Obsidian--0.14%; Basalt--0.14%; Burning
		AB2-1	50	34.1	BElr	0	0	40.9	56.9	2.2	
	30	AD1-1	65	16.4	BE*Lr	0	24.2	27	47.9	0.9	Obsidian--0.11%
		AD2-1	70	15.8	CBE*Lr	0	20.1	16.1	51.6	12.1	Obsidian--0.02%; Basalt--0.02%
		AD3-1	70	30.2	cbELr	0	7.7	40	50.6	1.7	Obsidian--0.21%; Basalt--0.13%; Burning

Table 4, continued.

Group	Feature	Excavation Unit	% Heat treatment	% Color	Opalite Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
	32	AF1-1	95	2.8	EL	0	0	78.8	20.3	0.8	
		AF2-1	85	7.6	EL	0	0	31.8	63.8	4.3	
		AF3-1	90	16.6	L	0	0	56.8	43.2	0	
Southern	14	S1-1	70	6.6	cbE*Lr	0	14.6	47.6	37	0.8	Obsidian--0.07%
		S2-1	65	4.6	cbElr	0	10.3	55.3	33.6	0.7	
		S3-1	65	3.4	bElr	0	20.8	42.3	35.2	1.6	Some burning
	21	W1-1	98	0.4	bELr	0	17.9	55.7	25.5	0.8	
		W2-1	98	9	cbELr	0	23.2	35.4	40.4	0.9	
		W3-1	95	7.3	bELr	0	14.7	47.8	37	0.4	
	22	X1-1	65	7.2	cBE*L	0	26.3	40.8	32.1	0.8	
		X2-1	90	13.7	bEL*r	0	13.1	46.8	38.2	1.9	
		X3-1	75	11.5	EL*	0	0	60.5	39	0.5	Some burning
		X4-1	60	17.4	bE*lr	0	8.2	36.6	54	1.1	
	25	Y1-1	75	11.7	B*Elr	0	14.1	54.4	30.4	1.1	Obsidian--0.18%
		Y2-1	70	4.5	B*Elr	0	27.3	52.1	20.2	0.4	Obsidian--0.09%
	26	Z1-1	60	32.4	cbEL	0	0	31.2	65.8	3	Obsidian--0.06%
		Z2-1	60	16.4	cBElr	0	13.8	33.1	51.5	1.5	Burning present
	27	AA1-1	80	30.6	cBElr	0	39.4	34.8	25.2	0.5	Heat failed pieces
		AA2-1	80	13.7	bE*Lr	0	11.7	16.4	69.1	2.7	Obsidian--0.07%; Basalt--0.1%; Burning
	28	AB1-1	60	27	bE*lr	0	7.6	57.1	34	1.3	Obsidian--0.14%; Basalt--0.14%; Burning
		AB2-1	50	34.1	BElr	0	0	40.9	56.9	2.2	
	29	AC1-1	70	4.4	belr	0	0	27.4	50.6	22	
		AC2-1	60	13.8	beLR	0	0	21.7	75.8	2.4	Basalt--26.1%

†c=core reduction; b=blank preparation; e=early thinning; l=late thinning; r=retouch
Lower case--minor component, Capital letter=common component, Emphasized capital--dominant

Table 5. Flaked Stone Artifacts Recovered from Feature Contexts.

	BIFACE STAGES														
	Indeter.	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Early 5	Late 5	Flake Tool	Core/ Mod. Chunk	Preform	Point	Total	Projectile Pt.
South Group															
Feature 14 (S)				3			1			2				6	
Feature 21 (W)	3				1					3				7	
Feature 22 (X)	5		1	1	5	1	1			2		1	2	19	2 Opalite Frags.
Feature 25 (Y)	1	2	1	4	2	3		1		1				15	
Feature 29 (AC)	3						2				1		1	7	Opalite Elko
	12	2	2	8	8	4	4	1	0	8	1	1	3	54	
	22.22%	3.70%	3.70%	14.81%	14.81%	7.41%	7.41%	1.85%	0.00%	14.81%	1.85%	1.85%	5.56%		
North Group															
Feature 1 (J)	1													1	
Feature 2 (K)	1	1												2	
Feature 3 (L)	1									2			1	4	Obsidian Elko
Feature 5 (M)	1			1	1					1				4	
Feature 8 (N)	8		1	1	1	1	1	2	1	5				21	
Feature 31 (AE)	8			3	1					1				13	
	20	1	1	5	3	1	1	2	1	9	0	0	1	45	
	44.44%	2.22%	2.22%	11.11%	6.67%	2.22%	2.22%	4.44%	2.22%	20.00%			2.22%		
Central Group															
Feature 9 (O)	3		1	1						5				10	
Feature 10 (P)	3		1	1		1				3	1		1	11	Opalite Frag.
Feature 11 (Q)	2	1		1	3		1	1		18	1		2	30	Opalite Elko, Opalite Out of Key
Feature 13 (R)	5		1		4		1	2	1	7	2		1	24	Opalite Frag.
Feature 15 (T)	4			4	2	1			1	2				14	
Feature 16 (U)			1		1					4				6	
Feature 17 (V)	7	2	1	1	3	1			1		1		1	18	Opalite Frag.
Feature 26 (Z)	3			1			1			1				6	
Feature 27 (AA)	6		2	1			2		1	8			1	21	Exotic Chert Frag.
Feature 30 (AD)	10		1	3	3		2	1		8			1	29	Opalite Elko
Feature 28 (AB)	1				1					1			1	4	Obsidian Out of Key
Feature 32 (AF)	1														
	45	3	8	13	17	3	7	4	4	57	5	0	8	173	
	26.01%	1.73%	4.62%	7.51%	9.83%	1.73%	4.05%	2.31%	2.31%	32.95%	2.89%		4.62%		

Central Group

The central group comprises the largest number (n=15) of surface features (9-13, 15-19, 26-28, 30 and 32). Most features were scattered for about 120 m down the axis of the southern ridge. Most lie on a flatter portion of the central ridge at about the same elevation as those in the northern group. Features 23 and 24 were excavated in 1992 (Ataman et al. 1992); these are not included in Tables 2 and 3. The largest features occurred in this group (cf. Table 3), but feature size was highly variable (mean feature area = 74.1±114.7 m2). Debitage in surface features of the central group was dominated by opalite, although several samples contained small amounts of other materials (cf. Table 3). Debitage density in this feature group ranged from 20 to 100 items per m2. Formed artifacts were relatively abundant (1.7 per feature) on the surface, including bifaces, flake tools, and projectile points; Features 15 and 17 were especially rich in bifaces (cf. Table 5; Ataman et al. 1992:Table 2). A scratched stone, a metate fragment, and a piece of fire cracked rock were found in Feature 11 (cf. Table 3).

Detailed information on the composition of the opalite debitage samples recovered from surface scrapes is given in Table 4. The mean fraction of heat treated debitage in the central group was 67.9±12.2 percent, while the percentage of colored chert was 22.0±12.2., the highest in both categories in any feature group. Features 15 (Block T), 17 (Block V), 14 (Block S), 21 (Block W), 25 (Block Y), and 29 (Block AC) are internally consistent in composition and technology suggesting each may represent one reduction episode. Feature 16 (Block U) however, was internally variable in technology and amounts of heat-treated and colored debitage (Ataman et al. 1992:25, Table 3). Obsidian flakes occurred in half (n=7) the central group features (Table 4). This group contained the highest number of debitage samples (n=163). The central group comprises the greatest range of the biface reduction sequence, with more core reduction here.

Southern Group

The southern group is comprised of eight features (14, 20-25, 29) on a low, bench-like terrace (Terrace 3) between the intermittent stream and the flank of the southern ridge. Historic Feature 20 (a can scatter) appeared in this group; without depth potential, it was not excavated. As in the central group, feature size varied (mean feature area = 60.5 ± 99.48 m^2). Opalite debitage dominated most surfaces, but Feature 29 contained fifty percent basalt (Table 3). Obsidian was the most common non-opalite material (with the exception of the high proportion of basalt in Feature 29) and surface tools were most abundant (2.9 per feature) in this group, including bifaces, a flake tool, a hammerstone, a preform, and an Elko point (cf. Table 5). Bifaces were particularly abundant in Features 22-25 (cf. Table 5; Ataman et al. 1992:Table 2).

In debitage samples from surface scrapes (cf. Table 4), mean fraction of heat-treated debitage was 58.8±32.9 percent; mean fraction of colored cherts was 14.0±10.5 percent. These values are very similar to those of the northern group; both are smaller than those of the central group. Little variability in debitage from scrapes (cf. Table 4) suggests that Features 14, (Block V), 21 (Block W), 25 (Block Y), and 29 (Block AC) are internally consistent in composition and technology, suggesting each represents one reduction episode. Feature 21 has a high percentage of heat-treated debitage relative to other features across the site. Features 22 (Block X), 23, and 24 were internally variable in technology and amounts of heat-treated and colored debitage (Ataman et al. 1992:25, Table 3). Significant quantities of basalt debitage were found only in Feature 29, a very small, sparse cluster of basalt and opalite reduction debitage containing an Elko point and few other tools (cf. Table 5). Its location at the head of a small surface runoff channel originally prompted us to think that the feature might have been eroded, but the internal consistency of both basalt and opalite technologies suggests remnants of the original feature (cf. Table 4). Seventy-five opalite samples were analyzed from this feature group. Most contain all or nearly all of the biface reduction sequence and do not differ markedly from the samples in the other feature groups.

Summary

Overall, four features (9, 11, 13, 28) contain noticeably high percentages of colored debitage; all four were part of the central group. Two of the three features which contain relatively large amounts of heat-treated debitage are in the southern group (Features 21, 22) and the third (Feature 32) in the central group, is on the northwest edge of the site. The internal consistency in technology and other characteristics of 15 features suggest single reduction events (Features 3, 5, 8, 9, 13, 14, 15, 17, 21, 25, 26, 28, 29, 31, 32). This consistency does not appear to be simply a result of sampling of a homogeneous background scatter. If that were the case we would expect more geographic clustering of this group (instead they occur across the site) and less variation among them in amounts of heat treatment and debitage coloration, non-local materials, and so forth.

The remaining 18 features are more difficult to characterize. Many likely represent a series of overlapping reduction events as evinced by the variability between samples from adjacent units and areas within larger features. Alternatively, some of these debitage clusters may be the result of geomorphic processes such as deflation or slopewash and may be mixed.

Percentages of heat-treated debitage are fairly high among most features at 26Ek5040, suggesting heat-treated materials were transported here for reduction or that heat treatment took place on site, although no unequivocal heat treatment hearths were located. In contrast, percentages of colored debitage are consistently low except in the features mentioned earlier, and even there percentages are modest (30-40%).

During the period of time represented by these surface features, the inhabitants of 26Ek5040 appear to have relied on a source of white opalite for the bulk of their toolstone. Non-opalite materials are fairly rare across the site, consisting of a very thin scatter of obsidian and a few sparse clusters of basalt. Obsidian is found in the largest relative amounts in features in the central group. Seven pieces of obsidian from surface features were subjected to hydration analysis. Samples from Features 2, 13, and 14 all had hydration rinds greater than 6.0 microns, while those from Features 11, 17, and 25 ranged from 1.4 to 6 microns. The measurement of 4.8 microns on a piece from Unit Q8 is more characteristic of the rind from pieces in lower levels of that block; it may have been transported from below.

Basalt debitage was rare in surface feature samples at 26Ek5040 and was much earlier in stage than opalite debitage, consisting mainly of core reduction and blank preparation flakes. Obsidian tools appear to have been made primarily from small obsidian nodules (cf. discussion in Chapter 5).

Variation in some aspects of feature composition was also noted between feature groups. Though Middle and Late Stage 3 bifaces were the most common biface type recovered from all features, they were most common in features in the southern group. Figure 20 illustrates major differences between flaked stone tool assemblages of different feature groups: northern and southern feature group tool assemblages are quite similar, but that from the central group has fewer bifaces and flake tools, and slightly more projectile points. Percentages of colored debitage were much lower in the northern group surface scrapes and in the southern group excavation units. A consistent factor between groups was representation of the entire reduction sequence from blank preparation flakes to retouch flakes in most features. Core reduction debitage was also fairly common.

To explore whether certain stages of reduction were more common in particular parts of the site, the weight of each size-graded portion of the debitage samples was converted to a percentage (cf. Table 4) and compared within and among features and groups. Most samples are dominated by G2 (1/2 in) and G3 (1/4 in) debitage, but some minor variation is apparent in the larger and smaller debitage sizes (cf. Table 4). On Terrace 1, two features in the southern group (22, 25) and one in the central group (16) have units with slightly elevated G1 (1 in) percentages (>20%). Little G1 debitage was recovered from Feature 1, while elevated amounts were found in Features 5 and 31 (northern group). Relatively large amounts of G4 debitage (>5%) were found in Features 2 and 3 in the northern group, and Feature 30 in the

central group. Feature 26 (central group) had a high percentage of G3 debitage. Finally, also in the central group, large percentages of G1 were found in Feature 10 coinciding with low percentages of G2 flakes. Features 11 and 32 (central group) were highly variable internally. The southern group, therefore, seems to contain a larger proportion of G1 debitage than the other groups. Conversely, proportionately higher percentages of G4 debitage were more common in the northern group.

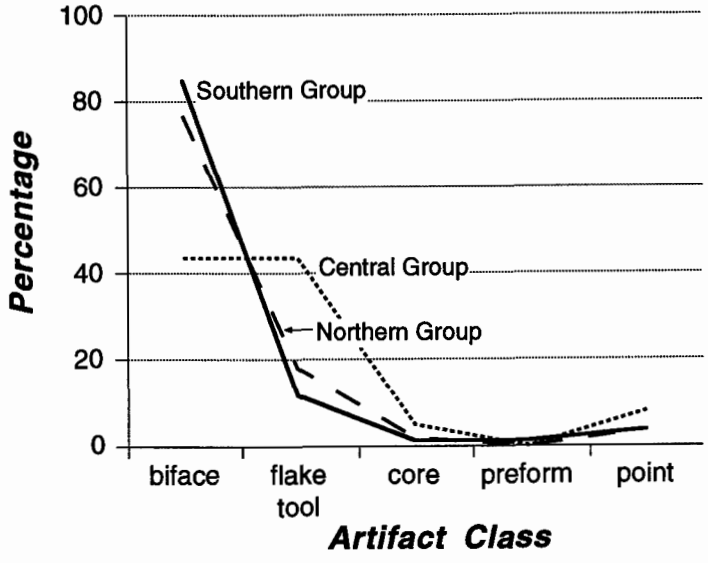


Figure 20. Artifacts recovered from feature contexts.

Analysis of the contents of surface features at 26Ek5040 shows some spatial variation in raw material use and tool manufacture and use/discard. This pattern suggests that activities on these surfaces may have varied through time or reflect internal site patterning. The following discussion explores variation in subsurface features.

Subsurface Cultural Features

In addition to the 32 surface features, nine subsurface features were encountered: one in Trench B, one in Block Q, one eroding from the wall of a 1992 test unit, and the remaining six in the mechanically scraped areas.

Feature 33 (Units Q5-Q8)

This cluster of fire-cracked rock (FCR) was uncovered during excavation of Feature 11 (Block Q), a diffuse surface opalite reduction scatter with groundstone and FCR (Figure 21). Excavation of Units Q5 & Q6 revealed a cluster of FCR 4-6 cm below the surface (Figure 22). Though charcoal flecks and burned flakes were noted in the screen, little charcoal was visible in the feature and flotation of soil samples returned insufficient charcoal for standard or extended count radiocarbon dating. Two fragmentary pieces of groundstone were associated with this feature, one a fire-cracked, highly polished fragment of basalt (Q6-2-1.4), and the other a moderately polished piece of welded tuff with an irregular use surface (Q5-2-2.1). Units Q7 and Q8 were excavated east and south, respectively, of this feature (cf. Figure 21), but contained only scattered pieces of FCR. The FCR cluster in Q5 and Q6 continued only to between 10 and 12 cm below surface (Appendix H, Figure H.5a). Debitage and tool counts also dropped sharply below this level.

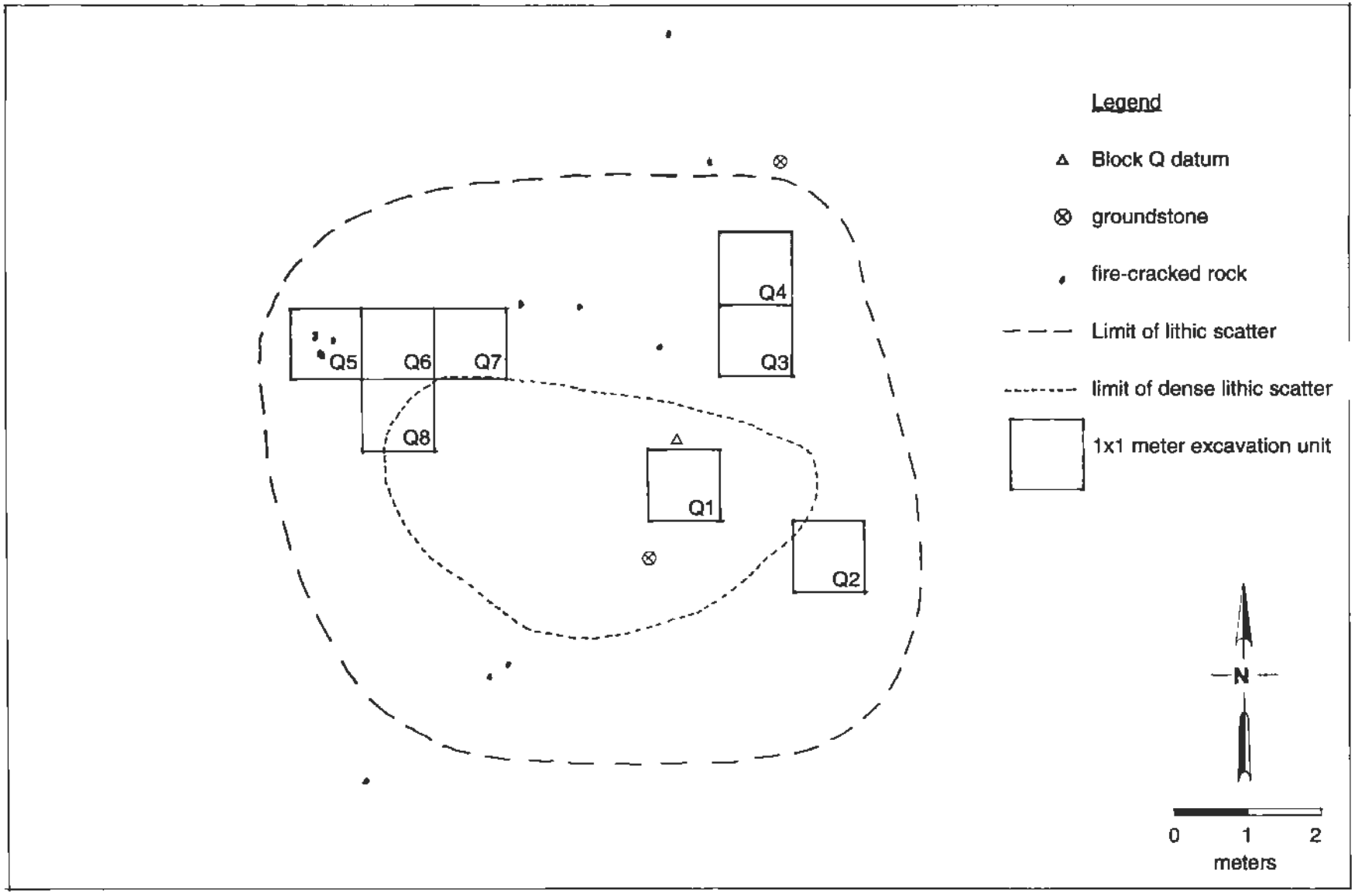


Figure 21. Plan view of Block Q with surface fire-cracked rock.

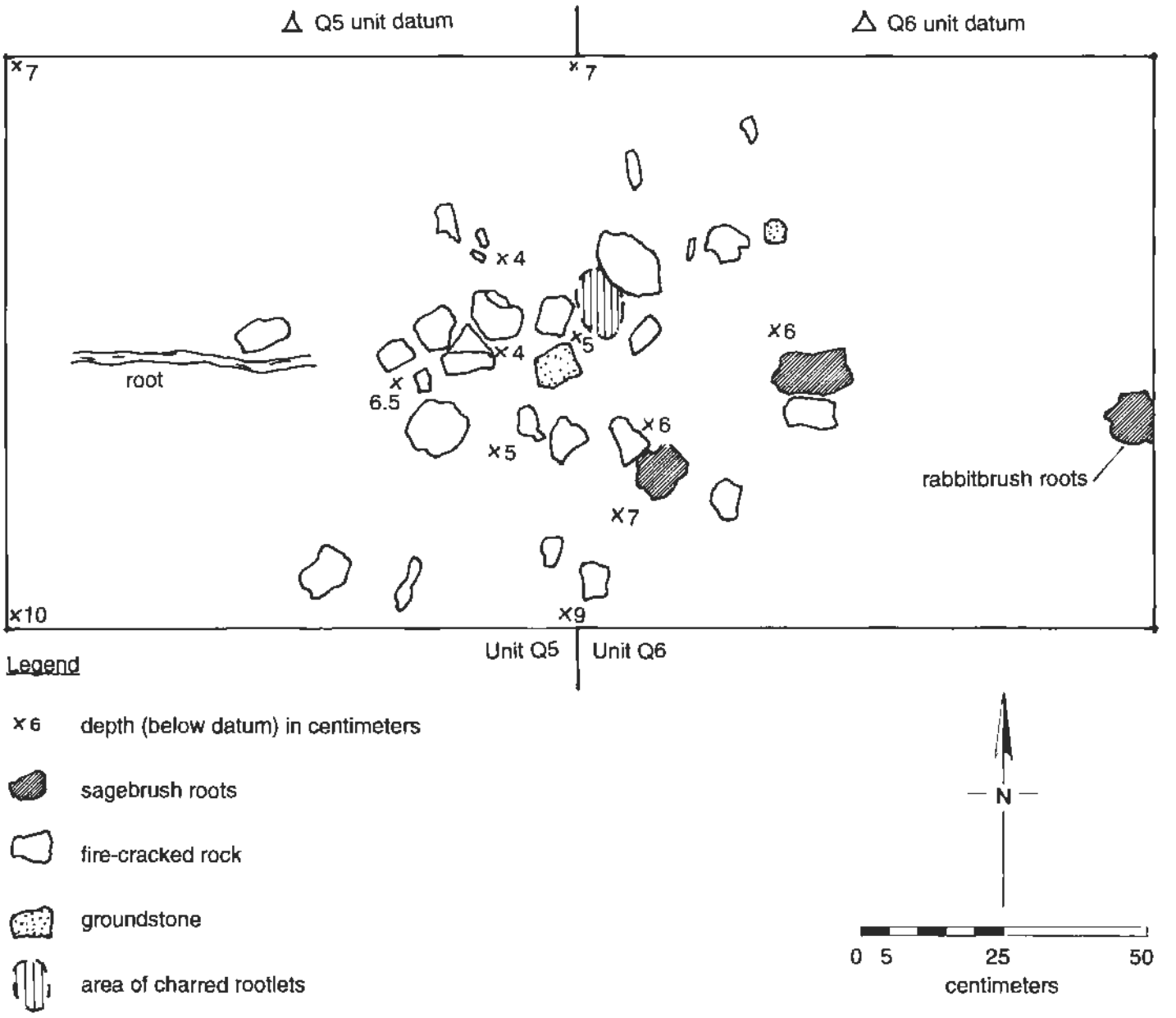


Figure 22. Plan view of Feature 33 (Units Q5 and Q6, after 4 cm surface scrape).

The lack of charcoal or ash and near-surface location in combination with the clustered arrangement of FCR suggests this feature has been eroded and may have once been a hearth. Any organic remains it may have contained have been leached from the fill; no feature outline was visible even in profile. Flotation of a sample of hearth fill returned only scanty sagebrush charcoal. An unidentified seed and a piece of grass stem tissue were also recovered (see Appendix G). Nonetheless, this area of the site seems to have been the focus of much activity. Projectile points, groundstone fragments, and other tools are common, and debitage is varied and numerous. A hearth in the midst of all this activity certainly would not be surprising.

Feature 34 (Unit AM1, 2)

This small charcoal stain was discovered in the north wall of Trench B during profiling. It consisted of a small, elongate, saucer-shaped lens of dark earth; further study discovered two strata within this burned layer. Excavation revealed that the feature extended from 15-34 cm below surface and consisted of two lenses of a dark gray-brown platy silt loam separated by a 2 cm thick layer of reddish brown burned earth. The fill had been mixed in places by insect or rodent disturbance. The deepest part of the feature appears to have been removed during excavation of the trench and only a small part was preserved in Unit AM2. Only the first platy fill layer and the layer of burned earth are visible in the unit's north wall profile (Figure 23); both dip steadily down toward the east-southeast. Though a flotation sample was taken from each fill layer, charcoal was scarce; a composite sample from all three layers returned a radiocarbon date of 850±200 B.P. (Beta-74722). The late date for this feature was unexpected because obsidian hydration data and projectile point typing have suggested primary occupation of the site occurred during the Middle Archaic (see discussion below and in Chapter 6). This hearth date and several narrow obsidian hydration measurements does suggest, however, that the site was used (if only occasionally) in the Late Archaic as well. Further evidence for a cultural surface at the level of this feature is found in the debitage samples from this unit (Table 6). There is a sudden abrupt decrease in heat-treated debitage and increase in colored debitage in samples from the feature's level of origin. As well, flake technology shifts abruptly from dominance by early stage debitage to an emphasis on the middle reduction sequence.

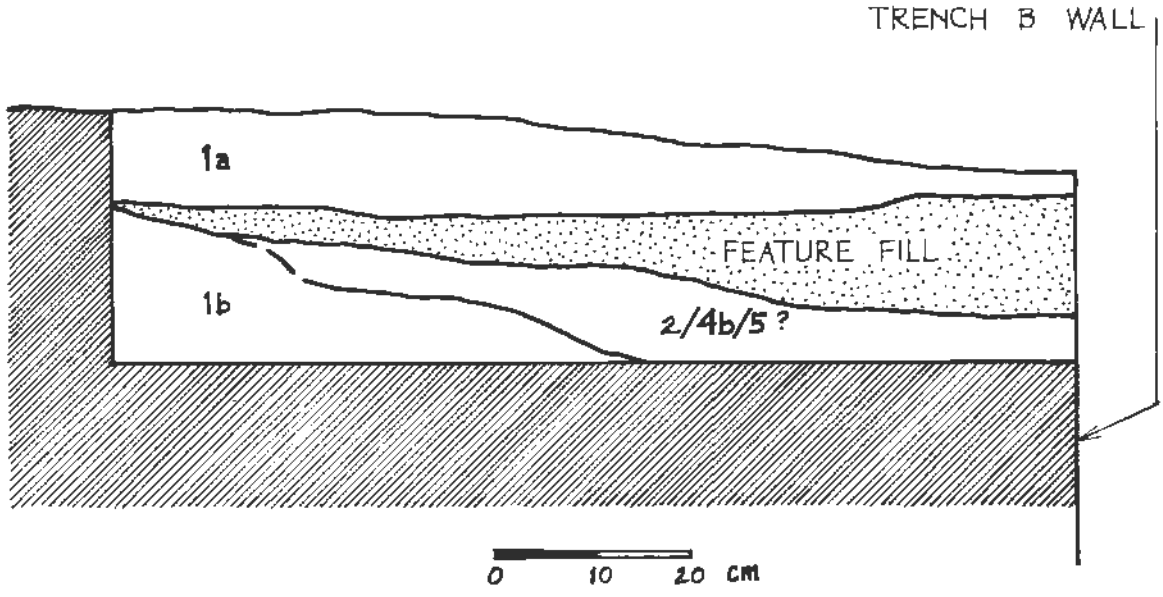


Figure 23. Profile of Feature 34 (Block AM) east wall of AM1.

Table 6. Debitage Samples from Excavation Units, by Level.

Unit/Level	% Heat treatment	% Color	Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
Northern Group									
J3-1 (F. 1)	60	20.6	bl	0	0	47	46.5	6.5	Obsidian--0.58%
J3-2	85	0	L*	0	0	67.7	32.2	0	
J3-3	75	18.9	L*r	0	0	22.6	74.2	3.2	
J3-4	75	22	L	0	0	45.5	53.2	1.3	
J3-5	70	2.5	beL	0	0	69.2	30.8	0	
N3-1 (F. 8)	85	45	cBEL*r	0	17.8	52.3	28.1	1.8	
N3-2	85	6.6	BeL	0	15	57.4	25.8	1.7	Obsidian--0.09%
N3-3	85	8.6	cbEL*r	0	22	46.5	30.2	1.3	
N3-4	90	4.4	b	0	22.8	38.1	34.8	2.6	
N3-5	65	12.4	belr	0	0	48	48.7	3.2	
N3-6	50	10.5	LR	0	0	69.6	30.4	0	Potlidded flakes
AE2-1 (F. 31)	50	0.9	bE*lr	4.4	38.2	42.5	14.5	0.4	
AE2-2	40	0.2	bE*lr	0	29.2	39.2	30.9	0.6	
AE2-3	40	1	bE*LR	8	29.2	41.4	20.2	1.1	
AE2-4	60	0.5	bEL*R	0	15.5	60.1	22.8	1.5	
AE2-5	55	42.3	E	0	0	31.1	68.9	0	
AE2-6	75	10	L*r	0	0	0	100	0	
Central Group									
P1-1 (F. 10)	80	16.9	cBElr	0	8.7	38.5	51.5	1.2	
P1-2	65	18.9	CbELr	0	18	45.8	35.4	0.8	
P1-3	85	23.1	cBEL*r	0	9	49.8	40	1.2	Obsidian--0.1%; burned, potlidded flakes
P1-4	60	15.6	cBEL*R	0	37.7	31.8	29.5	0.9	Obsidian--0.26%
P1-5	60	41.3	BEL*r	0	41.9	31.7	25.6	0.8	Obsidian--0.09%
P1-6	50	65.4	beL*r	0	0	48.1	47.7	4.1	
Q5-1 (F. 11)	60	31.7	cBELr	0	0	58.3	39.4	2.2	Obsidian--0.31%
Q5-2	80	14.7	cbELr	0	0	57.8	40.2	1.9	Obsidian--0.39%
Q5-3	70	39	CBE*LR	0	29.7	42.7	27	0.5	Obsidian--0.02%
Q5-4	70	18.4	cBELR	0	17.6	44.9	36.5	0.9	
Q5-5	70	21	CBELr	30.5	24	18.7	26	0.8	Obsidian--0.23%
Q5-6	60	23.2	cBeLr	0	11.2	35.7	50.1	3	Obsidian--0.56%

Table 6, continued.

Unit/Level	% Heat treatment	% Color	Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
Central Group, continued.									
Q6-1	75	24.4	bElr	0	4.3	45.9	47.4	2.3	Obsidian--0.26%
Q6-2	55	44.3	CbElr	0	7.1	52.8	37.8	2.1	Heat-failed pieces
Q6-3	70	26.9	cBEL*R	0	12.9	41.2	45	0.9	Obsidian--0.17%
Q6-4	75	25.6	CBeLR	0	12.1	45.4	41.3	1.1	Obsidian--0.04%; Potlidded flakes
Q6-5	55	33.5	CBELr	0	34	36.3	28.5	1.1	Obsidian--0.06%
Q6-6	65	35.6	bELr	0	7.8	39	50.3	2.8	Obsidian--0.49%
Q7-1	65	37.2	bELr	0	0	49.1	47.9	2.9	
Q7-2	75	29.9	cBEL*r	0	11.9	38.6	46.5	3	Obsidian--0.44%; Burned
Q7-3	60	29	cbeL*r	0	15.8	38.7	44	1.4	
Q7-4	80	25.3	cBeLR	22.7	6.3	34.7	34.3	2	Obsidian--0.06%; Basalt--0.13%
Q7-5	70	23.3	cBEL*R	0	25.1	35	37.3	2.5	Obsidian--0.15%; Basalt--6%
Q8-1	65	35.3	B*ELR	0	16	37	45.4	1.6	Obsidian--0.15%
Q8-2	65	33.1	bELr	0	13.2	41.5	44.1	1.1	Obsidian--0.08%
Q8-3	80	24.3	cBEL*r	0	7	45.9	46	1.1	Obsidian--0.10%
Q8-4	70	12.2	cBE*LR	16.3	32.8	30	20.4	0.4	Obsidian--0.02%
Q8-5	80	25.9	cbeLR	0	16.7	41.4	40	2	Obsidian--0.15%; Heat-failed pieces
R2-1 (F. 13)	75	43	cbELr	14.9	7.4	35.3	40.4	2.1	Some burning
R2-2	65	37	bElr	0	0	42.6	48.9	8.5	
R2-3	80	16.5	cbElr	0	0	54.8	40.6	4.6	Some burning
R2-4	80	22	cElr	0	0	26.8	66.1	7.05	Basalt--4.7%; Some burning
T2-1 (F. 15)	65	4.6	cbELr	0	13.2	54.5	31.6	0.6	
T2-2	75	3.4	cElr	0	19	45	35.3	0.7	
T2-3	65	8.2	cbELr	0	19.9	47.2	31.7	1	Some burning
T2-4	80	6.2	cbE*Lr	0	16.4	51.7	31.1	0.8	A few burned pieces
T2-5	65	18.3	cbElr	0	43.4	29.2	25.8	1.5	Obsidian--0.67%; Some burned flakes
V2-1 (F. 17)	60	16.4	cbElr	0	18.8	47.4	37.6	1.1	Obsidian--0.05%
V2-2	70	6.5	cbElr	0	42.6	32.2	24.2	1	
V2-3	25	25	bElr	0	51.8	26.1	20.7	1.3	
V2-4	50	19.6	bELr	0	31.1	33.8	32.5	2.6	

Table 6, continued.

Unit/Level	% Heat treatment	% Color	Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
Central Group, continued.									
AF1-1 (F. 32)	95	2.8	EL	0	0	78.8	20.3	0.8	
AF1-2	100	4.2	EL*	0	46.9	26.9	26.2	0	
AF1-3	90	16	EL*	0	0	66.3	33.2	0.5	
AF1-4	75	8.8	L	0	0	22	78	0	
AG1-1	70	17.8	bel	0	0	44.9	53.4	1.7	
AG1-2	70	24.8	BeLR	0	0	39.3	58	2.7	
AG1-3	80	13.1	bEL*R	0	9	46.2	43.3	1.4	Basalt--0.08%
AG1-4	60	12.9	bE*Lr	0	11	43.7	43.8	1.4	Obsidian--0.15%; Basalt--0.15%
AG1-5	65	33.5	bE*LR	0	10.8	56.9	31.2	1.1	Basalt--0.06%
AG1-6	65	22.1	ELr	0	0	23.5	73.7	2.8	
AG1-7	80	4.2	bE*Lr	0	27.4	31.6	38.8	7.2	
AG1-8	50	9.6	R	0	0	41.1	59	0	
AI1-1	100	16.9		0	0	60	40	0	
AI1-2	95	0	bL*	0	0	44.8	54.2	1	
AI1-3	80	6.7	beL*	0	41.1	28	28.8	2	
AI1-4	95	13.1	L*	0	0	73.8	26.1	0	
AI1-5	75	13.6	bl	0	0	65.8	34.2	0	
AM1-1	85	21.3	cBELr	0	8.2	50.7	39.2	1.9	Burning
AM1-2	40	75	bel	0	0	70.4	25.3	4.3	
AM1-3	60	17.4	cBELR	0	23.3	36	38	2.8	
AM1-4	60	33.3	CBE	0	5.9	56.5	36.2	1.4	Obsidian--0.16%; Potlidding
AN1-1 (F. 12)	85	13.2	BE*LR	0	21.3	38.7	37.6	2.3	Obsidian--0.05%; 1 bipolar flake
AN1-2	75	4.4	BE*Lr	0	43.6	42	14.3	0.6	
AN1-3	75	4.6	cBEL*r	10.5	19.9	42.9	25.3	1.4	Obsidian--0.01%; Basalt--0.01%
AN1-4	75	17.1	cBELr	0	45.2	30.2	23.7	0.8	Obsidian--0.11%
Southern Group									
S2-1 (F. 14)	65	4.6	cbElr	0	10.3	55.3	33.6	0.7	
S2-2	70	7.6	cbElr	0	9.7	54.2	35.5	0.6	
S2-3	75	5.9	bElr	0	17.8	33.6	47	1.6	

Table 6, continued.

Unit/Level	% Heat treatment	% Color	Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
Southern Group, continued.									
S2-4	65	6.6	cbElr	0	53.1	32.5	14.1	0.3	Potlidding and burning
S2-5	50	19.5	Elr	0	46	29.3	24.7	0	Obsidian--1.05%; Potlidding and burning
S2-6	80	9.4	cbEL	0	0	58.4	40.2	1.3	Basalt--12.9%
X1-1 (F. 22)	65	7.2	CBE*L	0	26.3	40.8	32.1	0.8	
X1-2	50	4.4	EL	0	0	42.6	57.4	0	
X1-3	80	19.6	beL*R	0	19.1	38.9	40.3	1.7	Some burning
X1-4	60	6	BEL	0	0	0	98.2	1.8	
Y1-1 (F. 25)	75	11.7	B*Elr	0	14.1	54.4	30.4	1.1	Obsidian--0.18%
Y1-2	80	17.6	bE*L	0	16.6	50.6	31.3	1.4	
Y1-3	75	11.6	cBELr	0	8.6	52.4	38.1	0.9	Obsidian--0.28%
Y1-4	70	30.5	bE*lr	0	0	54.8	43.3	1.9	Obsidian--0.09%
Y1-5	60	11.3	cbeL*r	0	0	55.1	41.5	3.4	
Y1-6	80	32	bElr	0	0	50.8	47.3	1.7	
AH2-1	65	28.9	BEL	0	0	54.7	45.3	0	
AH2-2	85	41.9	eL*	0	0	61.8	38.2	0	Burned pieces
AH2-3	70	27.9	BE*l	0	0	77.2	22.8	0	
AH2-4	90	46.4	cB*el	0	25.8	41.8	31.8	0.5	
AH2-5	75	21.1	E	0	41.9	36.4	21.6	0	
AH2-6	40	27.4	BELr	0	17.3	60.3	21.7	0.6	Basalt--0.21%
AH2-7	50	34	BeL	0	0	37.5	62.5	0	Basalt--0.38%
AH2-8	50	53.1	bE*l	0	14.7	68.1	17.2	0	
AH2-9	75	41.9	bEL	0	30.7	59	10.2	0	
AH2-10	75	48.3	cbElr	0	0	44.7	55.2	0	
AJ1-1	65	28	bEl	0	0	43.5	56.5	0	
AJ1-2	95	40.7	beL	0	0	76.3	23.6	0	
AJ1-3	65	15.9	bEL*r	0	17.9	40.3	40.2	1.5	
AJ1-4	85	10.5	eL*	0	0	51.2	48.8	0	Obsidian--0.19%
AJ1-5	85	17	cbeL*r	0	0	43.2	55.7	1.1	Obsidian--0.17%; Potlidding
AJ1-6	90	31.9	bE*L	0	37.5	41.5	20	1	
AJ1-7	75	60.2	Bl	0	0	70.2	29.8	0	Potlidded flakes

Table 6, continued.

Unit/Level	% Heat treatment	% Color	Technological Characterization†	Size Grade--% of Sample G0	G1	G2	G3	G4	Comments
Southern Group, continued.									
AL1-1	70	44.6	belr	0	30	29.3	38.5	2.1	
AL1-2	75	20.7	eL*r	0	27.2	34.7	35.5	2.6	
AL1-3	65	23.3	EL*r	0	19.8	41.6	37.4	1.2	
AL1-4	65	26.8	cbEL*R	0	20.7	39.1	39.4	0.7	
AL1-5	70	24.5	cBElr	0	45.6	34.8	19.1	0.4	
AL1-6	75	26.5	BeL*r	0	27.9	38.6	32.3	1.1	
AL1-7	65	23.1	cbeL*r	0	10.4	52.8	35.6	1.2	
AL1-8	60	15.7	BeL*r	0	10.6	56.6	32.1	0.7	Obsidian--0.06%
Other									
AK1-1	85	9.5	be	0	83.6	0	16.3	0	
AK1-2	85	9.1	ELr	0	0	52.6	46	1.4	
AK1-3	95	6.3	bE*LR	0	26.3	37.3	35	1.3	

† c=core reduction, b=blank preparation, e=early thinning, l=late thinning, r=retouch.
Small case--minor component, Capital letter--common component, Emphasized capital--Dominant

Five soil samples were collected from the feature, three from Level 3 of Unit AM1 and two from a column sample (labeled Unit AM2) of feature fill taken from the east wall of Unit AM1. Charcoal content was extremely low in all samples (these samples were picked through for radiocarbon assay before macrofossil analysis) although sagebrush and a hardwood were present. Rootlets and insect burrows were common throughout suggesting that bioturbation has been extreme. Twelve charred seeds were recovered, including goosefoot or chenopod (*Chenopodium* sp.), plantago (*Plantago* sp.), chickweed (*Stellaria* sp.), a bunchgrass seed, two unidentified grass seeds, and a tiny legume seed. Seed quantities are too low for interpretation as food remains. Plant tissue noted included grass stems, lily bulbs, and unidentified fragments (cf. Appendix G).

Feature 39 (Unit AN1)

Testing in 1992 excavated a unit in Feature 12, a dense, discrete, surface opalite reduction scatter covering a 6 m^2 area. Upon our return in 1994, we found this backfilled unit had been partially eroded along its north wall and that a small charcoal stain (Feature 39) was visible in the northwest corner. In addition, flake densities in the eroded area were extremely high, suggesting that surrounding untested deposits were rich. Therefore, a second unit was excavated off the north wall of the 1992 unit, designated Unit AN1.

Feature 39 was not encountered until the base of the surface scrape (4 cm below surface) and continued until 20 cm below surface. The fill consisted of a dark platy silt loam with charcoal flecks and numerous small thinning flakes. Feature fill was collected in two bulk samples. Though many small charcoal flecks were visible in these samples, dry sorting and flotation recovered insufficient charcoal for radiocarbon dating. Only an ephemeral boundary was visible in the unit wall after excavation. Once again, charcoal content was low in the soil sample analyzed for macrofossil identification; dark staining may thus have been due to modern organic content. Grass stems, sage twigs, and a grass seed were noted. Counts of small opalite flakes were particularly high.

Two interesting items were associated with Feature 39. First was a burned, charcoal stained area in the east half of the unit which extended from 4-6 cm below surface and encompassed Feature 39 in the southeast. This stain was mottled, soft in spots, perhaps badly mixed. Second, the level below the feature (Level 3) was extremely artifact rich, particularly in the south half of the unit, exhibiting clast-supported lenses of flakes and biface fragments. Feature fill at this level was also full of small thinning flakes. A large part of the concentration of materials in this area may be the result of erosion of the test unit with materials washed in and concentrating in this low spot. It is also possible that Feature 39 may have been excavated into this rich layer of artifacts.

Features 35-38, 40, 41

Numerous charcoal stains were exposed by mechanical scraping of the ground surface in non-feature contexts. The majority of these could be discounted by only cursory inspection as recent root burns. Six, however, were anomalous enough to require excavation. Units of 1 m x 50 cm bisected these features. In these units, half the feature was excavated and if it proved to be natural, excavation was terminated. Features 35, 36, 37, and 38 were excavated in this manner and abandoned; a biface fragment was collected from the surface of Feature 35. No unit materials were screened nor samples or artifacts collected.

Features 40 and 41, however, were more anomalous and were excavated like standard excavation units in one 10 cm level from an established datum. Feature 40 consisted of a 30 x 20 cm mottled smear of

black, red-brown burned, and dark brown earth which continued for approximately 10 cm in depth. Feature fill looked disturbed or badly turbated and small patches of mottled feature fill were encountered sporadically throughout the unit level. Feature fill was collected as a bulk sample; though dry sorted and subsequently processed by flotation, only rare charcoal flecks were recovered. Throughout excavation the feature boundary was ephemeral and no outline was visible in profile. No fire-cracked rocks were noted though some flakes looked burned. If this was a cultural feature such as a hearth, it appears to have received no formal preparation (such as pit excavation or a rock lining before use), and subsequently to have been severely turbated. It is possible this is a modern burn feature, though the lack of charcoal in such an instance is unusual. Botanical remains encountered in flotation residue consisted mainly of sagebrush. Herbaceous stem and grass tissue were also noted (cf. Appendix G).

A full 10 cm level was excavated in Feature 41. Feature fill was collected as a bulk sample; the remaining level spoil was screened and artifacts collected (30+ flakes). The feature consisted of a roughly circular dark stain averaging 50 cm in diameter with a platy dark silty loam fill interspersed with clay in insect and rodent burrows. Signs of mixing and bioturbation were common as were sagebrush roots. Particularly intriguing was the mixture of what appeared to be "fresh" and more weathered charcoals. Despite the abundance of charcoal flecks, sufficient carbon could not be recovered for either standard or extended count radiocarbon dating though the bulk sample was collected from the bottom of the feature (7-10 cm below surface) where it appeared less disturbed. Carbon content of this feature was low and no seeds were noted. Grass and herbaceous stem and root tissues were present (cf. Appendix G). Despite heavy disturbance it appears that Feature 41 consisted of a zone of heavy mixing and turbation above a small charcoal stain associated with a second, apparently recent, charcoal stain. The degree of disturbance in this area precludes specific interpretation of this feature.

Cultural Stratigraphy

Excavation was continued below the first level in 13 features (1, 8, 10, 11, 12, 13, 14, 15, 17, 22, 25, 31, 32); an additional seven discretionary units (Units AG1, AH1, AI1, AJ1, AK1, AL1, AM1) were excavated to test for cultural deposits and reveal stratigraphy in areas where no surface features were identified (cf. Figure 8). Table 6 summarizes debitage samples from each unit level—the categories are the same as those used in Table 4. Table 7 lists the number and type of tools recovered from each level. The following section begins with a brief discussion of variations down profile in each subsurface unit, correlated where possible to stratigraphic breaks. The record of these stratigraphic surfaces then is discussed in light of its implications for the character of site use through time.

Features chosen for subsurface excavation were selected by topographic location, surface feature composition, and potential to yield significant subsurface deposits. The following assessments of each unit utilize variation in debitage sample composition, tool content, and raw material to identify possible cultural surfaces.

Feature 1, Unit J3

This feature was located on the southeastern edge of Terrace 2 on the northern ridge. Excavation extended for five levels. Variations in debitage sample composition are most noticeable in Level 5, where colored debitage decreases and early stage debitage (blank reduction and early thinning flakes) occurs for the first time; late stage thinning flakes dominate the previous levels (cf. Table 6). A slight increase in heat-treated debitage was noted in Level 2, corresponding to a decrease in colored debitage in the same level. Finally, there is a peak in the percentage of G3 (1/4 in) debitage in Level 3 and in G2

Table 7. Artifact Tally for Excavation Units at 26Ek5040.

	BIFACE STAGES									Flake	Core/			
	Indeter.	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Early 5	Late 5	Tool	Mod. Chunk	Preform	Projectile Pt.	Groundstone
North Group	0	0	0	0	0	0	0	0	0	0	0	0	0	1 hammerstone
J3-1 (F. 1)	1													
J3-2														
J3-4	1			1										
J3-5	1													
N3-1 (F. 8)	2				1			1		2				
N3-2	1			1										
N3-3	10			2	2			4		2				
N3-4	2					1								
N3-5	1													
N3-6														
AE2-1 (F. 31)	6			1										
AE2-2	2													
AE2-3	2		1	1						1				
AE2-4														
AE2-5														
AE2-6	1													
Central Group														
P1-1 (F. 10)	2									1				
P1-2			1											
P1-3					2						1	1		
P1-4		1			1	1				1			Obsidian tip fragment	1 metate
P1-5										2	1			
P1-6														
Q5-1 (F. 11)										4				
Q5-2														1 metate
Q5-3					3					1				1 metate
Q5-4				1						2				
Q5-5	1			2						1				
Q5-6	1									1			Opalite fragment	
Q6-1 (F. 11)		1			1			1		5			Opalite Out of Key	
Q6-2					1	1								1 metate

Table 7, continued.

	BIFACE STAGES									Flake	Core/			
	Indeter.	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Early 5	Late 5	Tool	Mod. Chunk	Preform	Projectile Pt.	Groundstone
Central Group, continued.														
Q6-3	1			1	2		1	1		3				
Q6-4				1				1		4			Opalite Elko, Exo. Crt Elko	3 metate
Q6-5				1							1			1 metate
Q6-6	1			1				1					Opalite fragment	1 metate
Q7-1 (F. 11)	1									2				
Q7-2				1						2				
Q7-3			1		2					1				1 mano
Q7-4				2						2			Opalite tip fragment	
Q7-5		1			1				1	2				
Q8-1 (F. 11)					1		1			5				
Q8-2							1							
Q8-3				1			1			2			Opalite fragment	
Q8-4							1			1				
Q8-5		1	1							2				
R2-1 (F. 13)	1							1		5	1			
R2-2														
R2-3										2				
R2-4	1				1					1				
T2-1 (F. 15)				1	1	1			1	1				1 hammerstone
T2-2														
T2-3	2								1					
T2-4	1			1			1			2			Obsidian fragment	
T2-5					1									
V2-1 (F. 17)	1		1											1 metate
V2-2														
V2-3	1			2	1		4			1				
V2-4														
AF1-1 (F. 32)														
AF1-2														
AF1-3	1			1										
AF1-4														

Table 7, continued.

	BIFACE STAGES									Flake	Core/			
	Indeter.	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Early 5	Late 5	Tool	Mod. Chunk	Preform	Projectile Pt.	Groundstone
Central Group, continued.														
AG1-1	2				1							1		
AG1-2	2									2				
AG1-3	1	1		1	1					1	1			
AG1-4	3	1								3				
AG1-5	1	1	1											
AG1-6										1				
AG1-7	2								1	1				
AG1-8														
AI1-1														
AI1-2														
AI1-3														
AI1-4	2			1										
AI1-5														
AM1-1										1				
AM1-2														
AM1-3										1			Opalite fragment	
AM1-4										1				
AN1-1 (F. 12)														
AN1-2	2			2						1				
AN1-3	2		1	2	1		1			1	3	1		
AN1-4										3	1			
Southern Group														
S2-1 (F. 14)				1										
S2-2					1									
S2-3														
S2-4				2		1								
S2-5													Obsidian Large side-notched	
S2-6														
X1-1 (F. 22)	2		1											
X1-2														
X1-3										1				
X1-4														

Table 7, continued.

	BIFACE STAGES									Flake	Core/			
	Indeter.	Late 2	Early 3	Mid 3	Late 3	Early 4	Late 4	Early 5	Late 5	Tool	Mod. Chunk	Preform	Projectile Pt.	Groundstone
Southern Group, continued.														
Y1-1 (F. 25)	1		1	1	1	2				1				
Y1-2	1	1	1											
Y1-3				1			1							
Y1-4										1				
Y1-5														
Y1-6														
AH2-1				1										
AH2-2														
AH2-3														
AH2-4										1				
AH2-5														
AH2-6														
AH2-7										1				
AH2-8														
AH2-9														
AH2-10														
AJ1-1														
AJ1-2														
AJ1-3										2				
AJ1-4	2													
AJ1-5	2										1		Obsidian Elko	
AJ1-6														
AJ1-7	1													
AL1-1														
AL1-2										1				
AL1-3														
AL1-4														
AL1-5		1												
AL1-6										1				
AL1-7							1			1				
AL1-8			1							1				
Other														
AK1-1										2				
AK1-2				1						1				
AK1-3							1			3				

(1/2 in) debitage in Level 5. The sudden peak in G3 debitage in Level 3 occurs in Stratum 2a (Appendix H, Figure H.4a), which is the buried surface of the b2 paleosol described above. It has been dated to 4380±90 B.P. Tool counts also increase slightly below this contact (cf. Table 7). Level 5 at the base of the unit terminated in the B horizon of this soil; the concentration of larger debitage in this layer is most likely a result of geomorphic processes.

Feature 8, Unit N3

This feature is also located on Terrace 2 on the northern ridge. Excavation continued for six levels. Notable changes in debitage sample composition occur between Levels 4 and 5 (cf. Table 6) with a sudden decrease in the amount of heat-treatment; colored debitage in these levels increases relative to the rest of the unit record, exceeding 10%. There is a technological shift as well (cf. Table 6). Only blank reduction flakes are recorded in Level 4 though the sequence in the surrounding levels contains all flake types. Proportions of each debitage size grade also shift at this level. G1 (1 in) debitage drops out of the sequence after Level 4, while G3 (1/4 in) debitage increases from there. Worth noting is the large number of bifaces (18) recovered from Level 3 (Table 7). Two flake tools were also recovered from this level.

Level 3 of this unit encompasses a mixed zone between the first and second buried paleosols (cf.discussion above) (Appendix H, Figure H.4b) which may also contain a component of the modern soil. Variation in the debitage samples occurs below this zone in Stratum 2a, the buried surface of the second paleosol. Since changes in percentages of colored and heat-treated debitage should be independent of geomorphic sorting processes, the changes noted in Levels 4 and 5 most likely indicate a buried cultural surface.

Feature 10, Unit P1

Feature 10 is located on Terrace 3 on the crest of the southern interfluve. Six levels were excavated. The percentage of heat-treated debitage begins to decrease in Level 4 of this unit, contrasting with a marked increase in the amount of colored debitage in Level 5 (cf. Table 6). Core reduction debitage drops out of the technological sequence in Level 5. Tools were fairly common throughout this unit (cf. Table 7); counts increase slightly in Levels 3-5. Finally, there is an increase in G1 (1 in) debitage in Levels 4 and 5 (cf. Table 6) suggesting geomorphic "winnowing" on a stratigraphic surface. The stratum in which these changes occur is Stratum 2, the second buried soil (Appendix H, Figure H.4c). Level 5 is Stratum 4b, a mixed zone which is part of the third buried paleosol; cultural deposits from this level may represent the pre-Mazama record at this site.

Feature 11, Units Q5-Q8

This extensive feature was located on Terrace 3, the crest of the southern interfluve. Four units were excavated in a block with a single datum so that unit levels correspond. Units Q5 and Q6 continued for six levels, Q7 and Q8 for five.

In Unit Q5, percentages of colored debitage shift from level to level, high in Levels 1 and 3 and low in 2 and 4 (cf. Table 6). There is no change in flake types down the profile although changes occur in debitage size. Large G1 debitage is present only from Level 3 on and G0 is present only in Level 5. G3 debitage decreases in Levels 3-5 (where larger debitage increases), then peaks abruptly in Level 6. There is a marked increase in larger debitage in Levels 4 and 5.

In Unit Q6, an increase in colored debitage corresponds to a decrease in heat-treated debitage in Levels 5 and 6; conversely, in Unit Q7 there is an increase in heat-treated debitage in these levels. The percentage of heat-treated debitage in Unit Q8 increases in Level 3 along with a decrease in colored materials. As with Unit Q5, the technological sequence varies little in Q6, Q7, and Q8 aside from a lack of core reduction flakes in Level 1. In Units Q6, Q7, and Q8 there is an increase in large G0 (2 in) and G1 (1 in) debitage in Levels 4 and 5 (cf. Table 6) followed by an increase in G3 debitage in the following level in two units.

Flake tools were common in all units, the most coming from Level 1 and decreasing steadily down the profile (cf. Table 7). Elko series projectile points were recovered from Unit Q6, Level 4, and Q7, Level 1, and point fragments from all units. Bifaces were more common in lower levels (3-5) of Q5, Q6, and Q7, although stages were comparable.

Such variation in adjacent units suggests unit sediments have been disturbed. Obsidian hydration rind thicknesses from these units support this possibility. Obsidian flakes with rinds from 4.8 to 8.0 microns were recovered from Levels 4, 5, and 6 of Units Q5-Q8. However, obsidian from Unit Q7, Level 2 also measured 6.7 microns and from Unit Q8, Level 1, 4.8 microns. Such thick rinds in upper levels of these units suggests deposits are mixed.

The concentration of large debitage in Level 4 suggests size sorting by natural processes, although changes in debitage composition and tool quantities also indicate a possible cultural surface at this level. The strata are so mixed in this location that we cannot determine if a stratigraphic break is present and, if so, its correlation to the stratum in the master profile. Shifts in sample composition were noted in all units around Levels 4 and 5, suggesting that a once extant cultural surface has been destroyed by bioturbation and pedoturbation.

Feature 12, Unit AN1

This feature, just off the crest of the central ridge, was excavated adjacent 1992 test units. There is an enormous jump in quantity of debitage in Levels 3 and 4 of this unit, but no real change in the characteristics of the sample (cf. Table 6) aside from the introduction of core reduction debitage in Level 3. Tools are concentrated in Levels 3 and 4, including cores, preforms, flake tools, and bifaces (cf. Table 7). Amounts of large debitage are high throughout this unit with a noticeable decrease in Level 3 followed by a peak in Level 4. Samples from this unit are unusual in that they are dominated by G1 and G2 debitage rather than the G2 and G3 flakes of most units (cf. Table 6). The increase in tools and debitage in Level 3 occurs in Stratum 1b, on what is most likely the depositional break between 1a and 1b, and corresponding to the late Holocene soil surface (the first buried soil) dated to 850±20 B.P. (cf. above). The concentration of large debitage and tools such as bifaces and cores in these lower levels also suggests geomorphic size sorting on a depositional surface.

Feature 13, Unit R2

Feature 13 is located on the southwestern end of the southern ridge. Excavation continued through four levels. Only minimal change was noted in this unit (cf. Table 6). Heat-treated debitage increased in Levels 3 and 4, accompanied by decreased colored debitage. Technologically, there is minor variation in amounts of early stage debitage. In terms of size graded debitage, sample composition is most notably different between the sample from the surface and that from subsurface (Table 6). Debitage of all sizes appeared on the surface but only G2-G4 debitage appeared in the remainder of the unit. There is a noticeable spike in amounts of G3 debitage in the last level and amounts of G4 debitage are relatively

high compared to other units on the site (cf. Table 6). Once again geomorphic sorting appears to be at work on a stratigraphic contact. The stratum in which these changes occur is the weathered zone with bedrock clasts which underlies the modern soil on the high points of Terrace 2 (Appendix H, Figure H.5b).

Feature 14, Unit S2

This feature was located on the far eastern end of the southern group. Unit S2 continued for six levels. There is essentially no change in debitage composition in this unit except for a small dip in the amount of heat-treated debitage, accompanied by a slight rise in colored debitage, in Level 5. Technologically, there are some minor changes, most notably in Level 5 where early stage debitage suddenly drops out of the sequence (cf. Table 6). A Large Side-notched obsidian point base also was recovered from Level 5. Large debitage is more common in Levels 4 and 5, possibly indicating a stratigraphic surface. Stratum 2 in this level has been identified as the B horizon of the second buried soil (Appendix H, Figure H.4c).

Feature 15, Unit T2

Feature 15 was located on the western edge of the southern ridge; the unit extended for five levels. Variations were minor, consisting of a slight increase in colored debitage in Level 5 and a slight increase in heat-treated debitage in Level 4 (cf. Table 6). Late thinning debitage increases slightly in Levels 3 and 4. Large debitage dominates the sample by Level 5. A wide range of biface stages was recovered from this unit, but there is no patterned variation in stage down the profile. As in Unit R2, the shifts in sample composition in Levels 4 and 5 occur in the contact zone between the mixed modern and late Holocene soils and the zone of weathered bedrock float above the Pleistocene paleosol (Appendix H, Figure H.6a).

Feature 17, Unit V2

Feature 17 is located in the center of the southern ridge. Unit V2 continued for four levels. The record from Unit V2 is marked by a decrease in the percentage of heat-treated debitage in Level 3, contrasted with a sharp rise in the amount of colored debitage in this level (cf. Table 6). Technologically, change is minor, including a loss of core reduction flakes in the last two levels and an increase in late thinning flakes in Level 4. Tool counts are high in Level 3 (cf. Table 7). Amounts of large G1 (1 in) flakes increase steadily down profile to Level 3 then drops off in the last level. Changes in color, heat-treatment, and tool counts along with the concentration of larger debitage in Level 3 suggest a stratigraphic break, once again falling in the mixed zone between Stratum 1/2 and the underlying Pleistocene soil (Appendix H, Figure H.6b).

Feature 22, Unit X1

This feature was located in the southern feature group; excavation continued for four levels. Changes noted include an increase in heat-treated and colored debitage in Level 3 and the sudden loss of early stage debitage in Level 2 (cf. Table 6). Blank preparation flakes return in Level 4. This alternation is reflected in debitage size grade as well where the mix of G1, G2, and G3 debitage in Levels 1-3 suddenly gives way to an almost pure sample of G3 debitage in Level 4 (cf. Table 6). This sorting is most likely natural inasmuch as it occurs on and just above the contact with the late

Pleistocene soil. Changes in color and heat treatment in Level 3, which should be independent of soil processes do, however, suggest a cultural surface at this level even though the stratigraphic record is mixed (Appendix H, Figure H.6c).

Feature 25, Unit Y1

Feature 25 is located in the southern group. Unit Y1 contained six excavation levels. While amounts of heat-treated debitage hold relatively steady throughout Unit Y1 (cf. Table 6), the percentage of colored debitage is more volatile, fluctuating from Levels 4 through 6. Technologically, the sequence is extremely mixed, shifting from level to level (cf. Table 6). Tool counts were high only in Level 1, dropping through the remainder of the profile. G1 debitage drops out of the sequence in Level 4. Level 4, Stratum 2 represents the buried surface of the second paleosol (b2) (Appendix H, Figure H.6d). The fluctuations noted in the remaining levels occurred in a mixed stratigraphic zone.

Feature 31, Unit AE2

Unit AE2, located on the far northern edge of the northern ridge, continued for six levels. Percentages of heat-treated debitage increase suddenly in Level 6 while percentages of colored debitage increase to a high of 42.3% in Level 5 (cf. Table 6) then decrease rapidly in Level 6. Technologically, there is little change until Level 5 where only early thinning flakes occur, and Level 6 where late thinning and retouch flakes are dominant. Tool counts are highest in Level 1 (cf. Table 7). Reflecting changes in technological composition, the smaller debitage size grades increase in Level 5 with the disappearance of larger debitage types. Level 5 (Stratum 2) marks the surface of the second buried paleosol; Level 6 falls in the B and C horizons of the same soil (Appendix H, Figure H.7a).

Feature 32, Unit AF1

Feature 32 is located on the far western edge of the site, an outlier of the central group. Excavation continued for four levels. Changes in the sequence include a modest decrease in heat-treated debitage in Level 4. Only thinning flakes were recovered throughout the unit. Two changes occur in the size grade proportions: G1 debitage occurs only in one level (Level 2), and there is a sudden rapid increase in G3 debitage in Level 4 to the exclusion of other size grades. Level 4 is composed of Stratum 1b sediments which constitute the B horizon of the first buried paleosol (dated to 850±200 B.P.) (Appendix H, Figure H.7b). Since changes occur only in debitage size in this level, natural rather than cultural processes may be responsible for the variation noted.

Unit AG1

This discretionary unit was excavated on the northern slope of the central ridge. Surface debitage here was sparse and no features were identified; surface tools also were less common in this area. Unit AG1 extended for eight levels. Proportions of colored debitage are variable, increasing in Level 2, decreasing through Levels 3 and 4, then increasing again in Level 5, with a sudden drop in Level 7. The technological sequence is highly variable (cf. Table 6). Tools are found throughout the unit (cf. Table 7). Proportions of each debitage size grade shift within this sequence. G1 (1 in) debitage appears only in Levels 3-5 and Level 7, G2 debitage, consistently common throughout, drops suddenly in Level 6 opposite a spike in G3 debitage. Overall, the composition of Level 6 and Level 8 samples are anomalous compared to the remainder of the unit.

The first soil changes occur in Level 2, Stratum 1b, the B horizon of the first buried paleosol. Level 5 consisted of Stratum 25 sediments, which is a mixed stratum of Mazama ash and silt (Appendix H, Figure H.7c). Levels 6 and 8 occur in a mixed zone between Stratum 25 and the underlying Pleistocene soil, which may contain a badly turbated B horizon for the third buried soil.

Unit AH2

This unit was located on the low terrace along the southern edge of the site. Excavation continued for 10 levels, encountering a 40 cm thick mixed bed of Mazama ash and silt between 30 and 70 cm below surface (Appendix H, Figure H.7d). Heat-treated debitage increased slightly in Levels 2 and 4, and again in Levels 9 and 10 (cf. Table 6); increases in colored debitage correspond to increases in heat treated debitage in Levels 2 and 4. Increases were also noted in Levels 7 and 8, during a decline in heat treatment. Emphasis shifts from middle stage flake types in the first three levels to dominance by the early reduction sequence in Level 4 (cf. Table 6). In Level 10, the entire flake sequence is apparent although early thinning flakes are most common. Tools were rare throughout the unit (cf. Table 7). Larger G1 debitage did not appear until Level 4-6; G2 debitage begins to decrease in these levels. A peak in G3 debitage occurs in Level 10.

The most notable changes in this sequence occur in Levels 2, 4, and 10, and Levels 6-8 are highly variable. Level 2 (Stratum 1b) corresponds to the B horizon of the late Holocene buried soil (soil b1) dated to 850±200 B.P. Level 4 falls on the contact between Stratum 2 sediments, the second buried paleosol, and the mixed ash and silt layer of Stratum 25. Krotovina disturbance is particularly heavy in this zone. Levels 6-8 encompass the bulk of Stratum 25; the degree of fluctuation in all samples from this level is not surprising considering the enormous amount of bioturbation that has occurred in this zone. Level 10 of this unit is a badly mixed zone of weathered bedrock float and portions of other strata. Changes in this level of Unit AH2 most likely are the result of bioturbation.

Unit AI1

Like Unit AG1, Unit AI1 was placed to test deposits in an area of sparse surface remains on the northern slope of the central ridge. The unit continued for five levels. Percentages of colored debitage are the most variable element in this unit (cf. Table 6), decreasing to nothing in Level 2 then increasing in Levels 4 and 5. Late thinning dominates the technological sequence; some early thinning flakes are in Level 3 (cf. Table 6). Tools were found only in Level 4. Composition of the size graded debitage samples changes little down profile aside from the limited occurrence of G1 debitage in Level 3.

Changes described above for Level 4 suggest a cultural and stratigraphic surface may occur at this level in which Stratum 1b gives way to Stratum 2a, the surface of the second buried paleosol (Appendix H, Figure H.8a). The concentration of larger debitage in Level 3 most likely is the result of a change in depositional processes between the surface soil (Stratum 1a) and buried paleosol (Stratum 1b) in this level.

Unit AJ1

This unit was sited on the juncture between colluvial and alluvial sediments along the low terrace on the southern edge of the site (cf. Figure 10), in the hope of encountering deep cultural deposits. Excavation continued for seven levels. Heat-treated debitage fluctuate somewhat in the first levels, increasing in Level 2 but decreasing immediately in Level 3 (cf. Table 6). Changes in amounts of colored

debitage echo those in heat-treatment, increasing in Level 2, decreasing in Level 3, and then increasing twofold in Levels 6 and 7. Technologically, the upper unit levels are dominated by thinning flakes (cf. Table 6); early stage flakes begin to appear in Level 5. No tools were recovered from this unit until Levels 4 and 5 (cf. Table 7). Size graded debitage is dominated by 1/2 in (G2) and 1/4 in (G3) sizes with 1 in (G1) debitage occurring only in Levels 3 and 6.

The pattern of changeability in this unit is not immediately apparent. Two zones of change are apparent, however, encompassing Levels 2 and 3, and Levels 4 and 5. The shift in Levels 2 and 3 corresponds to the change between Stratum 1a (modern soil) and Stratum 1b (the first buried paleosol) (Appendix H, Figure H.8b). Levels 4 and 5 encompass the transition from Stratum 2, the second buried paleosol, to Stratum 25, the mixed layer of silt and Mazama ash. Change within these levels is variable, precluding an interpretation which favors either geomorphic or cultural processes.

Unit AK1

This unit was placed toward the far southeastern end of the site on the central ridge where no features, units, or trenches had been excavated. Unit AK1 was very shallow, encountering the weathered Pleistocene paleosol in only three levels. Heat-treated debitage increased slightly on this contact in Level 3 (cf. Table 6). Bifacial tools were found only in the last two levels (cf. Table 7). The change in technological stages down profile from rare flake types in Level 1 to the entire sequence in Level 3 suggests winnowing of smaller materials down profile by natural processes. Debitage size grade data echoes this progression (cf. Table 6). Level 1 is dominated by G1 flakes which rapidly give way to G2 and G3 debitage in the last levels.

Unit AL1

Cultural deposits in this unit, on the low terrace on the southern edge of the site, continued for eight levels. Decreases in colored debitage occurred in Levels 2 and 8; there is also much fluctuation from level to level in debitage technology (cf. Table 6). Most abrupt is a shift to early stage flakes in Level 5. Thinning flakes dominant through the remaining levels as do G2 (1/2 in) and G3 (1/4 in) debitage. A sudden peak in G1 debitage in Level 5 echoes the increase in early stage flakes mentioned above. Tools occur only below this zone in Levels 5, 7, and 8 (cf. Table 7). The shift in colored debitage noted in Level 2 corresponds to Stratum 1b, the buried late Holocene soil. Level 5 corresponds to Stratum 25, and Level 8 to either Stratum 21 or Stratum 4.

Unit AM1

This unit was excavated on the northern wall of Trench B to expose a small burned feature (Feature 34) noted in the trench wall. The feature was exposed in Level 3, 15 cm below surface, and continued to 34 cm below surface, gradually pinching out to the east. Feature fill was excavated as a bulk sample for flotation; materials from this sample are excluded from Tables 5 and 6. Feature 34 excavation, appearance, and content are described above.

Notable changes in this unit sequence include a sharp decrease in the amount of heat-treated debitage in Level 2 mirrored by an increase in colored debitage. Technologically, Level 2 is anomalous for containing only middle stage flakes (cf. Table 6). This, however, is an extremely small sample from a partial level, which most likely explains much of its variation from the composition of the sample from levels above and below. Early stage flakes were most common in Level 4 at the base of the unit. It

is rather unusual that no bifaces were recovered from this unit when flake tools were found throughout and an opalite point fragment was recovered from Level 3.

Feature 34 was excavated into the B horizon of the first buried soil and served as the source for the date on this soil of 850±200 B.P. Shifts noted in Level 4 signal a change in depositional mode from the late Holocene soil to a mixed zone beneath.

Occupational Surfaces

There is clear evidence for two distinct occupational surfaces at 26Ek5040, and there is tantalizing evidence of an occupation around or possibly even before the time of Mazama ashfall (6850 B.P.), but these strata have been badly mixed by bioturbation and pedogenic processes which prevents secure identification of surfaces. Evidence from a group of units (R2, T2, V2, X1, AK1) also reveals areas where the cultural sequence has been compressed into a mixed layer which has been concentrated by natural sorting into lag deposits of large flakes and tools on the contact with the Pleistocene soil which underlies all site deposits.

Data from comparison of the feature groups has suggested changes through time and space in raw material use, tool manufacture, and tool use/discard at 26Ek5040. Comparison of the record on the three buried soil surfaces also reveals such variation. Table 8 lists the unit levels that have significant changes associated with the buried surfaces of the late Holocene (850±200) post-Mazama (4380±90), and possible Pre-Mazama buried soils.

Table 8. Unit Levels Associated with Buried Soil Surfaces.

Late Holocene soil (ca. 4380±90 B.P.–850±200 B.P.)
Unit AN1, Level 3
Unit AF1, Level 4
Unit AG1, Level 2
Unit AH2, Level 2
Unit AL1, Level 2
Unit AM1, Level 3

Post-Mazama soil (ca. 4380±90 B.P.–6900 B.P.)
Unit J3, Level 3
Unit P1, Level 4
Unit AE2, Levels 5, 6
Unit N3, Levels 4, 5
Unit S2, Levels 4, 5
Unit Y1, Level 4
Unit AH2, Level 4
Unit AI1, Level 4

Possible Pre-Mazama soil (pre 6900 B.P.)
Unit P1, Level 5
Unit AG1, Levels 6-8
Unit AH2, Levels 6-8

The records of each of these surfaces are typical of those for the site as a whole. Percentages of heat-treated debitage fall in the moderate range (60-75%) for most unit levels and percentages of colored debitage in the low range (5-20%). Unit AH2, Level 2 in the late Holocene soil, and Units AE2, Level 5 and AH2, Level 4 in the post-Mazama soil, exhibit higher than average percentages of colored debitage. Heat treatment is also higher than average in Units AH2, Level 4 and AI1, Level 4 in the post-Mazama soil. Late thinning flakes are the most common reduction type on both surfaces, with

other flake types present in varying amounts. Biface stages are more varied in the post-Mazama deposits, compared to the Late Holocene deposits, in which biface stages closely resemble the more standardized production focus of the Late-Archaic dominated areas of the Tosawihi Quarries (cf. Chapters 5, 6). Heat-treatment of bifaces is slightly higher in the post-Mazama deposits, as are the figures for debitage heat-treatment. There is also a slightly higher proportion of bifaces made of colored chert in the post-Mazama deposits compared to the Late Holocene deposits.

Relative quantities of other artifact types also vary slightly between the two deposits. Groundstone, flake tools, and cores and modified chunks are slightly more common in the Late Holocene unit levels, while projectile points and obsidian are slightly more common in the post-Mazama unit levels.

Despite these differences, the record suggests is that there has been a fair degree of continuity in the ways 26Ek5040 was used through time, and that activities were varied and widespread during both these occupations. Some spatial variability between occupational surfaces is recognized, however. The units which contain intact records from the late Holocene occupation of 26Ek5040 are all located on the southern ridge. The northern ridge either did not achieve the same level of use during this time as during other occupations, or the late Holocene record on this surface is not well preserved. Conversely, several units on the northern ridge contain post-Mazama deposits, as do those on the southern interfluve. These spatial differences are also reflected in the obsidian hydration readings from these areas of the site which are discussed later in the report (cf. Chapter 6).

Three units hint at a possible pre-Mazama component at 26Ek5040. These units exhibit shifts in artifact type and quantity in sediments below Stratum 25, the mixed Mazama ash and silt layer, but these deposits have been so badly mixed it is unclear if a cultural surface is represented. In these sediments, percentages of heat-treated debitage are slightly lower than average (50-60% range) and percentages of colored debitage higher (25-40% range). Unit AH2 also contained one of the few substantial basalt samples from this site. Debitage technology is dominated by early and late thinning in all units. The biface assemblage from these unit levels is very small (n=3) and thus difficult to compare to those from later deposits. Only one of the three bifaces recovered could be placed in the reduction staging scheme used in our analysis (cf. Chapter 2), it was a finished Stage 5 biface. One of the three bifaces was made of colored chert and the other two of white opalite. Other artifacts from these unit levels include four flake tools and one core. Though distributed across the southern interfluve, all these units share a position in areas where Holocene-age sediments are particularly thick (cf. Figure 19).

Conclusions

Four soil surfaces were identified in site sediments but only two of them (b1, b2) contain stratigraphically distinct cultural components. There is some suggestion of a third component as well, but the strata in this zone (4a, 4b, 21-25) are too confused to permit clear interpretation. Differences noted between the composition of features in the surface feature groups and in the subsurface components of some units, have shown that the record of site use has been fairly homogeneous in some aspects and changeable in others. The kinds of tools being produced and the forms of raw material of their production appear to have remained fairly constant through time. Reduction trajectories for these materials were different, however. Use of 26Ek5040 also seems to have varied spatially through time, with tools of different materials, types, and stages manufactured in different places on site.

White opalite was the dominant material throughout use of the site, colored cherts seem to have been more common during the post-Mazama occupation. Both materials appear to have been

transformed into bifacial tools on the same reduction trajectories. Core reduction and, to a lesser extent, retouch flakes, are rare in non-feature settings. Background scatter at the site is composed primarily of thinning flakes. In a number of units, the relationship of heat-treatment and color was notable; when the percentage of one category increased, the other usually decreased. This could represent laboratory bias to the extent that heat-treatment is more difficult to distinguish on colored debitage.

Only a small proportion of the artifacts recovered from the site derived from these three dateable unit level groups. Tool samples are very small and comparisons, thus, superficial. Conclusions derived from analysis of obsidian hydration readings and projectile points discussed in Chapter 6 interpret the bulk of the site deposits contemporary with the Post-Mazama strata.

Analysis of the assemblage from 26Ek5040 has shed new light on two questions posed during testing. Fifteen of the 32 features identified by 1994 excavations were internally consistent in composition, suggesting that each represents one reduction episode and, concomitantly, that each is a cultural feature rather than a post-depositional phenomenon. The remaining 17 features seem a mix of natural and cultural aggregations of debitage and tools. Too, a near surface and surface Late Archaic component at 26Ek5040 has emerged. Data from testing had suggested the site was occupied exclusively during the Middle Archaic. The post-Mazama component (which probably contains multiple occupations which could not be precisely dated) certainly comprises the most substantial occupation at the site, but the Late Archaic and possibly pre-Mazama components add temporal dimension to the occupation.

Chapter 4

ARTIFACT ANALYSES

Kathryn Ataman and Margaret Bullock

With little obvious cultural stratigraphy and almost no organic preservation, flaked and ground stone artifacts and their distributions provide much of the available information about occupation of 26Ek5040. This chapter describes the flaked, percussion, and ground stone tool assemblages; the one following describes debitage and core assemblages, the technological analysis of debitage, and raw material and tool trajectories. Artifact distributions and activity delineation are covered in Chapter 6.

Flaked Stone Tools

Flaked stone tools from 26Ek5040 include bifaces, projectile points and preforms, and several types of flake tools. Each is discussed in turn, following a word about the raw materials from which flaked stone tools at 26Ek5040 were crafted.

Most artifacts from 26Ek5040 are made of local hydrothermally altered silicic material of various derivations and appearances (Table 9), but the bulk is white, grey, or beige opalitic chert. A nearby source of similar light-colored, high quality material is a quarry complex located 1 km north of the site (cf. Figure 7), most likely the main source of material at 26Ek5040. This nearby source (CrNV-12-11927) consists primarily of outcrop quarrying locations, although pits may be concealed beneath the quarrying debris blanketing the ridge on which the site is located (Dugas 1994). The source appears exhausted; any previously existing surface outcrops have been quarried away.

Table 9. Flaked Stone Tool Classes and Raw Material.

	Number of Items					
	Tosawihi Chert	Exotic Chert	Basalt	Obsidian	Other	Total
Bifaces	463	8		3		474
Flake Tools	165	3	5			173
Points and Preforms	27	5		7		39
Cores and Modified Chunks	20		1	1	1	23
Debitage	50628	2	22	168	12	50832
Total	51303	18	28	179	13	51541

Colored cherts, derived from hydrothermal alteration of paleosols developed in both volcanic tuff and basalt bedrock (cf. Chapter 3), comprise the bulk of the remaining material. This toolstone can be found at various localities in the Tosawihi Quarries. Color is controlled by minerals in the parent material and by circumstances of deposition. Much of the altered basalt is slightly softer and more brittle than the opalite derived from tuff paleosols, and it responds differently to heat-treatment. Tuff and basalt-derived opalites are similar in appearance and no consistent differences in flaking quality

are apparent, therefore we consider these two local materials as one, referring to them as 'colored' chert or opalite. We take variability in proportions of colored opalite in tool and debitage assemblages as an indicator of intensity of use of sources other than the nearest sources described above (where these colored materials do not occur).

Other raw materials appearing in the assemblage are obsidian, basalt, and exotic chert; the latter two are rare and obsidian is nearly so. Basalt is assumed to be local because basalt is readily available in the area, but the source(s) of the exotic cherts is unknown. Exotic cherts differ from the local colored cherts in color and glassiness; local cherts are primarily brown, purple, and yellow and have a dull luster. Forty-nine of the 179 obsidian artifacts recovered were analyzed for age and source (Appendix A). Most of the analyzed samples derive from one of the nearest obsidian sources, Paradise Valley, although several other sources were utilized by the inhabitants of 26Ek5040, as will be discussed in Chapter 6.

Despite the preponderance of local material in the flaked stone tool assemblage, material preference selection for certain tool types is apparent. Analysis of tool classes by raw material using adjusted standardized residuals (Table 10) yielded a significant chi square value. The null hypothesis, that there is no significant difference in raw material selection among tool classes, is rejected (df=12, x^2=143.97, P=.001). Bifaces are made from Tosawihi chert more often than expected and less often from basalt, obsidian, or exotic chert; flake tools are made of basalt more often than expected, while points and preforms show more exotic chert and obsidian specimens than expected and fewer than expected Tosawihi chert specimens.

Table 10. Adjusted Standardized Residual Values for Raw Material and Tool Type Relationships.

	Bifaces	Flake Tools	Points and Preforms	Cores
Tosawihi Chert	4.38	0.12	-7.81	-1.88
Exotic Chert	-1.45	-5.3	4.57	-7.4
Basalt	-3.49	3.38	-0.59	1.86
Obsidian	-2.81	-1.9	8.52	1.1
Other	-1.42	-0.57	-0.24	5.47

Values >+/- 1.9 are considered significant

Biface Technology

Most formed artifacts in the 26Ek5040 collection are bifaces; 474 complete and fragmentary specimens were recovered during data recovery and 163 during testing. The latter are described in Ataman et al. (1992), not to be reiterated in this report except in discussions of distribution (cf. Chapter 6).

In addition to the bifaces made of local opalites, the assemblage contains eight bifaces of variously colored dark cherts exotic to the Tosawihi Quarries and three obsidian bifaces derived from Paradise Valley, from Pinto Peak (Washoe County) or the Double H Mountains (Humboldt County), and from the widespread Brown's Bench source area located 75 to 175 km northeast of the site. The raw material data summarized in Table 11 are used in spatial analyses in later discussions.

Table 11. Biface Raw Material and Color.

	Local Material		Exotic Material			
	Frequency	Percent	Frequency	Percent	Total	Total Percent
White	293	63.8	0	0	293	61.7
Beige	41	8.93	0	0	41	8.7
Yellow	23	5.01	0	0	23	4.9
Brown	8	1.74	4	26.7	12	2.5
Black	0	0	4	26.7	4	0.8
Grey	49	10.67	1	6.7	50	10.6
Purple	9	1.96	2	13.3	11	2.3
Blue	4	0.87	1	6.7	5	1.1
Pink	28	6.10	1	6.7	29	6.1
Red	3	0.65	1	6.7	4	0.9
Green	1	0.22	1	6.7	2	0.4
Total	459	100.00	15	100.0	474	100.0

Biface manufacturing attributes can be used to examine spatial or temporal differences in technology. Five technological features are considered here: blank form, reduction stage, sequence of reduction, thermal alteration, and manufacturing failure. Each is discussed below and the data applied to subsequent analyses of context.

Blank Form

We are interested in blank form because it reveals information about technological processes often obscured by subsequent reduction. At residential sites or campsites at some remove from raw material sources, most tools are found in finished or near finished state and early stages are absent; only at production sites do we find evidence of early stage reduction (Ataman and Bloomer 1992:648-649; Bloomer, Ataman, and Ingbar 1992:130-131).

Biface blanks may be flake blanks detached from a core or directly from the bedrock; they also may be derived from alluvial or colluvial cobbles or blocks extracted from surface or subsurface bedrock. Flake blanks produced from cores and from bedrock can be morphologically similar, as is the debitage produced in their reduction, although bedrock-detached flake blanks at Tosawihi more frequently exhibit straight profiles, wide platforms, and hinged terminations (Ataman 1992b:89).

Flake blanks in early stages of reduction can be recognized by characteristic features on the unworked portions of the ventral surface, including point and cone of percussion, compression rings, and curved profile. Other, less convincing, evidence for the use of flakes as biface blanks is the presence of large cores. However, large cores can be worked into small ones and cores can be worked directly into bifaces; therefore, absence of flake-based biface reduction cannot be inferred from absence of cores. Similarly, presence of cores offers only circumstantial evidence of blank form.

Use of quarried blocks for blanks is even more difficult to recognize from relict features on bifaces. Unless a considerable portion of the original blank remains unworked, use of block blanks can be presumed only by reference to a combination of conditions: absence of cores, absence of flake blank produced bifaces, and absence of characteristic flake blank indicators in the debitage (bulb removal

flakes and alternate flakes or edge preparation flakes with original flake blank surfaces present). Based on observations at other quarry locations at Tosawihi (Ataman 1992b:89-91), block-based reduction was common, but decisions to use the technique may be based on characteristics of particular toolstone deposits. Use of quarried blocks for biface blanks is difficult to examine in non-quarry contexts.

Since there are no suitable bedrock sources immediately around the site, we assume that large, heavy blocks were not imported. Opalite cobbles are available, although not plentiful, in the drainages running along the east and west margins of the 26Ek5040. Here, flake blank bifaces are contrasted with cobble bifaces and with those of indeterminate origin.

Approximately 40% of the biface assemblage was made on flake blanks, less than 1% on cobbles (Table 12). The proportion of recognizable flake blanks decreases with stage, as more material is removed from the biface; thus it is likely that the true proportions of both flake and cobble blanks are somewhat greater than they appear.

Table 12. Biface Blank Form and Reduction Stage.

	Blank Type				
	Flake		Cobble	Indeterminate	Total
Stage	Frequency	Percent	Frequency	Frequency	Frequency
Early 2	2	100	0	0	2
Late 2	19	95	1	0	20
Early 3	29	56.86	0	22	51
Middle 3	46	48.94	2	46	94
Late 3	38	48.10	1	40	79
Early 4	10	40	0	15	25
Late 4	12	38.71	0	19	31
Early 5	4	18.18	0	18	22
Late 5	0	0	0	9	9
Indeterminate	26	18.44	0	115	141
Total	186	39.24	4	284	474

Compared to other Tosawihi assemblages (Ataman 1992b:Table 22), the amount of flake blank reduction in the biface assemblage at 26Ek5040 is slightly higher, while incidence of cobble blanks is about the same.

Reduction Stage

Our biface reduction stages are based on Callahan's scheme (1979) for biface manufacture. Variation in extent of reduction (flake scar patterning), cross-section, and width/thickness ratio all contribute to the determination of stage. The first stage consists of the unworked blank, the second stage refers to blank preparation and edge preparation, the third stage to primary thinning (Figure 24), the fourth stage to secondary thinning (Figure 25), and the final stage to shaping and finishing (Figure 26). In previous work at Tosawihi (Bloomer, Ataman, and Ingbar 1992), we subdivided some of these stages (Stages 2 and 4 into early and late, and Stage 3 into early, middle, and late) to gain more detail about the organization of biface production. We use the same scheme here, and subdivide Stage 5 into early and late as well.



Figure 24. Selected Stage 3 bifaces.

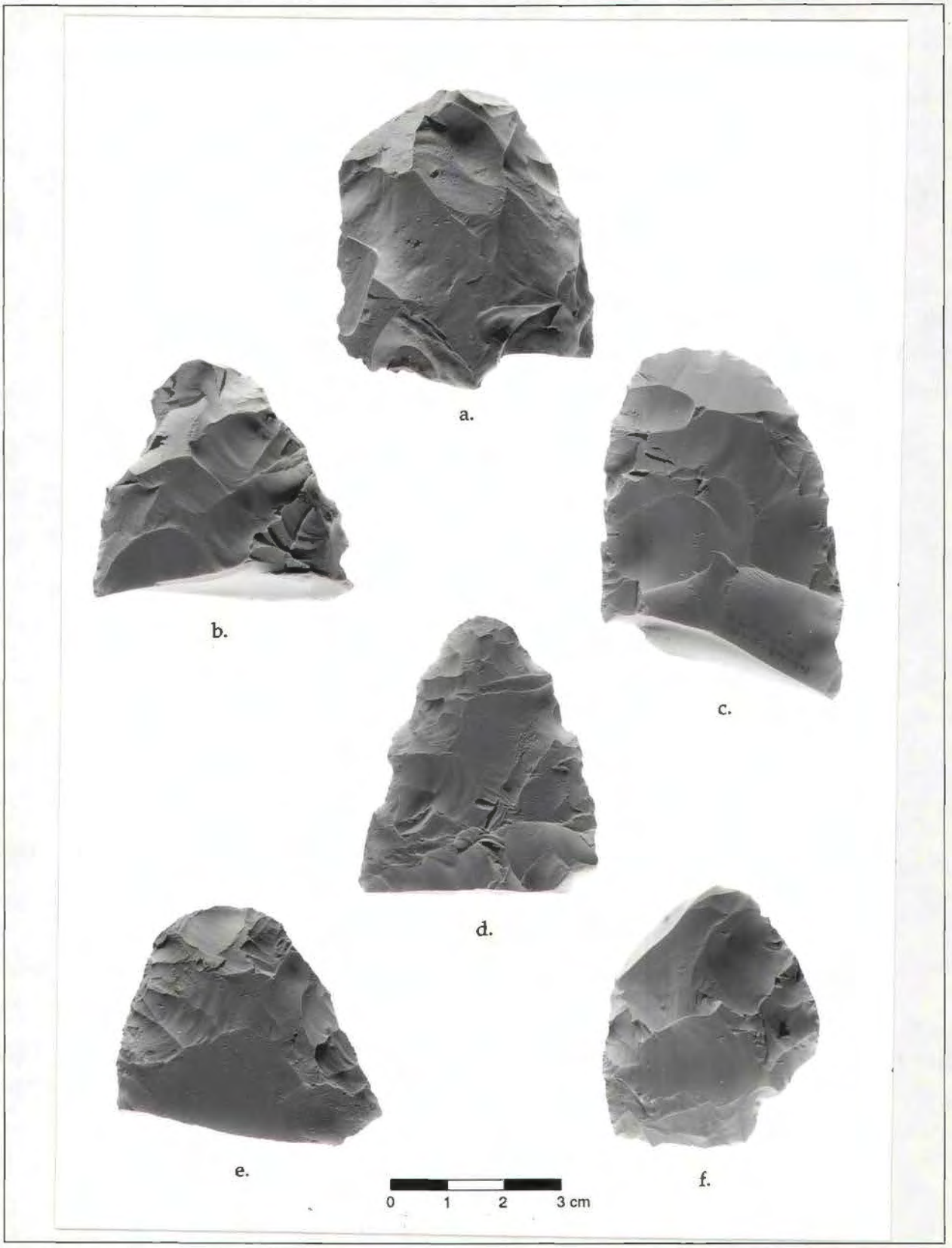


Figure 25. Selected Stage 4 bifaces.

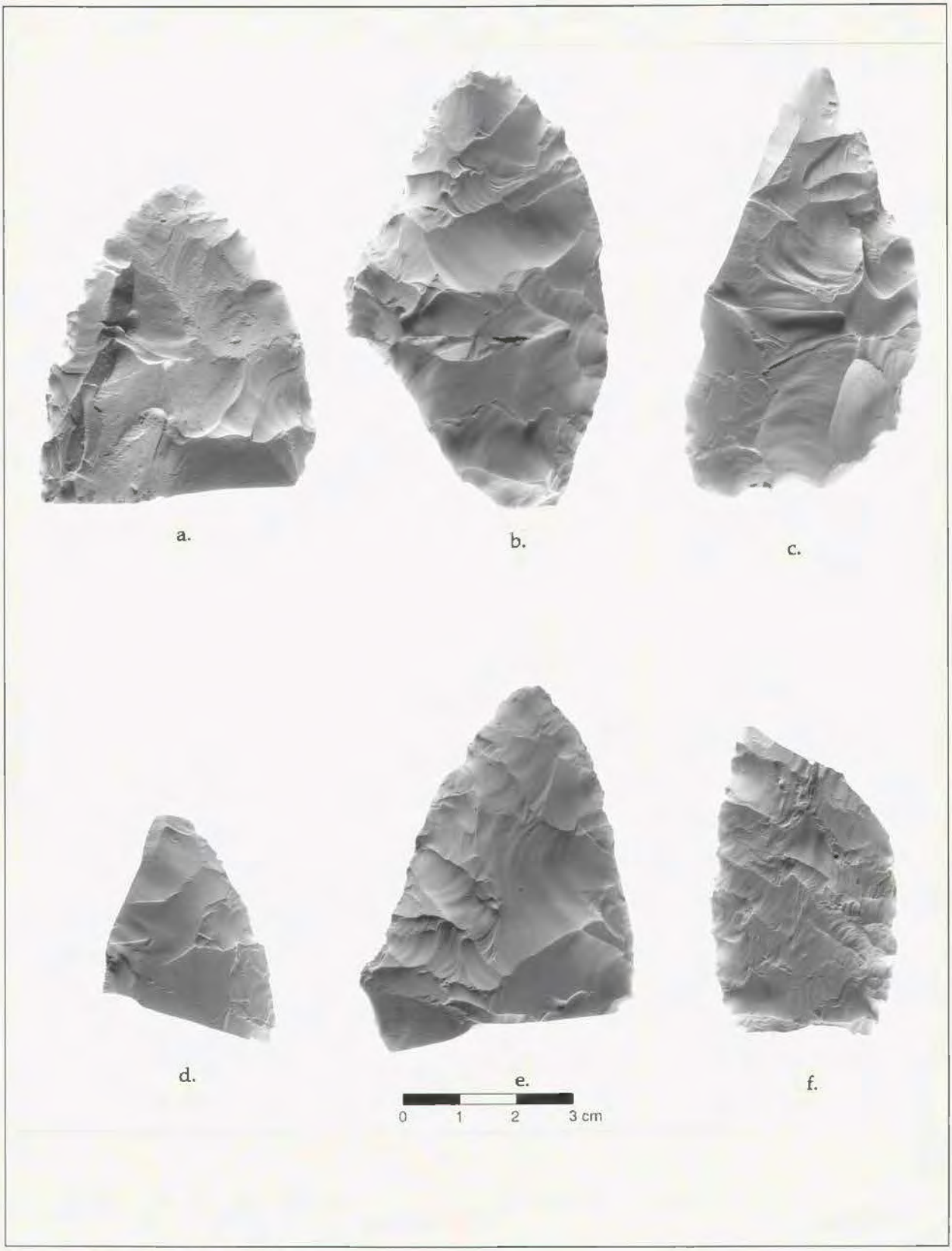


Figure 26. Selected Stage 5 bifaces.

The incidence of Stage 1 bifaces is usually very low because, as defined, a Stage 1 biface must have been selected for use in order to distinguish it from a rejected flake or block. In practice it often is not possible to recognize selected but unworked blanks, unless they are found in unusual contexts (e.g., a cache). At 26Ek5040, no artifacts were identified as Stage 1 bifaces.

As at most sites peripheral to the Tosawihi Quarries, the most common reduction stage represented in the 26Ek5040 biface assemblage is Middle Stage 3, halfway through primary thinning (Table 13). At this site, however, there is a greater range of stages represented, an indication that most of the biface thinning sequence, from Early Stage 3 to Late Stage 4, was undertaken here. Cores and core reduction debitage is rare and Stage 2 bifaces are infrequent, so it is likely that partially reduced bifaces, rather than chunks of unreduced raw material, were brought to the site for processing. The paucity of core reduction debitage (cf. below) supports this conclusion. The number of near finished late stage bifaces (Stages 4 and 5) is somewhat greater than at other Tosawihi sites (cf. Figure 50). The large proportion (30%) of indeterminate fragments is also indicative of later stage focus since heat-treatment, which often causes biface fragmentation (see below), is most common among later stage bifaces.

Table 13. Reduction Stages in the Biface Assemblage.

	Frequency	Proportion
Early Stage 2	2	0.42
Late Stage 2	20	4.25
Early Stage 3	51	10.83
Middle Stage 3	94	19.96
Late Stage 3	79	16.77
Early Stage 4	25	5.31
Late Stage 4	31	6.58
Early Stage 5	22	4.67
Late Stage 5	9	1.91
Indeterminate Stage	141	29.87
Total	474	100

Dorsal/Ventral Reduction

The extent of reduction on each face of the tool is an interesting representation of reduction sequence. The pattern of the sequence may be dependent on technological factors such as the shape of the blank. For instance, if the blank is thin at the start, there is less need for ventral thinning, which may be delayed until reduction on the dorsal face is more advanced. However, this technique can also reflect idiosyncratic rather than technological behavior, and thus indicate stylistic preferences of a particular group of people (Skinner 1990:243; Ataman 1992b:97). In order to examine differences in dorsal and ventral reduction, the reduction stage on each face (determined by flake scar patterning *on each face*) was considered separately.

At 26Ek5040, most (73%) bifaces are reduced equally on each face as reduction proceeds (Table 14). Among unequally reduced bifaces, the ventral surface in Stage 2 is sometimes reduced prior to the dorsal surface. Similarly, in Early and Middle Stage 3 *most* unequal reduction involves earlier dorsal than ventral reduction, and in Late Stage 3, Stage 4, and Early Stage 5 *all* are more extensively reduced on the dorsal than the ventral surface. In Late Stage 5, both surfaces usually are flaked entirely so that all Late Stage 5 bifaces appear equally finished. The unequal reduction is probably a function of both desired form and the use of flake blanks, because a flake blank usually has a fairly flat ventral surface and a convex dorsal surface. Thus, somewhat more effort is required to reduce the dorsal surface and produce a symmetrical cross-section.

Table 14. Differential Dorsal/Ventral Reduction on Bifaces.

Stage on Ventral Surface	Stage on Dorsal Face: Early Stage 2	Late Stage 2	Early Stage 3	Middle Stage 3	Late Stage 3	Early Stage 4	Late Stage 4	Early Stage 5	Late Stage 5	Indet.	Total
Stage 1			2		1		1				4
Early Stage 2	**2**			2	1						5
Late Stage 2	1	**19**	11	18	8	1	2	1		3	64
Early Stage 3		2	**25**	3	4			1		1	36
Middle Stage 3	1		1	**59**	8		1				70
Late Stage 3		1		2	**42**	2					47
Early Stage 4						**13**					13
Late Stage 4							**25**				25
Early Stage 5								**12**			12
Late Stage 5									**9**		9
Indet.			2		1					**141**	144
Total	4	22	41	84	65	16	29	14	9	145	429

Bold type indicates frequency of bifaces with equivalent extent of reduction on each face

At Locality 36, the only other Tosawihi site at which the reduction sequence has been investigated (Ataman 1992b: Table 23), the earlier stage profile of that assemblage allowed recognition of a much greater proportion of dorsal and ventral surfaces. There, a somewhat greater proportion of bifaces was reduced equally on each face, but the pattern through stages was similar to that at 26Ek5040 and, thus, does not suggest major differences in the sequence of reduction practiced at the two sites.

Heat-Treatment

Heat-treatment in the course of biface manufacture was common at non-quarry Tosawihi sites. Heat-treatment renders the percussion and pressure flaking of Tosawihi opalite easier to control, facilitating the production of thin bifaces and projectile points. When a flake or a tool is heat-treated the exterior surface retains its matte finish, but any subsequent flake scars exhibit a glossy, smooth surface characteristic of heat-treatment (but no color change). Comparison of those scars which are heat-altered and those which are not sometimes can reveal the point in the reduction sequence at which heat-treatment was undertaken (Ataman and Bloomer 1992).

Heat-treatment of Tosawihi opalite is recognized by changes in texture, transparency, and sheen of material revealed in post-treatment flake scars. Texture becomes smoother, appearance is less transparent and more glossy. On white and light-colored opalites, a high degree of heat-treatment is clearly apparent; under-heated artifacts are less easy to recognize. Heat-treatment recognition on local colored cherts is more problematic because the physical changes are less pronounced.

Among the 474 bifaces from 26Ek5040, 67% are definitely heat-treated, 12% are possibly heat-treated, and 21% are untreated (Table 15).

Table 15. Frequency of Heat-Treatment in Reduction Stages.

	Unheated Bifaces		Heated Bifaces		Possibly Heated Bifaces		
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Assemblage Total
Early Stage 2	1	50.00	1	50.00	0	0.00	2
Late Stage 2	9	45.00	10	50.00	1	5.00	20
Early Stage 3	18	36.00	25	50.00	7	14.00	50
Middle Stage 3	28	29.79	54	57.45	12	12.77	94
Late Stage 3	8	10.13	61	77.22	10	12.66	79
Early Stage 4	3	12.00	21	84.00	1	4.00	25
Late Stage 4	1	3.23	28	90.32	2	6.45	31
Early Stage 5	2	9.09	19	86.36	1	4.55	22
Late Stage 5	0	0.00	7	77.78	2	22.22	9
Indeterminate Stage	28	19.85	94	66.20	20	14.08	142
Total	98	20.55	320	67.51	56	11.81	474

The stage at which heat-treatment is initiated cannot be determined for the majority (58.3%) of those bifaces from 26Ek5040 with definite indications of heat-treatment, but heat-treatment of the remainder was undertaken during several reduction stages. Of the heat-treated specimens, more are heated as blanks than detached from untreated cores (Tables 16, 17). The proportion of heat-treatment increases as reduction proceeds. The proportion of heat-treated or possibly heated bifaces rises from 50% of early Stage 2 bifaces to 100% of finished tools (cf. Table 15).

Table 16. Stage of Heat-Treatment by Biface Reduction Stage.

	Biface Stage										
	Early Stage 2	Late Stage 2	Early Stage 3	Middle Stage 3	Late Stage 3	Early Stage 4	Late Stage 4	Early Stage 5	Late Stage 5	Indet.	Total
Heat-Treatment Stage											
Blank from Heat-treated core			4	3	1		1			2	11
Heat-treated as Blank but stage indeterminate		5	3	16	14	3	5	2		12	60
Heat-treated in Stage 2	1	3	4	4	3		1	2		3	21
Heat-treated during thinning but stage indeterminate			2	4	6	1		1		6	20
Heat-treated in Stage 3				3	1					2	6
Heat-treated Early Stage 3			6	4	1	1					12
Heat-treated Late Stage 3						1	1	1			3
Heat-treated Stage 4											
Post-manufacture thermal alteration											
Possibly Heat-treated		1	7	12	10	1	2	1	2	20	56
Not thermally altered	1	9	18	28	8	3	1	2	0	28	96
Heat-treated but stage indeterminate		2	7	20	35	15	20	13	7	68	186
Total	2	20	51	94	79	25	31	22	9	141	474

At sites excavated on the periphery of the Tosawihi Quarries, heat-treatment was initiated most often in Stage 3, probably between Middle and Late Stage 3 (Bloomer, Ataman, and Ingbar 1992), while at quarry sites such as Locality 36 (Ataman 1992b) very little heat-treatment was observed. We have concluded elsewhere (Ataman and Bloomer 1992), that at Tosawihi bifaces were transported from quarries in a partially finished (Early-Mid Stage 3), unheated state, and that they were subsequently heat-treated and further reduced before being exported from the Tosawihi vicinity.

Since the evidence indicating stage of heat-treatment (co-occurrence of matte and glossy flake scars) is removed in late stages of reduction, most bifaces in the 26Ek5040 assemblage are classed as possibly heat-treated or indeterminate. Sample size notwithstanding, at 26Ek5040 heat-treatment of bifaces was initiated over a wider range of stages than previously noted elsewhere at Tosawihi: as cores, unworked blanks, or edged blanks, as well as during thinning (cf. Table 17). While our interpretation of 26Ek5040 as a place where heat-treatment was undertaken is consistent with previous conclusions (Bloomer, Ataman, and Ingbar 1992; Ataman and Bloomer 1992), this wider range of representation may indicate a less standardized approach to biface manufacture than seen elsewhere in the Tosawihi vicinity.

Table 17. Summary of Heat-Treatment by Reduction Stage.

Biface Stage	Frequency
Pre-Stage 1	11
Stage 1 or 2	21
Early Stage 3	12
Late Stage 3	3
Stage 3	6
Stage 1,2,3,4, or 5	186
Stage 2,3,4, or 5	60
Stage 3 or 4	20
	319

Breakage

Observation of bifaces broken in various stage of manufacture, along with data from debitage studies, allows us to reconstruct production methods (Callahan 1979) and to identify reduction techniques that may be peculiar to particular features, sites, regions, or timeframes.

Bifaces fail for a variety of reasons: raw material flaws, knapping mistakes, unworkable edges or unacceptable proportions, thermal failure during heat-treatment. Reasons for discard are linked to these failures; some are functional (i.e., they no longer can proceed on the intended trajectory), some refer to cultural preference regarding size, proportion, or shape.

Here we consider material failures, thermal failures, and knapping errors; the remainder of breaks are due to indeterminate causes (Table 18). Material failures are ascribed to internal fracture planes, inclusions, and other flaws in the natural structure of the stone or induced by quarrying or post-quarrying processes. Thermal failures occur when bifaces are over-heated, weakening the basic fabric of the toolstone. Knapping errors include hinge fractures, edge collapses, and so on.

Table 18. Manufacture Failures in the Biface Assemblage.

Breakage Type	Frequency	Percentage
Unbroken	29	6.12
Hinge Break	7	1.48
Outre passe Failure	3	0.63
Fracture plane Failure	41	8.65
Material Flaw	49	10.34
Edge Collapse	96	20.25
Bending Break	140	29.54
Thermal Failure	40	8.44
Bending/Material Flaw	10	2.11
Bending/Fracture Plane	7	1.48
Bending/Thermal	6	1.27
Thermal/Material Flaw	4	0.84
Thermal/Fracture Plane	7	1.48
Other Multiple	5	1.05
Indeterminate	30	6.33
Total	474	100

Only 29 bifaces (6.2%) in the 26Ek5040 assemblage are whole. The remainder, to the benefit of the present analysis, are broken. Some were discarded when their dimensions reached unacceptable proportions during manufacture, others may be dull or exhausted tools. Some stages are poorly represented. Nevertheless, when breakage is considered by stage, the one clear pattern to emerge is that breakage increases with reduction stage from Early Stage 3 until Early Stage 4, where it levels off (Figure 27, Table 19). Perhaps significantly, the proportions of bifaces discarded due to unacceptable shape are higher in Early and Middle Stage 3 than are discards due to breakage (cf. Figure 27). Overall, approximately 25% of failures were due to material flaw, 21% to knapping error, and 12% to over-heating. Seven percent are attributable to a combination of these.

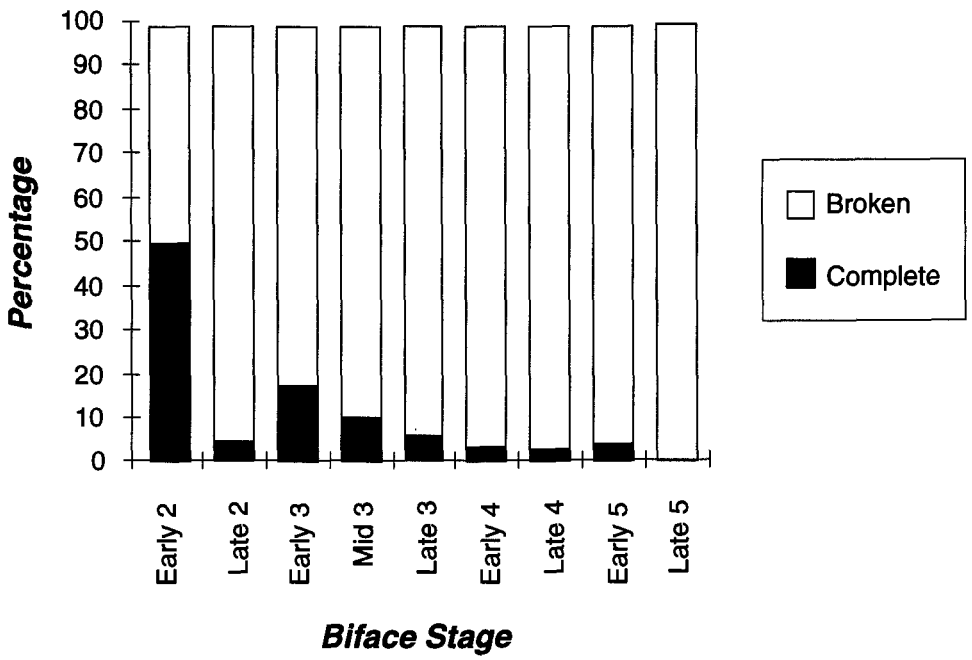


Figure 27. Biface breakage.

Table 19. Complete and Broken Bifaces by Stage.

Stage	Complete Frequency	Complete Percent	Broken Frequency	Broken Percent	Total
Early 2	1	50.00	1	50.00	2
Late 2	1	5.00	19	95.00	20
Early 3	9	17.65	42	82.35	51
Mid 3	10	10.64	84	89.36	94
Late 3	5	6.33	74	93.67	79
Early 4	1	4.00	24	96.00	25
Late 4	1	3.23	30	96.77	31
Early 5	1	4.55	21	95.45	22
Late 5	0	0.00	9	100.00	9
Indeterminate	0	0.00	141	100.00	141
Total	29	6.12	445	93.88	474

Biface Export

In previous work at Tosawihi we concluded that most prehistoric occupation of the area was of short duration related primarily to the procurement and processing of toolstone intended for use elsewhere (Elston 1992b). Thus, bifaces produced at Tosawihi were exported out of the area of production. One of the questions we are interested in addressing with the present analysis examines the form and stage of bifaces leaving 26Ek5040. Our previous work (Ataman 1992b; Ataman and Botkin 1991; Bloomer, Ataman, and Ingbar 1992) and other replication and archaeological studies of breakage have noted that successive stages of reduction, heat-treatment, and soft hammer use tend to increase breakage rates. If the incidence of broken pieces serves as proxy for breakage rates, various scenarios of export can be modeled.

We examine the question of export stage with several classes of data. We use incidence of breakage in each stage of the reduction sequence in the archaeological assemblage and observation of biface breakage in experimental replication to set up expectations about breakage. Then, from the proportion of the total represented by each stage in the archaeological assemblage (using only broken examples), breakage rates and export stages are modeled (Ataman and Botkin 1991; Ataman 1992b).

A simple mathematical simulation model of biface production uses insights gleaned from experimental flint knapping and the available archaeological data. We start with a pool of 1000 Stage 1 bifaces. The overall success rate (i.e., proportion of bifaces successfully reduced for transport) is fixed at 70%, a figure derived from experimental success rates (Ataman 1992b). Thus, sometime prior to transport, 300 bifaces must break. Their distribution across stages must match the observed archaeological distribution of biface stages.

Two conditions are allowed to vary in the simulation: breakage rate from one stage to the next, and number of bifaces leaving the assemblage at each stage. Breakage rates are determined, in part, by number of bifaces transported since these are removed from the pool of available bifaces. As noted above, breakage rates at 26Ek5040 seem to increase from Early Stage 3 through Early Stage 4, whereupon they level off somewhat. "Transporting" differing numbers of bifaces at each stage following Stage 2 (since there is no archaeological evidence for transport of Stage 1 or Stage 2 bifaces) causes breakage rates to change. Different export scenarios can be explored easily using this simulation. With the entire model in a spreadsheet, one simply changes the number of bifaces "transported" at each stage and examines the resulting breakage rates to see if they fit the pattern of the archaeologically and experimentally observed breakage rates.

Applying this technique to bifaces recovered elsewhere at Tosawihi, we concluded that 50% of the bifaces leaving the quarries were Middle Stage 3, 50% were Late Stage 3 or later, and most were heat-treated. (Ataman and Bloomer 1992). Examination of several museum collections from the greater Tosawihi region supported the conclusion that few, if any, Stage 1 or Stage 2 bifaces left Tosawihi for destinations outside the production area, that most transported bifaces were Middle Stage 3 or later, and that almost all of these were heat-treated. The export scenario revealed by the collection from 26EK5040 is somewhat different: most bifaces are exported at Middle or Late Stage 3 (more in Late Stage 3), as elsewhere at Tosawihi, but finished bifaces were exported as well.

Points and Preforms

This section describes the projectile point and preform assemblage from 26Ek5040 and discusses their manufacture, use, rejuvenation, and discard. In addition to functional considerations, the chronological value of projectile points in the Great Basin is well known (Heizer and Baumhoff 1961; Heizer and Hester 1978; O'Connell 1967; Clewlow 1967; Thomas 1971, 1981). Their relative dating can be used to construct local chronologies and to date associated geological strata. While several researchers (Flenniken 1985; Flenniken and Raymond 1986; Titmus and Woods 1986; Flenniken and Wilke 1989) question the validity of the current Great Basin projectile point sequence, suggesting that breakage and subsequent modification produce morphological variation sufficient to render many types poor temporal indicators, we found little in a large projectile point assemblage from the Tosawihi area to support this contention (Ataman and Drews 1992). The 26Ek5040 assemblage is too small to examine the question.

Projectile points can provide a framework in which to analyze temporal variation in technology, intensity of use, subsistence, mobility, and stylistic change. The chronological discussions below are descriptive, relating to point style and temporal sequence; a chronological synthesis and discussion of variation in activities is presented in Chapter 6.

For purposes of this study, preforms are defined as pieces discarded during the process of projectile point manufacture. Preforms for larger points often are indistinguishable from small bifacial tool preforms; such pieces here remain in the more general biface group. Distinctions between preforms and points were made on the basis of degree of finishing. Very small pressure-flaked tool fragments which could be remnants of projectile points or preforms, as well as of bifaces or flake tools, comprise a category of flake tool described later in this chapter.

Typology and Chronology

Test excavations generated nine projectile points and a preform, which are considered in later analyses. Here we examine the 34 projectile points and five preforms recovered by 1994 excavations at 26Ek5040, using Thomas's typological scheme (1981). Fifteen points are typeable (Figure 28); the remainder are out of key or fragmentary.

Large Side-notched Points. Thomas (1981) combines several side-notched variants (Northern, Bitterroot, Madeline Dunes, Elko, and Rose Spring; cf. Gruhn 1961; Swanson 1966; Riddell 1960; O'Connell 1975; Clewlow 1968; Heizer and Hester 1973) into one broadly defined series. Large Side-notched points are triangular in outline, with straight, concave, or notched bases. Notches are removed from sides rather than from corners of the blank. The series predates A.D. 1300, extending as far back as the No Name Phase (5000 B.C.) of the Upper Humboldt Valley sequence.

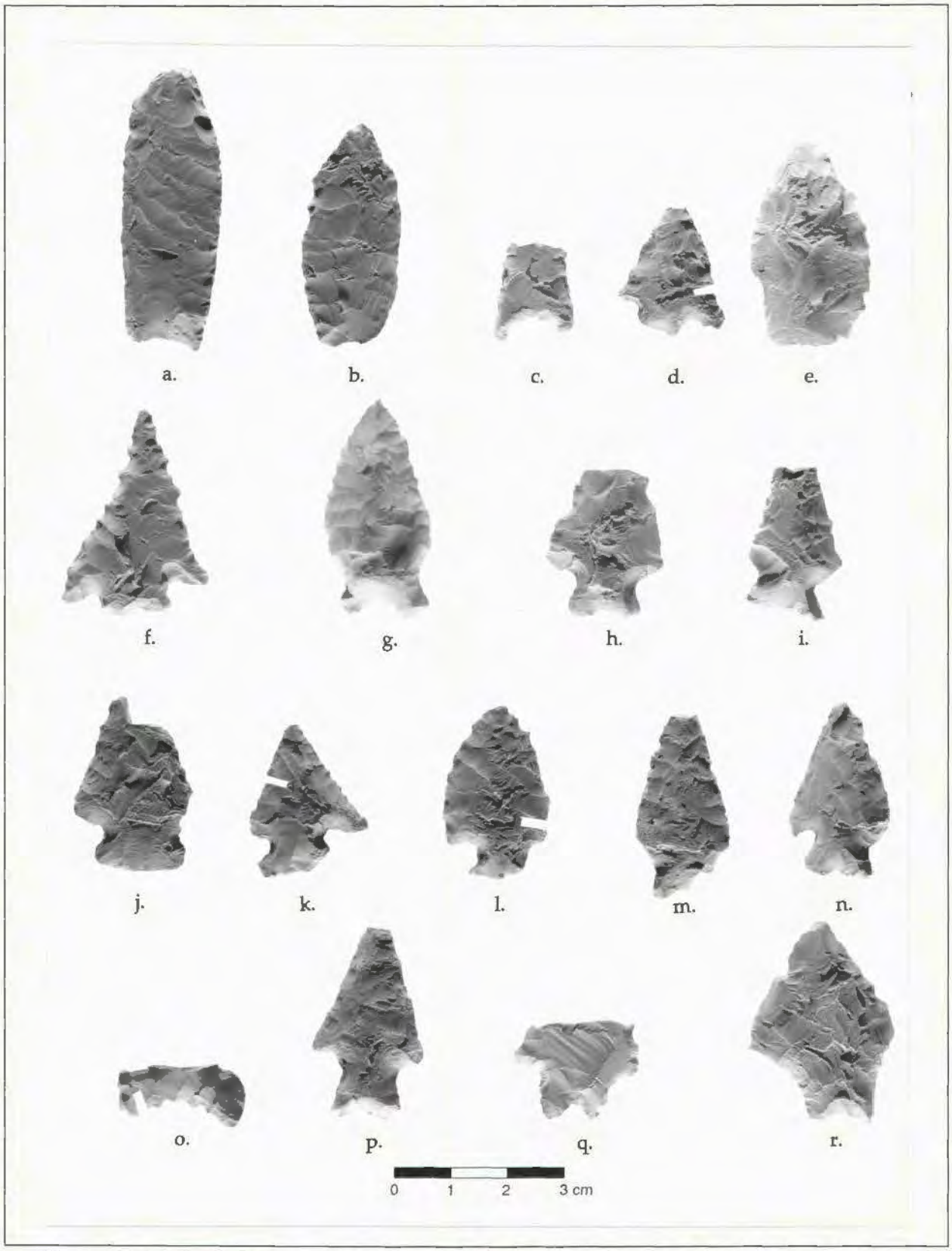


Figure 28. Selected projectile points, including all typeable specimens: a, b. Humboldt Series; c, e. out of key; d. fragment (Elko or Rosegate); f-n. Elko Series; o. Large/Northern Side Notch; p-r. Gatecliff Series.

One specimen was classified as a Large Side-notched point. It is an obsidian basal fragment broken through the notches and derives from an obsidian source at Pinto Peak or the Double H Mountains in northwestern Nevada. It's average hydration rind reading is 4.8 microns.

Humboldt Series. The Humboldt Series was defined by a surface assemblage at the Humboldt Lakebed site (Heizer and Clewlow 1968). Humboldt points are lanceolate, of variable size, with slight to deeply concave bases . Morphological variability and a broad temporal range renders them relatively poor time markers in the Great Basin. Dating between 3000 B.C. and A.D. 700 (Thomas 1981), the series spans several chronological phases of the Upper Humboldt Valley sequence.

Two specimens from 26Ek5040 are Humboldt points, one of Tosawihi opalite and the other of exotic chert. The opalite specimen has roughly parallel flaking extending to the midpoint while the more refined exotic chert specimen exhibits regular parallel diagonal flaking crossing the entire width of the point on one face. The latter specimen is basally thinned and has a distal impact fracture. One additional specimen is too small to fit the Humboldt key but resembles the type, as does one mid-section too fragmentary to type.

Gatecliff Series. A number of contracting stem and split stem forms appear in the Gatecliff Series. On the basis of similar morphologies, Thomas (1981) reclassified Elko Contracting Stem (Heizer and Baumhoff 1961) and Gypsum Cave points (Harrington 1933; Fowler, Madsen, and Hattori 1973; Heizer and Berger 1970) as Gatecliff Contracting Stem variants, and Pinto Points (Clewlow 1967; Heizer and Hester 1978; Thomas 1971) as Gatecliff Split Stem.

Three 26Ek5040 specimens, all made of Tosawihi opalite, are Gatecliff. Two are made of pink glassy opalite and one of white/pink speckled coarse material.

Elko Series. The Elko Series is comprised of Elko Corner-notched and Elko Eared types (Heizer and Baumhoff 1961; Heizer, Baumhoff and Clewlow 1968; Lanning 1963). Elko points are relatively large, triangular in outline, with deep corner notches and relatively straight, expanding (Corner-notched) or deeply notched (Eared) bases.

O'Connell (1967) demonstrated the utility of Elko points as time markers in the western Great Basin. Flenniken and Raymond (1986) warn that reworking of Elko points may obscure typological boundaries. The Series dates between 1300 B.C. and A.D. 700 (Thomas 1981); it represents the latter portion of the South Fork Phase and the entirety of the James Creek Phase of the Upper Humboldt sequence.

Elko Series points comprise more than one-half the classifiable points in the assemblage. Five are made of Tosawihi opalite, two of obsidian, and two of exotic chert. The Tosawihi examples include four white points and one caramel colored point with a clear impact fracture; all exhibit only minimal breakage. The obsidian specimens, both of which are nearly complete, derive from the Paradise Valley obsidian source; the hydration band of one measures 4.4 microns and the other 6.0 microns. The other exotics include a dark grey glassy chert specimen and one of a grey/brown coarse-textured material, possibly a rhyolitic tuff.

Rosegate Series. Rose Spring and Eastgate types have been combined to represent this series (Thomas 1981). Rose Spring Corner-notched points were defined by Lanning (1963) and named for the Rose Spring Site in southern Owens Valley; Wagon Jack Shelter, near Eastgate, Nevada is the type locality for Eastgate points (Heizer and Baumhoff 1961). Rosegate Points are assignable to the Maggie

Creek Phase of the Upper Humboldt Valley sequence; they represent a relatively short time span, dating between A.D. 700 and A.D. 1300 (Thomas 1981).

While no Rosegate points appear in the assemblage, one fragmentary obsidian point made of material from the Brown's Bench source with a hydration band of 5.3 microns no doubt would key to either Rosegate or Elko Series were it more complete.

Out of Key. Points complete enough to attempt to classify but failing to meet Thomas's key criteria, are "out of key." One square-based point, possibly unfinished, and one opalite point shaped like a Humboldt but too small to fit the key are included in this category. Our subjective speculations as to their origins appear above.

Fragments. Sixteen fragmentary points were recovered, mostly tip fragments. Twelve were made of local material, three of obsidian, and one of exotic chert. The obsidian was all from Paradise Valley with hydration bands measuring 4.7 and 6.0 microns, and one diffuse band. The exotic chert specimen is a dark, glassy material.

Raw Material

Raw materials used for points and preforms are summarized in Table 20. Most are opalite, with several obsidian and exotic chert specimens. Although the sample of projectile points is small, the incidence of exotic materials noted in Table 10 reflects differential patterns of raw material acquisition and utilization for bifaces and points. A low incidence of obsidian and exotic chert debitage indicates that some portion of the projectile points discarded at 26Ek5040 arrived there in a finished or partially finished form. No statistically significant relationships were noted between projectile point type and material type.

Table 20. Projectile Point Types by Raw Material.

Point Type	Tosawihi Opalite	Obsidian	Exotic Chert	Total
Elko	5	2	2	9
Gatecliff	3	0	0	3
Humboldt	1	0	1	2
Large Side-Notched	0	1	0	1
Out of Key	2	1	0	3
Fragment	12	3	1	16
Preforms	4		1	5
Total	27	7	5	39

Point Manufacture

Determining projectile point production techniques is sometimes difficult even in the presence of all stages of debitage and large point samples, of which neither condition prevails at 26Ek5040. Original

blank form often is obscured by subsequent reduction, and few cores, which might elucidate blank form, were recovered. Since numerous types of flake tools are made on biface thinning flakes and since biface reduction is the most common reduction technique observed, it seems likely that at least some of the flakes on which preforms and projectile points are made were produced during biface reduction, regardless of the primary purpose of reduction. Blanks for larger point types should be derived from early stage biface manufacture, while blanks for smaller points could have been removed from bifaces during any stage of reduction (Ataman and Drews 1992).

It was once assumed that Early and Middle-Archaic dart points in the Great Basin were made on small percussion flaked bifaces, while Late Archaic arrow points were made on thin flake blanks reduced directly by pressure flaking (O'Connell 1967; Lanning 1963; Zerga and Elston 1990). This notion has been questioned by Novick (1987), Ataman and Drews (1992), and Ataman and Ingbar (1994), who observe that Early Archaic Gatecliff and Middle Archaic Elko points from central Nevada frequently exhibit remnants of the ventral surface of the flake blank and that, consequently, these point types at least occasionally were produced directly from flakes by pressure rather than from percussion flaked bifaces.

At 26Ek5040, 26% of projectile points show ventral detachment scars and 12% percussion flaking, suggesting that some points were made from bifacially percussion flaked preforms but most probably were made directly on flakes; we infer common use of flakes in point manufacture at 26Ek5040.

Resharpening and reworking extend the use life of larger points, making discard necessary only when a piece is broken beyond repair. Maintenance of the edges of smaller points is restricted by their size, so that their resharpening may be of limited utility; consequently, complete small points with worn or damaged edges may be discarded.

Thomas (1983) suggests that tool maintenance, redirection, and discard may signal the intensive, well planned resource exploitation associated with long term, seasonal occupation. But sites with assemblages reflecting the reuse and reworking of projectile points may just as well be short term, single component sites related to hunting. At 26EK5040, approximately 25% of recovered points show signs of reworking, recognized primarily by asymmetric or non-standard form. A similar proportion show impact fractures; these points probably were brought to the site after use, either in a carcass or still attached to an arrow or spear shaft.

Recognition of Manufacture, Use, and Reworking Locations at 26Ek5040

Unlike other classes of broken tools which may have been produced in one place, used in another, and discarded in a third, it is unlikely that broken preforms, irreparably broken points, and pressure flakes were intentionally transported anywhere. So, the distribution of these artifacts reflects intentional discard actions. Insofar as discard occurs in specific activity contexts, they are useful indicators of those activities. The relatively small number of points and preforms at 26Ek5040 precludes detailed analysis of specific loci function (cf. Chapter 3), but some general observations can be made.

Locations of manufacture, hunting/butchering, reworking, and base camp activity can be recognized in terms of the following indicators:

Manufacture Location. Preforms, which we define as unfinished points, usually are found broken in manufacture, so their presence at a particular locus probably is an indication of point or preform manufacture there or nearby. Similarly, concentrations of pressure flakes at a particular locus likely indicate an area of projectile point manufacture. Notching flakes (Titmus 1985), a specialized form of pressure flake, provide evidence for *in situ* point finishing or reworking. These, however, are very small and may escape recovery, leaving this flake type underrepresented in any particular assemblage.

Hunting/Butchering Location. Points lost or irreparably broken *during* hunting should be discarded near capture or processing locales. Those lost often are complete points. Points exhibiting use breakage are more common; they identify kill or butchery sites, sites where carcasses were processed or consumed, or places where points were reworked. Broken tips may have been transported to base camps in meat, or left among the waste portions of carcasses abandoned at kill or butchering sites. Tips and unrecognizable fragments can be produced by fragmentation on impact and are discarded when found in the meat. Point bases retained on the shaft are later discarded. Expectations concerning fragment types recovered in this particular activity area are discussed in greater detail below.

Retooling Location. A site containing primarily bases and/or pressure flakes can be interpreted as a place where hafted bases are removed and discarded, or are reworked at the tip. Other broken fragments may be in evidence, but tips should be rare. Expectations concerning fragment types recovered in this particular activity area are discussed in greater detail below.

Short-term Base Camp Location. A wide range of activities can be expected at a base camp, including point manufacture, retooling, butchering, and even storage of finished or partially finished points. Thus all fragment types, pressure debitage, and complete and broken preforms could appear in quantity at a base camp.

To reiterate, at point manufacturing sites preforms, points broken in manufacture, notching flakes, and pressure flaking debitage should be present. At retooling sites (at least those where notched points predominate) (cf. Ataman and Ingbar 1994), point assemblages should be dominated by bases and pressure debitage, while at hunting/butchering sites, point assemblages should contain tips, barbs, few bases, and indeterminate fragments; few complete points, and little pressure debitage should be present. When all these fragment types are present in similar proportions, all these activities are indicated, suggesting components of a more complex activity locus such as a base camp.

Fifty-nine percent of debitage samples from 26EK5040 contain pressure flakes, but only five preforms were recovered, one notching flake was noted, and no projectile points exhibit manufacture breaks (but note that many manufacturing breaks are not diagnostic). There is a high degree of fragmentation in the point assemblage (Table 21); only six points are complete and 17 specimens (some of which could have broken in manufacture) are too fragmentary to classify to type. Point fragments are of various types, suggesting generalized campsite activities, which might include butchering/ consumption, manufacturing and retooling. The high degree of fragmentation could indicate butchering/ consumption were the most common of these activities.

As noted above, differential patterns of raw material acquisition for points and bifaces suggests that some points arrived at 26Ek5040 in a finished or partially finished form. This observation, in conjunction with the proportion of points exhibiting reworking suggests that these items were highly curated tools: tools which were used, maintained, and discarded very differently from the bifaces manufactured and transported from the site and the quarry vicinity in general.

Table 21. Point Fragment Types.

	Frequency	Percent
Complete	6	17.65
Base	3	8.82
Tip Missing	4	11.76
Barb/Tang Missing	3	8.82
Tip	4	11.76
Base Missing	3	8.82
Mid-section	4	11.76
Lateral Fragment	1	2.94
Indeterminate	2	5.88
Multiple Breaks	4	11.76
Total	34	100.00

Flake Tool Technology

Flake tools are flaked stone tools exclusive of bifaces, preforms, and projectile points. At 26Ek5040, they are the second most common flaked stone tool type (after bifaces). Flake tool function is difficult to assign. Many flake tool assemblages, especially those recovered from the surface, provide only limited information on function because post-depositional alteration of micro-topographic wear surfaces obscures otherwise diagnostic polish and edge damage. The present study does not consider wear characteristics in the relatively small flake tool assemblage. We have attempted to exclude the more equivocal pieces from analysis, in favor of more heavily retouched items, but it often is impossible to distinguish deliberate or use-induced retouch from post-depositional retouch (Howes 1980; Young and Bamforth 1990); trampling and other post-depositional processes may produce macroscopic and microscopic edge damage mimicking deliberate and use-induced retouch (Flenniken and Haggarty 1979; Knudson 1979; Tringham et al. 1974).

We identify 15 morphological flake tool types, grouping them into six general tool classes. As described elsewhere (Ataman 1992a), flake tools are classified according to overall morphology and outline of working edge. While sharing some morphological attributes, pieces assigned to the same class may not have shared a common function. Nonetheless, the seemingly functional term "scraper" is used here because it describes a generally recognized tool class. We use this term explicitly, to denote a common morphology (flakes with continuous abrupt or semi-abrupt retouch serving to strengthen or regularize a straight or convex edge) and disavow implied functional characterizations. Three categories of scraper-like tools are included among the morphological types: side-scrapers and end-scrapers (Figure 29) were defined by the location of retouch on the blank, and a category of miscellaneous and fragmentary scraper specimens was established.

Three categories of pointed tools include specimens commonly called perforators, awls, drills, and gravers. Because these terms often are used interchangeably, and to avoid functional ascriptions, morphologically descriptive terms are used instead; we recognized elongate and short symmetrically pointed tools, and asymmetrically pointed tools (cf. Figure 29).

Pieces exhibiting notches (Figure 30) are assigned to one tool class. Two categories of flake tools exhibit bifacially worked edges (straight or sinuous edge profiles) (cf. Figure 30), distinguished from bifaces by their pressure flaking, which most often is not invasive, and by the frequently regularized edge.

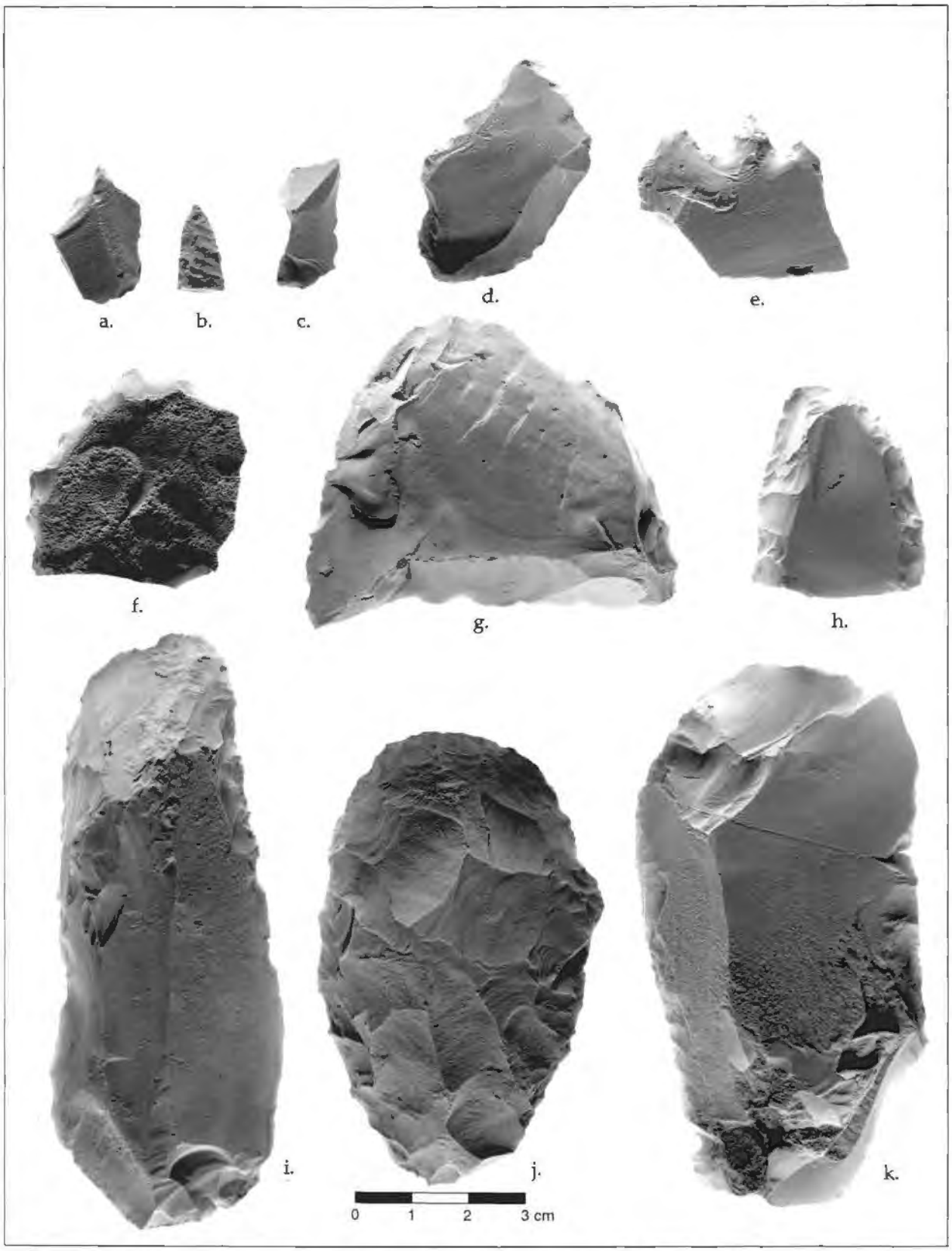


Figure 29. Selected scrapers and pointed tools. a-e. pointed tools; g, i, k. side scrapers; f, h, j. end scrapers.

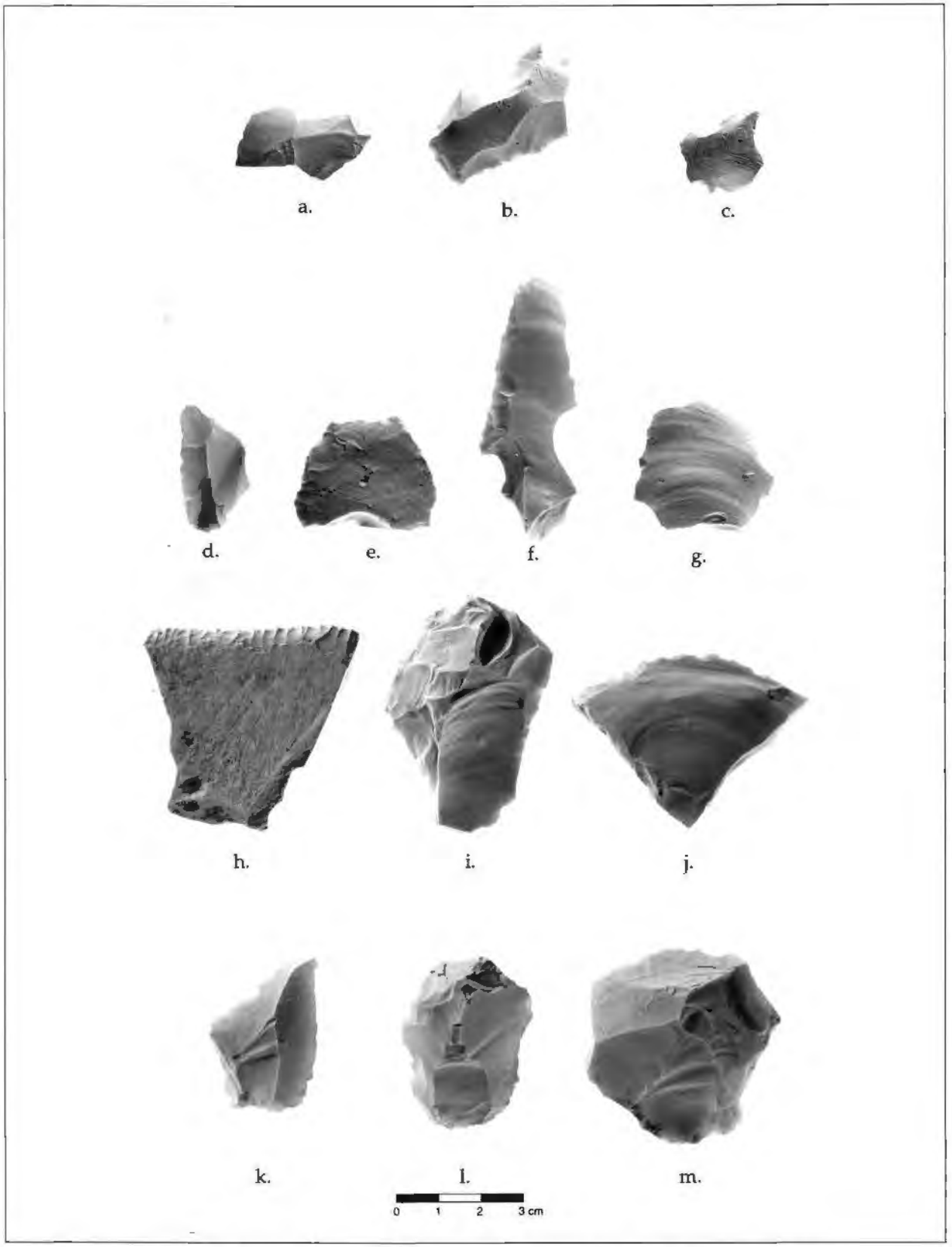


Figure 30. Selected notched tools (a-c.), retouched flakes (d-g. and k-e.), and bifacial flake tools (h-j.).

Retouched flakes are segregated by extent and location of retouch. We recognize five categories: flakes with continuous or localized retouch on one edge, those with continuous or localized retouch on multiple edges, and those with variable retouch patterns on multiple edges (cf. Figure 30).

In addition to these, summarized in Table 22, we assign to yet another category tools which fit none of these groups, and tally as well pressure flaked pieces too fragmentary to classify. Of 173 flake tools, most (50%) are retouched flakes without formal shapes, but scrapers (14%) and notched tools (10%) are proportionally significant.

Table 22. Flake Tool Type and Raw Material.

	Material				
Morphological Type	Tosawihi Chert	Exotic Chert	Basalt	Other	Total
Side-scraper	12				12
End-scraper	4				4
Misc. scraper	8	1			9
Symmetrically pointed elongate	1				1
Symmetrically pointed short	2				2
Asymmetrically pointed	2				2
Notch/denticulate	16		1		17
Bifacial with straight profile	2	1			3
Bifacial with sinuous profile	6		1		7
Flake with continuous retouch on 1 edge	39			1	40
Flake with continuous retouch on >1 edge	11				11
Flake with localized retouch 1 edge	21				21
Flake with variable retouch pattern	17				17
Pressure flaked tool fragment	18				18
Flaked percussion tool	0		1		1
Other	2		2		4
Indeterminate	4				4
	165	2	5	1	173

Manufacture

Several aspects of flake tool manufacture were examined, including material preference, blank selection, and thermal alteration. As noted above, the vast majority of flake tools were made of the local chert. There are a few (n=5) basalt tools and even fewer (n=2) made of exotic material. Unlike other categories of flaked stone tools at 26Ek5040, none is obsidian.

Approximately one-half the blanks of flake tools could not be identified, but the remainder are made on core reduction flakes, biface thinning flakes, angular chunks, and tabular pieces. Blank form is related to tool type (Table 23). Scrapers, which are larger than most other flake tools, are more often made on core reduction flakes, while notched tools and miscellaneous retouched flaked are more commonly made on biface thinning flakes. Since many miscellaneous retouched flakes and pressure flaked fragments are made on flakes whose type cannot be determined, we infer that scrapers are more formal tools and most of the other types present more expedient.

Table 23. Flake Tool Blank Types.

	Indeterminate Flake	Core Reduction Flake	Biface Thinning Flake	Angular Chunk	Tabular Piece	Total
Scrapers	8	13	4	0	0	25
Pointed Tools	4	0	1	0	0	5
Notched Tools	4	3	9	1	0	17
Bifacial Tools	6	2	1	0	1	10
Misc. Retouched Flakes	42	8	32	7	0	89
Pressure Flaked frags	18	0	0	0	0	18
Other	1	1	0	1	2	5
Indeterminate	4	0	0	0	0	4
	87	27	47	9	3	173

Heat-treatment is also related to tool type and blank type (Table 24). Scrapers (which are detached from cores) are less often heat-treated. This may be due both to function, where more brittle tool material is less desirable, and to size, inasmuch as flakes removed from a mid-stage or later stage biface are smaller than those chosen for the manufacture of formal tools. Pressure flaked fragments, which usually are heat-treated, were most frequently heated as flakes, and miscellaneous retouched flakes are detached from heat-treated cores, probably bifaces.

Table 24. Heat-treatment of Flake Tools.

Flake Tool Type	Detached from Heat-treated Core	Heat-treated as a Flake	Heat-treated at an Indeterminate Stage	Possibly Heat-treated	Not Heat-treated	Total
Scrapers	2	1	1	3	18	25
Pointed Tools	2	1	0	1	1	5
Notched Tools	3	0	0	7	7	17
Bifacial Tools	0	2	0	3	5	10
Misc. Retouched Flakes	22	4	5	21	37	89
Pressure Flaked Frags	2	5	3	6	2	18
Other		1	0	0	4	5
Indeterminate			1	1	2	4
	31	14	10	42	76	173

Percussion Tools

The percussion tools from 26Ek5040 are few (n=10) but morphologically diverse; four distinct types are identified (hammerstones, basalt slabs, battered flake tools, other battered tools). Analysis of the percussion tools was designed to explore the kind, length, and intensity of tool use through focus on four main attributes: angle of the working edge, location of wear, extent of wear, and intensity of wear. Extent of wear assesses the percentage of overall surface that has been modified by use and the percentage of the edges that have been modified. Intensity of wear is a more subjective attribute used to describe the degree to which a tool has been used based on a combination of the types of wear present

and the degree of edge damage; it is recorded on a relative scale from low to high. Broadly, the edge angle and location of wear may help illuminate the ways in which a tool was used while extent and intensity of wear help determine to what degree a task may have been pursued at a particular location.

Hammerstones

Hammerstones, stones battered by use in lithic tool reduction, ground stone resharpening, and other percussive tasks, are common on Great Basin sites and have been found throughout the Tosawihi region (Schmitt 1992a; Schmitt and Carroll 1992). Four were recovered from 26Ek5040 (Table 25). Three are cobbles of basalt, and one is of quartzite; all are ovoid to irregular in shape, with battered edges. Figure 31 illustrates one such hammerstone.

Table 25. Attributes of Percussion Tools.

	Material	Working Edge Angle	% Surface Battered	% Edges Battered	Intensity of Use
Hammerstones					
0-0-94.52	Basalt	Obtuse/rounded	10	75	Moderate
Q8-3-1.12	Basalt	Obtuse	Indeterminate	Indeterminate	Low
W1-1-2.1	Quartzite	Rounded	Indeterminate	Indeterminate	Moderate
TC-0-1.1	Basalt	Obtuse	5	25	High
Basalt Slabs					
MS1-0-1.3	Basalt	Acute	Indeterminate	Indeterminate	Low
MS1-0-1.5	Basalt	Acute	10	Indeterminate	Mixed
Battered Flake Tools					
0-0-94.79	Opalite	Rounded	5	45	Mixed
AG1-4-1.6	Opalite	Acute	Indeterminate	Indeterminate	Low
Other Battered Tools					
0-0-94.264	Welded Tuff	Rounded	5	0	Moderate
MS2-0-1.7	Basalt	Rounded	Indeterminate	Indeterminate	High

Wear is generally confined to the borders or lateral edges, though in one case it is located on one end. The angle of the working surfaces on hammerstones ranges from obtuse to rounded. Extent of edge use on these tools proved minimally informative since it was so variable, ranging from indeterminate to 75% of available edges. Intensity of use was also highly variable, including one minimally and one moderately used piece and two highly worn tools (cf. Table 25). Wear consisted of crushing and battering on all tools with the addition of spalling and flaking on the heavily battered tool.

A quartzite specimen (W1-1-2.1) may be a pestle fragment inasmuch as wear is confined to one end and there is a small ground patch on one edge which may represent shaping. However, quartzite is common among Tosawihi hammerstones, and the ovoid shape of this specimen is more typical of Great Basin hammerstones. A minimally battered tool (Q8-3-1.12) may be a hammerstone spall.



Figure 31. Hammerstone with impact fractures.

These hammerstones were most likely used for early reduction tasks such as core reduction, blank preparation, and early biface thinning. Since blanks for hammerstones are readily available in the numerous drainages in the Tosawihi area, their infrequency suggests early reduction did not dominate reduction activity at 26Ek5040. Indeed, analysis of the debitage (cf. Chapter 5) suggests that early reduction was less common than biface thinning and shaping.

Battered Basalt Slabs

Two fragmentary battered basalt slabs (Figure 32) were found during mechanical scraping. These two fragments do not refit but seem, nevertheless, to be elements of the same tool. Use has caused spalling, crushing, and battering of the acutely angled edges of both fragments. Some step fracturing and microflaking is present. The intensity of battering is variable, with specimen MS1-0-1.3 evincing only light use but specimen MS1-0-1.5 exhibiting a mixed pattern of use ranging from moderate to high (cf. Table 25). These tools resemble battered basalt slabs recovered elsewhere at Tosawihi and interpreted as quarrying tools (Schmitt and Carroll 1992:121-123).

Battered Flake Tools

Two opalite flake tools exhibit step fracturing on the flaked edge (cf. Table 25). One has a steeply angled scraper-like edge which is battered and step fractured; the intensity of this wear varies along the worked edge. An adjacent rounded surface and side are also battered. Wear suggests use as a chopping tool.

The other is step fractured from use as a battering tool along a 3 cm long, flaked, acute angle edge; the intensity of wear is low. The presence of battering wear on such a small tool edge is unusual; its function is unknown.

Other Battered Tools

This category includes a mano-hammerstone and a battered basalt cobble (Figure 33). The mano-hammerstone is described here rather than with the ground stone section because its last use was as a percussion tool (Figure 33b). It is a cobble of welded tuff of which two convex surfaces have been used in grinding functions; the smaller of the two ground surfaces is battered as well. Unlike other tools in the percussion tool category, none of the edges of this piece have been used. One end may be battered but the wear is minimal and equivocal. The moderately battered facet is located adjacent the ground facet and partially obliterates it. Wear is centered on the highest point of the rounded surface meaning, essentially, that a very broad "edge" was used to batter. A hammerstone with a similar wear pattern from Tosawihi has been interpreted as a percussor for bipolar reduction (Schmitt 1992a:275), but the softness and lightness of welded tuff makes this an unlikely use for the present tool. Wear could be from use as an anvil stone or to break resistant materials such as bone or seeds.

The second tool is a roughly cylindrical piece of basalt, broken at one end (Figure 33a). One hundred percent of the extant edges of the fragment have been battered (cf. Table 25). These rounded edges, which run along the cylinder's length, exhibit a high degree of wear consisting of spalling, crushing, battering, pitting, and step fracturing. Its possible function is unknown.

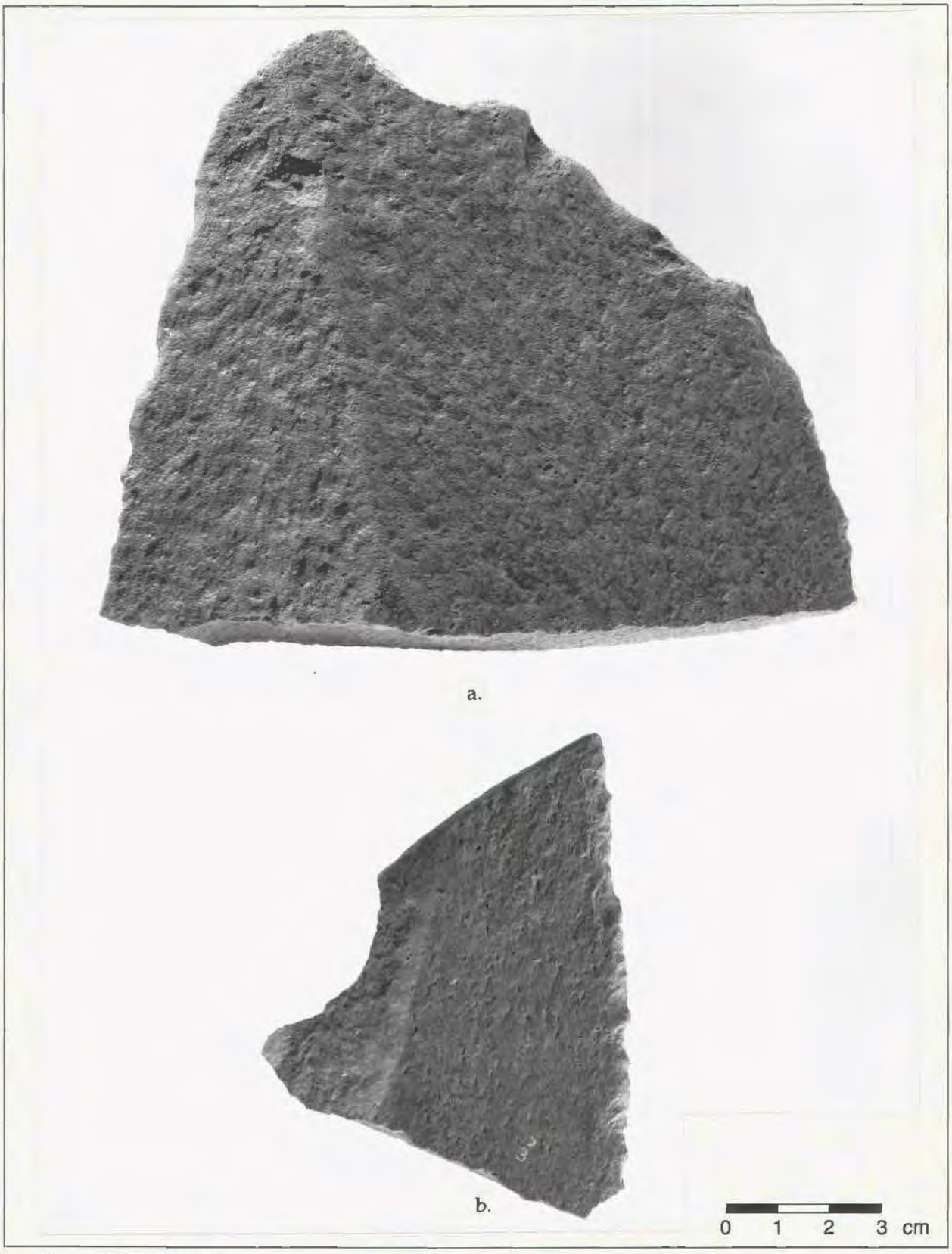


Figure 32. Battered slabs.



a.



b.

0 1 2 3 cm

Figure 33. Other battered artifacts: a. cylindrical basalt heavily battered object; b. welded tuff cobble with flat battered surface.

Ground Stone Tools

Thirty-six pieces of ground stone were collected, 20 as surface isolates and the remainder from below surface. Four additional pieces were surface collected in 1992 (Ataman et al. 1992:34). Though a number of tool types are represented in this assemblage, several broad trends crosscut categories. Basalt (including andesitic basalt) is the most common raw material (55.5%), followed by rhyolite (16.6%; Table 26). Welded tuff, tuff, and quartzite are also represented. Formal shaping appears only on one pestle; one quartzite mano has a ground edge facet, but this is believed to be from use rather than manufacture (see below). The ground stone assemblage is highly fragmentary; only five complete tools were recovered. Unifacially worn tools predominate and use surface profiles are generally planar, although irregular and convex surfaces are present. Modifications other than grinding wear include striations on two tools, battering on three pieces, ochre staining on a mano, and fire-cracking of two tools.

Table 26. Raw Material of Groundstone Tools.

	Basalt/ Andesitic Basalt	Rhyolite	Tuff	Welded Tuff	Quartzite	Other	Total
Manos				3	1		4
Metates:							
Block	1	1					2
Slab	6						6
Boulder	1	1				1	3
Metate Frag.	3	2					5
Mortar			1				1
Pestle				1			1
Groundstone Fragment	9	2		1			12
Anomalous					1		1
Total	20	6	1	5	2	1	35

Analysis of the ground stone was designed to explore morphological variation as well as differences in use-wear facet shape, size, and intensity of use. Types in this analysis are based on morphological characteristics and do not necessarily indicate a specific mode of use (e.g., mortars are tools with circular to oval concave wear facets; wear may be from pounding or grinding). Analysis of the use wear facets focused on two attributes: the *extent* of the use wear facet relative to the surface area available and the *intensity* of wear present. Intensity of wear is a relative scale based on a continuum from minimal (little surface modification, wear difficult to see or feel) to high (highly polished, entire facet surface looks modified/slick). Tracking use wear facet extent proved minimally informative for this analysis because of the lack of complete specimens. Intensity of wear fell most often in the moderate to high range.

Manos

Four manos were recovered during excavation; two fragments refit and are counted as one item. The selection of quartzite and welded tuff for these tools contrasts with the ground stone assemblage as a whole where basalt is selected more often (cf. Table 26). Selection of these less common materials may

refer to raw material form, inasmuch as rhyolite and basalt in this area occur as slabs or angular chunks rather than small cobbles suitable for handstone use.

None of the manos has been formally shaped. The quartzite mano (Figure 34b), however, has a highly polished, flat, shouldered facet on one edge; the degree of wear is such that it has altered the plan-view outline of the tool from oval to plano-convex. This facet is from use rather than manufacture. The function of this tool is unknown, but facet shape and location suggest it was a scraping or rubbing tool. Three similar edge facets appear on a second quartzite cobble from 26Ek5040, as discussed below.

Mano use wear facets are fairly uniform: oval in outline, covering 75% of the available surface, and exhibiting moderate to high intensity wear. Modifications other than grinding include ochre staining on one specimen (Figure 34a), and high intensity bifacial wear, and pecking or battering on the non-use surface of another. The exterior of the latter is badly weathered making it difficult to separate cultural and natural wear.

Metates

Six slab, two block, and three boulder metates were collected (cf. Table 26). Four additional slab metate fragments were recovered during testing (Ataman et al. 1992). These metate types refer not to function, but to original shape of the raw material used. Like the manos, none of these tools appears shaped or otherwise manufactured. They are made from unmodified locally available raw materials. All but one are fragmentary unifacial tools of basalt or rhyolite (cf. Table 26) with planar use surface profiles. Wear intensity ranges from light to high, though moderate wear is most common; extent of wear proved fruitless for analytical purposes as most tools were fragmentary. Unusual wear types include minimal flaking and battering on the edge of one broken slab metate; wear echoes that of the possible quarrying tools described in the hammerstone section above. Battering appears to have occurred after the piece was broken.

Striations were noted on two tools, one a boulder of tuff with striations on both convex surfaces and grinding on one. The presence of striations on this piece may be due to the softness of the raw material. Another metate exhibits striations on the ground facet, accompanied by high intensity wear.

Metate fragments (cf. Table 26) include five tools too fragmentary to determine the original form of the raw material. All are unifacial; use wear facet profiles range from planar (n=3), to concave (n=1) and convex (n=1). Wear is light to moderate in intensity. Wear on two fragments is notable. On specimen AG1-2-2.1 wear is confined to a pockmarked, wavy, convex surface although the opposite side of the tool is flatter, more smooth, presumably a better grinding surface. This tool probably is an edge remnant from a much larger tool. One metate fragment (AH2-7-3.1) has only a small (2.5 x 4 cm) wear facet on one broken edge although the available surface area is quite large. This fragment is also most likely part of a much larger piece.

The high degree of fragmentation in this assemblage is intriguing. The predominance of moderate intensity wear does not suggest that the tools broke solely from grinding fatigue. Fire-cracking and staining is not found on these tools. A combination of grinding fatigue and natural processes such as freeze-thaw cycles may be responsible for the breakage. On the other hand, use-wear replication studies have shown that basalt slabs of the type used for ground stone at 26Ek5040 require frequent resharpening to maintain grinding efficiency (Bullock 1994b). Frequent pecking to resharpen tools may have contributed to tool breakage.

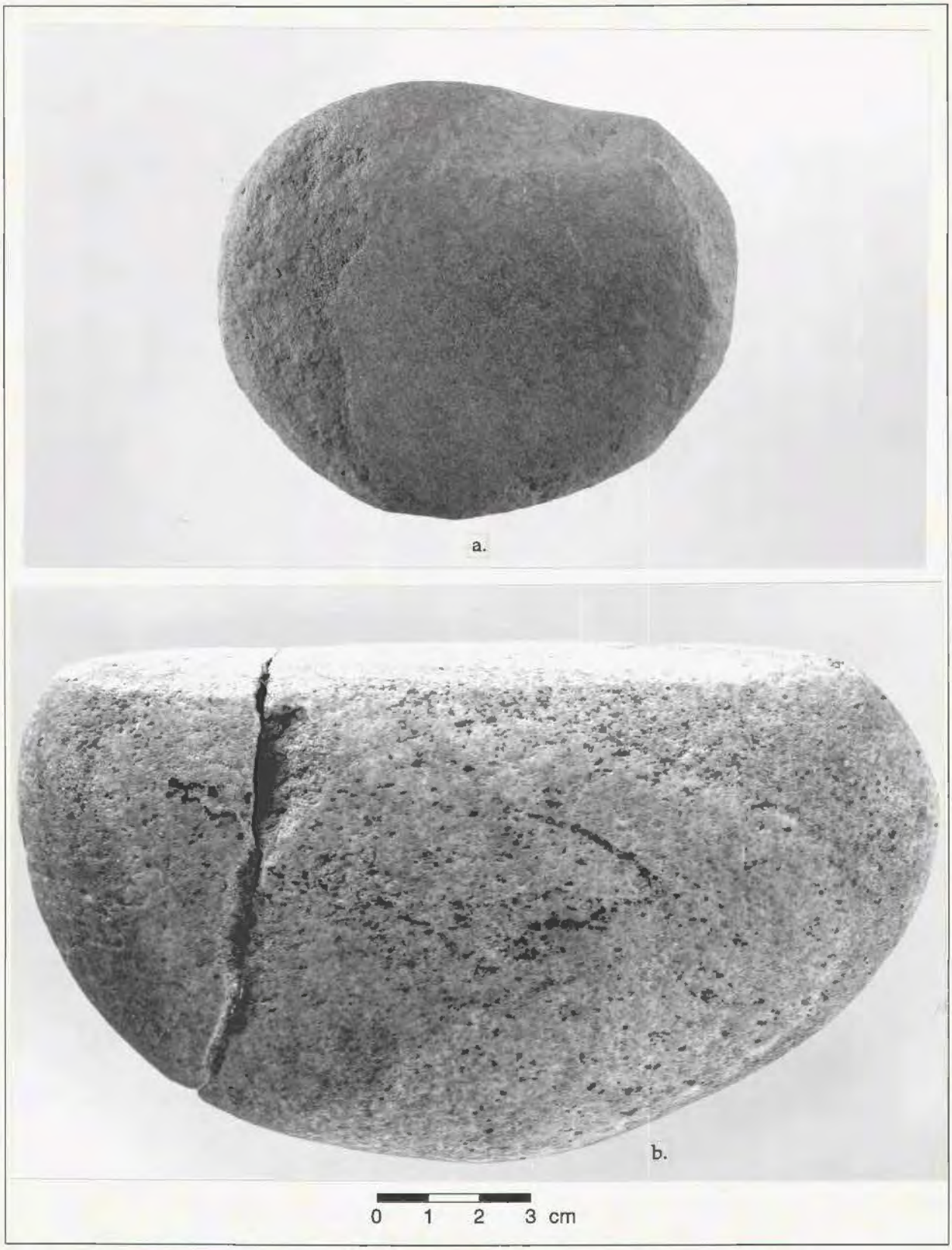


Figure 34. Selected manos: a. mano with ochre staining; b. mano with heavily polished flat facet.

Mortar and Pestle

The only mortar from 26Ek5040 is a piece of tuff with an oval, concave use surface. Wear on the facet is from grinding rather than pounding. The mortar is fragmentary, measuring 13.6 cm in length and 12.8 cm wide; the wear facet is 5.5 centimeters in diameter. The mortar cup is shallow but its high polish argues against an incipient mortar surface.

A complete pestle (Figure 35) was recovered from the backhoe bucket during excavation of Trench D. The pestle is 26.4 cm long and 9.2 cm wide (cf. Figure 35). It is an elongated cobble of welded tuff, oval in plan and in cross-section. It has been shaped by grinding along one edge, and possibly on others but the surface is too badly weathered to tell accurately. One end of the pestle is subrectangular in outline, flattened by use, polished and battered with some signs of spalling and flaking. Again, extensive weathering has confused or obliterated wear traces. The other end of the pestle is rounded but appears unworn.

Trifacially Ground Cobble

This quartzite cobble is faceted on three edges; the convex faces are unmodified. Facets consist of linear bands ranging from 5.1 to 7 cm in length and 0.6 to 1.0 cm in width. The surfaces of all three ground edge facets are flattened, highly polished, and noticeably shouldered from wear. Two of the three facets have been truncated by breaks or spalls. As mentioned previously, these facets resemble the edge facet on the quartzite mano (specimen 0-0-94.270/271) in both morphology and wear. It is unknown what kind of use left these wear traces, but they may be from use as a scraping or rubbing tool.

Ground Stone Fragments

Twelve pieces of ground stone were too fragmentary to type. All are unifacial with wear on the majority ranging from moderate to high. Wear on three, however, is marginal and may be natural. The more unusual pieces include specimen 0-0-94.265, which has scratches across both surfaces; microscopically (10X) these appear to be features of the rock's cortex rather than from wear. Specimen 0-0-94.167 is a small (8.7 x 6.5 cm) irregularly shaped rock with a tiny ground facet on one uneven surface; its use is unknown. Finally, though fragmentary, the projected size and shape of the complete tool represented by fragment Q5-3-2.1 would classify it as a palette; its length and width fall well below the mean for other metate types.

Summary of Ground Stone Tools

The ground stone tools from 26Ek5040 are of local materials invested with minimal manufacturing effort. A variety of ground stone types represents a variety of grinding tasks. The high degree of fragmentation in the collection is puzzling, perhaps attributable to the harsh, changeable winters of the Tosawihi area.

The ground stone assemblage from 26Ek5040 varies in a number of aspects from collections at other sites in and peripheral to the Tosawihi Quarries. Ground stone is proportionally more abundant here than at other Tosawihi sites (Schmitt 1992b:283; Schmitt and Carroll 1992:119). The lack of shaping is also distinctive, particularly among slab metates which, elsewhere in the quarries, were all shaped (Schmitt 1992b:284). Much of the ground stone recovered from sites peripheral to the quarries was battered, particularly the manos (Schmitt 1992b:284). Battering is not a feature of the ground stone tools from 26Ek5040. Finally, wear on the ground stone from the periphery sites was minimal for the most part (Schmitt 1992b:284) but moderately intensive at 26Ek5040.



Figure 35. Pestle.

Some characteristics of the 26Ek5040 assemblage do resemble other Tosawihi ground stone collections. Local materials predominate and unifacial wear is most common for both manos and metates. Mortars with small polished surfaces like the one recovered at 26Ek5040, and similar cobble pestles have been observed (Schmitt 1992b:287-288).

Because this ground stone assemblage was highly fragmentary, variations in use wear facet shape, extent, and intensity provided only equivocal information. The larger, more diverse ground stone assemblage at this site relative to other Tosawihi sites suggests more attention to plant resources.

Chapter 5

TRAJECTORIES OF DEBITAGE AND TOOL PRODUCTION

Kathryn Ataman

By-products of flaked stone tool manufacture include tools broken in manufacture and reworking, cores, modified chunks, and debitage. The tools of 26Ek5040 are discussed in the previous chapter; here by-products of their manufacture are examined. Relative frequencies of debitage types and other by-products provide information about site-specific activities beyond that available from the study of tools alone. In addition to identifying loci of lithic reduction, stages and types of reduction produced in particular places can be determined, and sometimes even the form of artifacts imported or exported from a locus may be evident.

Technological Analysis of Debitage

Debitage is by far the largest artifact assemblage, both numerically and by weight, recovered from 26Ek5040, and that made of local chert comprises the vast majority. Of the local cherts, the variously colored altered basalts have been distinguished from the light colored altered tuffs, but the former contribute only about 3 percent of the material recovered; other raw materials comprise even smaller quantities and of these, only obsidian is described (Table 27).

Table 27. Total Debitage Samples and Counts.

	Samples	Counts
Tosawihi Altered Tuff	318	49159
Tosawihi Altered Basalt	100	1469
Basalt	16	22
Tuff	2	7
Andesite	4	5
Obsidian	142	168
Exotic Chert	2	2
Total	584	50832

As described in Chapter 2, in the technological analysis of debitage, each lot (the sample of a particular raw material from each provenience) was analyzed separately and the proportions of diagnostic flake types representing core reduction, blank preparation/edge preparation, early biface thinning, late biface thinning, and retouch/finishing reduction stages were characterized as *absent*, *rare*, *common*, or *dominant* in the sample. Just under 50,000 pieces of debitage from 443 lots were analyzed using this system. A relatively small number of flakes (n=141) pulled from miscataloged lots were not incorporated in the analysis. The system was designed primarily to describe biface reduction activities, which comprise the dominant technological industry during the whole of the Archaic at Tosawihi and in much of the surrounding region. Three types of data are produced using this technique: the number of samples of each material which contain each reduction stage, the relative frequency of that stage in each sample and in the assemblage as a whole, and the components of the reduction sequence in a given locus for a given material.

Summary results of the technological analysis appear in Table 28. This summary presents only the relative proportions of reduction activities represented in the assemblage as a whole, and declines to describe the combinations of activities in individual lots; that is, to address how much of the reduction sequence is represented in a given location.

Table 28. Results of Technological Analysis.

	Basalt		Chert		Exotic Chert		Obsidian		Opalite			
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Total Count	Total Percent
Debitage Samples with Core Reduction												
Absent	16	84.21	76	80.00	2	100.00	126	89.36	115	62.16	336	76.02
Rare	0	0.00	12	12.63	0	0.00	0	0.00	64	34.59	76	17.19
Common	0	0.00	5	5.26	0	0.00	0	0.00	6	3.24	11	2.49
Dominant	3	15.79	2	2.10	0	0.00	15	10.64	0	0.00	20	4.52
Total	19	100.00	95	100.00	2	100.00	141	100.00	185	100.00	442	100.00
Debitage Samples with Blank Preparation/Edge Preparation												
Absent	16	84.21	51	53.68	2	100.00	133	94.33	39	21.08	241	54.52
Rare	0	0.00	20	21.05	0	0.00	0	0.00	100	54.05	120	27.15
Common	0	0.00	20	21.05	0	0.00	0	0.00	42	22.70	62	14.03
Dominant	3	15.79	4	4.21	0	0.00	8	5.67	4	2.16	19	4.30
Total	19	100.00	95	100.00	2	100.00	141	100.00	185	100.00	442	100.00
Debitage Samples with Early Biface Thinning												
Absent	19	100.00	63	66.32	2	100.00	138	97.87	19	10.27	241	54.52
Rare	0	0.00	18	18.95	0	0.00	0	0.00	38	20.54	56	12.67
Common	0	0.00	11	11.58	0	0.00	0	0.00	97	52.43	108	24.43
Dominant	0	0.00	3	3.16	0	0.00	3	2.13	31	16.76	37	8.37
Total	19	100.00	95	100.00	2	100.00	141	100.00	185	100.00	442	100.00
Debitage Samples with Late Biface Thinning												
Absent	19	100.00	63	66.32	0	0.00	122	86.53	7	3.78	211	47.74
Rare	0	0.00	14	14.74	0	0.00	1	0.71	65	35.13	80	18.10
Common	0	0.00	14	14.74	0	0.00	4	2.84	76	41.08	94	21.27
Dominant	0	0.00	4	4.21	2	100.00	14	9.93	37	20.00	57	12.90
Total	19	100.00	95	100.00	2	100.00	141	100.00	185	100.00	442	100.00
Debitage Samples with Retouch/Finishing												
Absent	19	100.00	61	64.21	2	100.00	93	65.96	54	29.19	229	51.92
Rare	0	0.00	19	20.00	0	0.00	0	0.00	108	58.38	127	28.67
Common	0	0.00	10	10.53	0	0.00	3	2.13	22	11.89	35	7.90
Dominant	0	0.00	5	5.26	0	0.00	45	31.91	1	0.54	51	11.51
Total	19	100.00	95	100.00	2	100.00	141	100.00	185	100.00	442	100.00

For the assemblage as a whole (all materials combined), late biface thinning appears in the greatest number of samples; core reduction is least represented. Late biface thinning and retouch are *dominant* in more samples than other reduction stages, but the high retouch figure is influenced by numerous obsidian samples which contain a single pressure flake, and in which the stage represented by a single diagnostic flake is considered to dominate the sample. Early biface thinning is the most represented stage of the *common* measures, while blank/edge preparation and retouch/finishing stages are more often *rare* in a sample than other reduction stages. Thus, the middle stages of biface reduction dominate most of the assemblage as a whole, suggesting that bifaces were imported to the site partially finished and were exported before they were finished by pressure flaking.

When reduction stages are considered by debitage raw material, retouch/finishing is most often represented in the obsidian samples, edge/blank preparation is the most frequent stage represented among the colored Tosawihi chert samples, while Tosawihi opalite samples most often contain early and late biface thinning stages (Table 29).

Table 29. Proportion of Debitage Samples Containing Evidence of Reduction Stage.

	Colored Tosawihi Chert	Tosawihi Opalite	Obsidian
Core Reduction	20	37.9	10.7
Edge/Blank Preparation	46.3*	78.9	5.7
Early Biface Thinning	33.7	89.7*	2.1
Late Biface Thinning	33.7	96.2*	13.6
Retouch/Finishing	35.8	70.8	34.1*

* indicates stage with highest proportion(s) within each material type

In the system we have devised for recording technological information, the relative proportions *(absent, rare, common, or dominant)* of each element in the reduction sequence (core reduction, blank/edge preparation, early biface thinning, late biface thinning, and retouch/refinishing) in any given sample are recorded. The raw data appear in Appendix J; here we summarize the combinations of stages present in samples. Several hundred combinations of elements are possible, and can be used to identify the parts of the reduction sequence appearing in a given sample.

In the present analysis, more than one hundred different combinations characterize reduction. A sample which contains, for example, equal proportions of core reduction, blank preparation, early biface thinning, late biface thinning and retouch/refinishing could indicate production of bifaces taken all the way through the reduction sequence, or a number of separate instances of different portions of the reduction sequence undertaken in the same spot on the ground. A sample containing equal proportions of core reduction and blank preparation, no early or late biface thinning, and rare retouch could, on the other hand, represent the production of prepared biface blanks and some projectile point or biface finishing or resharpening (two separate actions). Table 30 compares the number of reduction sequence elements, or parts of the reduction sequence in samples of local cherts. Obsidian has been excluded because so many samples contain only one piece.

Table 30. Number of Reduction Sequence Elements Represented in Debitage Samples.

	Colored Chert		Opalite			
	Frequency of Samples	Proportion of Samples	Frequency of Samples	Proportion of Samples	Total Frequency	Total Percent
Not Characterized	16	16.84	4	2.16	20	7.14
One Element	38	40.00	7	3.78	45	16.07
Two Elements	16	16.84	20	10.81	36	12.86
Three Elements	11	11.58	29	15.68	40	14.29
Four Elements	12	12.63	64	34.59	76	27.14
Five Elements	2	2.11	61	32.97	63	22.50
Total	95	100.00	185	100.00	280	100.00

Approximately half of all samples contain either four or five elements, nearly the entire reduction sequence. In most places, reduction through three or more continuous stages took place. This suggests that there was little spatial segregation of lithic reduction activity, or that activity was intense enough to produce several different reduction sequence episodes in the same place.

Comparing the frequency of reduction elements by numbers of samples (cf. Table 30), we see that fewer complete sequences are represented in the colored chert. Thirty-eight (40%) samples of colored chert contain only one element, while only seven opalite samples (4%) contain only one reduction element (Figure 36). This pattern probably reflects the smaller sample sizes of the colored chert assemblage. Each stage of the sequence is about equally represented in the colored chert samples containing only one element; core reduction is the least common element and blank/edge preparation is the most common.

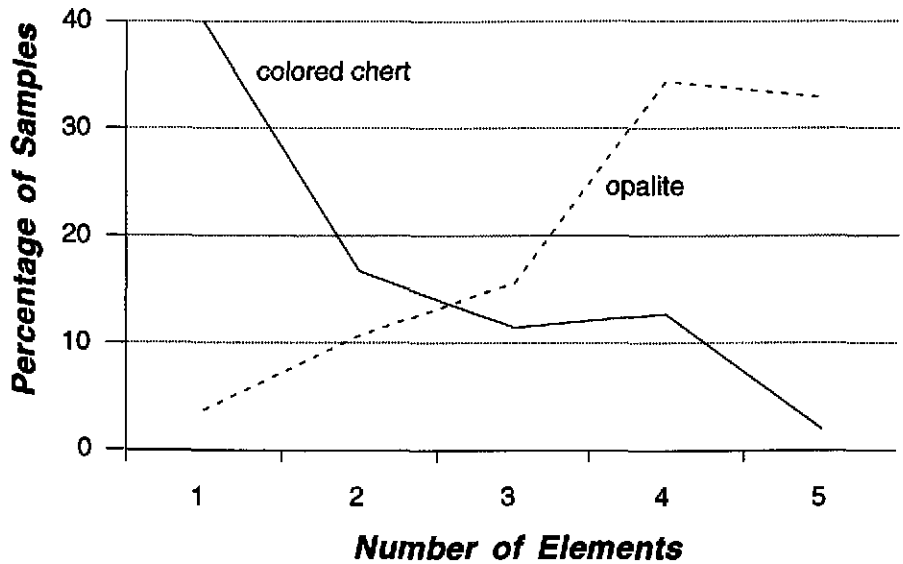


Figure 36. Comparison of opalite and colored chert reduction elements.

Eight point two percent of samples contain discontinuous sequences of reduction stages; that is, part of the sequence is missing and more than one event is represented. Discontinuous sequences are more common in colored chert samples (14.7%) than in opalite samples (4.9%). Chert reduction is a less important, less formal activity, smaller pieces are produced, and some flake core reduction may be present in addition to biface manufacture. In contrast, very few of the opalite samples either could not be characterized or contained only one element, reflecting in part the substantial sample size of most lots. As mentioned above, the element missing most often from the opalite is core reduction and since 68% of the samples contain either four or five elements, most of the reduction sequence, with the exception of core reduction, is present. Many samples could represent single reduction event scenarios in which a biface is reduced from Stage 2 to Stage 5. Alternatively, the samples could represent multiple reduction events.

Other Debitage Analyses

Several other types of variability in the debitage assemblage were also examined. Microdebitage analysis was conducted on soil samples from one feature and variation in the incidence of heat-treatment, size, and color were considered.

Microdebitage Analysis

The study of debitage too small to be recovered in standard excavation screens often has been used to identify locations of lithic reduction (Fladmark 1982; Metcalf and Heath 1990). Here, we used it to identify the nature of reduction, relying on the same flake morphologies observed in macrodebitage. Two samples of microdebitage were analyzed from Unit Q8 (cf. Chapter 3), collected from two levels where high densities of very small flakes which would have escaped 1/4 in. mesh were encountered. Examination of microdebitage identified a heat-treatment hearth at site 26Ek3092 (Leach, Dugas, and Elston 1992:385; Ataman and Bloomer 1990) in our previous excavations at Tosawihi. When overheating of opalite occurs, the bifaces, flakes, or blocks being heated may disintegrate, leaving only small angular fragments and potlids. When only slightly overheated, small pieces may be detached from thin edges. Over-heated objects may disintegrate upon subsequent reduction (the frequency and locations of bifaces whose failure is due to overheating are described in Chapters 3 and 4). Small to very small size debitage is continuously produced at every stage of reduction. Small flakes may move up and down in the soil matrix. In relatively flat areas such as Block Q they are unlikely to have moved horizontally from the location of primary deposition. Moreover, it is unlikely that either in the case of a heat-treatment hearth or the location of reduction that the small flakes produced would be moved by deliberate human agency to another location.

The samples recovered from Levels 4 and 5 of Unit Q8 were screened through 4 millimeter, 2 millimeter, 1 millimeter, and 500 micron mesh, and the debitage sorted from gravels and vegetable material (Table 31). The samples from each screen size were examined separately and none showed evidence of failed heat treatment. The <4 millimeter samples contain several flake types, including blank/edge preparation, late biface thinning, and retouch flakes; the 2 millimeter and 1 millimeter samples contain a few examples of retouch flakes, but most were not diagnostic to stage; and pieces from the 500 micron samples were too small to identify macroscopically.

Table 31. Microdebitage Analysis Sample Components.

Sample Q8-4-2-1 Original Sample Weight 5200g Sorted Sample Weight 457g

Mesh Size	Flakes weight	Flakes count	Obsidian Count	Gravel Weight	Rootlets
4 mm	31.1	91		206.6	
2 mm	3.3	106	2	73.5	
1 mm	2.5	270	5	134.8	
500 microns	0.1	43		3.9	
<500 microns					1.3
Total	37	510	7	418.8	1.3

Sample Q8-5-2-1 Original Sample Weight = 4600g Sorted Sample Weight=597.4

Mesh Size	Flakes weight	Flakes count	Obsidian Count	Gravel Weight	Rootlets
4 mm	23.6	90	1 (mahogany)	308	
2 mm	6.1	265	1	192	
1 mm	1.1	311		177.8	
500 microns	0.1	56	3	106	
<500 microns				121.6	
Total	30.9	722	5	905.4	

A number of pieces of obsidian and various colors of local chert were recovered from both samples, indicating that the lithic reduction activity represented consisted of more than one reduction event.

Heat-treatment

The heat-treatment of bifaces was discussed in Chapter 4, where it is explained that about 75% of bifaces exhibited signs of heat-treatment. The amount of heat-treatment in the debitage assemblage was used in Chapter 3 to examine the integrity of stratigraphic deposits. Samples of debitage were scanned and rough percentages of heat-treated material from each lot noted. Some tools, especially projectile points, are heat-treated during manufacture, others are made on heat-treated by-products of biface manufacture. The mean percentage of heat-treated debitage in a sample is 68.67%, which is quite high. We conclude that most bifaces processed at 26Ek5040 were heat-treated before transport to the site or at the site itself. Although a large number of debitage samples contained burned flakes (brush fires can cause the discoloration of flakes but successful heat-treatment rarely burns the exterior of a treated artifact), and a number of heat-failed bifaces were recorded, no evidence of heat-treatment hearths was found.

Size Grading

Samples of opalite debitage were size graded to assist in the stratigraphic analysis. Samples were passed through graded screens of 2 in., 1 in., 1/2 in., 1/4 in., and 1/8 inch mesh, and each sample was counted and weighed. This allowed examination of quantities and sizes of debitage which could be used in conjunction with technological and color analysis to evaluate integrity of deposits. (cf. Chapter 3).

Color

The proportion of colored debitage (that is, neither white, nor grey, nor beige) was estimated for each debitage sample (altered basalt and altered tuff samples combined). These were used in conjunction with size grade data and technological data to evaluate integrity of deposits (cf. Chapter 3).

Cores and Modified Chunks

Cores and modified chunks inform about the nature of lithic production. Our analysis defined cores as blocks of stone reduced to produce flakes rather than to transform the block into a tool. We defined modified chunks as minimally modified pieces which may represent either tested cobbles (pieces from which a few flakes were removed to test the workability of the stone) or as by-products of such an early stage of biface reduction that they are not clearly recognizable as bifaces. Some cores in the assemblage could be classed as patterned cores, that is blocks of stone (cobbles, chunks, pebbles, tabular pieces) from which several flakes have been removed in an organized fashion. Most patterned cores also exhibit prepared platforms created by intentional flake removals.

Seven cores and 16 modified chunks were recovered from the site (Figures 37, 38). Four of the cores are made of light colored opalite, one of altered basalt, one of basalt, and one of obsidian. Most have multiple irregular platforms, but the basalt core is a single platform split cobble example. Only the basalt core is made on a cobble.

Because both cores and modified chunks probably were discarded in the place where they last were used, they can inform about location of lithic production. The presence of cores and modified chunks on a site indicates that tool blanks, and perhaps tools, were produced there. At 26Ek5040, only one (an obsidian example) of the 23 was made of material imported from outside the project area.

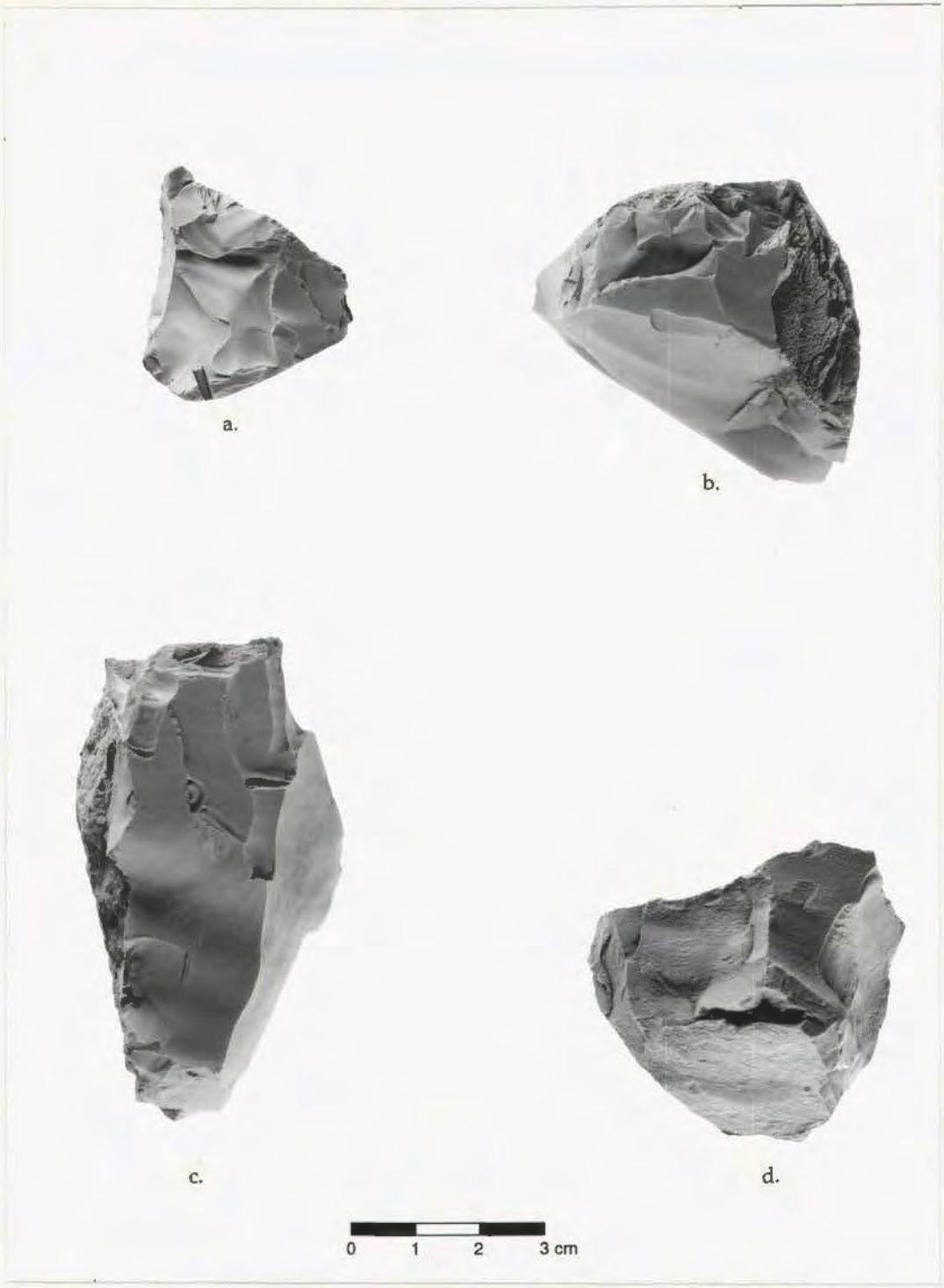


Figure 37. Selected cores.

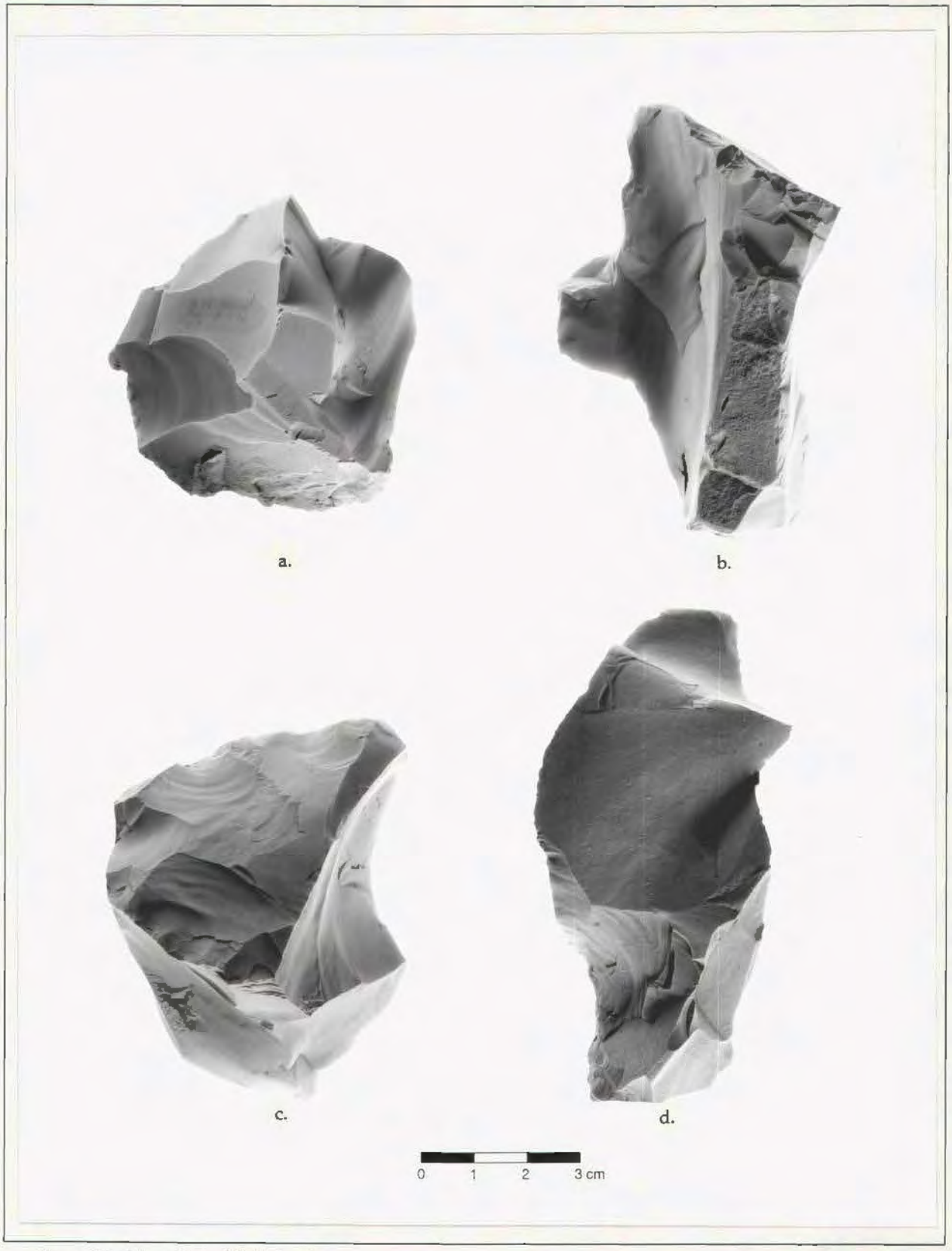


Figure 38. Selected modified chunks.

The extremely small number of cores recovered from this site reinforces our impression that most tool production at 26Ek5040 involved biface manufacture and that bifaces arrived at the site partially finished. It is unclear what the cores at this site were used to produce, but flake tools and projectile points are most likely. The modified chunks probably represent early stages of biface production; both cores and chunks are used to indicate manufacturing loci on the site.

Trajectories

Differences between tool form, methods of production, degree of reduction, and utilization are evident in the 26Ek5040 chipped stone assemblage. The following summarizes trends in tool production and use for each of the major raw materials represented, as can be determined from the tool and debitage analyses discussed above.

Obsidian

Obsidian samples were treated differently from samples of other raw materials in our analysis: surface debitage was collected as isolates and many specimens were recorded as individual pieces rather than in lots because so little obsidian was recovered. Nevertheless, most of the samples contained diagnostic flakes; of the 141 samples, only 51 could not be characterized. Core reduction, late biface thinning, and retouch are most strongly represented, while edge preparation and early thinning is much less common, suggesting that obsidian biface manufacture is rare at 26Ek5040 (in fact, only three obsidian bifaces were recovered). Tool finishing and/or reworking and the production of points on flakes removed from small cores were probably the most common obsidian reduction activities undertaken at 26Ek5040.

Tosawihi Altered Basalts

A much higher proportion (16 of 95 samples) of this colored material could not be characterized than was true of opalite samples, which are more numerous and usually larger. Only a minor amount of core reduction is apparent in the colored chert samples. The reduction stages represented are mostly blank production and thinning; blank/edge preparation is more common in these samples than in the light colored opalites. Bifaces are probably the intended product, but some flake production may also have been practiced.

Tosawihi Altered Tuffs

There were many more samples of this material than of any other and the samples were much larger. Only four of 185 samples could not be characterized. Few samples contained evidence of only one stage of reduction; 68% of samples evince either four or five of the five reduction stages. The one stage most often missing is core reduction. Retouch is a minor component of the samples; in most samples where retouch flakes are present, they are rare compared to other diagnostic flake types. Bifaces are the intended end product of opalite reduction at 26Ek5040. By-products of the process probably were used to produce smaller quantities of other tools (we have at least some evidence for opalite point manufacture), some of them expedient forms. The paucity of core reduction debitage and the abundance of biface reduction debitage and broken bifaces strongly suggests biface import for further reduction and, quite likely, heat-treatment on site. Some of these bifaces were used and broken on site, but most were exported in partially finished and finished form.

Summary

In addition to 'white' Tosawihi opalite, the prehistoric people who made bifaces at 26Ek5040 also used colored cherts from various Tosawihi sources and smaller quantities of obsidian, deriving from Paradise Valley located about 100 km to the northeast. Obsidian debitage was produced by reworking and rejuvenating tools brought to the site in finished form and by producing a small quantity of projectile points and other tools from small obsidian nodules transported to the site in cobble form. The debitage from colored cherts represents the reduction of bifaces which may have been brought on site in the form of flake blanks or partially reduced bifaces, but not as cores or chunks. Opalite debitage, which represents the vast majority of the artifactual assemblage at the site, is primarily the debris from biface production. The opalite bifaces were brought on site in partially finished form; partially finished and finished bifaces were exported for use elsewhere.

Chapter 6

26Ek5040 IN TIME, SPACE, AND THE TOSAWIHI PRODUCTION SPHERE

Kathryn Ataman

Insights into the prehistoric occupation of 26Ek5040 are most valuable for the comparative standards they provide, against which patterns of land use in the region of the Tosawihi Quarries can be observed. This chapter examines the chronology of 26Ek5040 and compares biface manufacture, toolstone exploitation, and obsidian trade with patterns observed elsewhere at Tosawihi (Elston and Raven 1992a; 1992b).

Site Chronology

A temporal context for 26Ek5040 derives from two radiocarbon dates, one tephra date, 19 typeable projectile points, and 45 obsidian hydration measurements. Comparable data from other Tosawihi sites are taken mainly from Elston and Drews (1992).

Stratigraphic Data

As described in Chapter 3, there is, near the base of the occupation debris at 26Ek5040, a layer of tephra or volcanic ash erupted from Mount Mazama (Crater Lake, Oregon) approximately 6900 years ago. Some cultural material is within and below this ash deposit. While this cultural material is slightly different in composition from material directly above the ash, with lower than average percentages of heat-treated debitage and higher percentages of colored debitage (cf. Chapter 3), natural mixing of deposits renders it impossible to determine if this material represents a pre-Mazama occupation of 26Ek5040. Soil from a stratum above the Mazama ash yielded a date of 4380 ± 200 years B.P. (cf. Figure 17). This stratum does not appear everywhere on site, but it allows assessment of the antiquity of those areas where it is observed. Charcoal from a hearth discovered in the north wall of Trench C, just below the present surface and extending to 15-20 cm below surface, has provided a date of 850 ± 200 years. Although these data-yielding strata are superimposed in some places, as attested by artifactual data, the occupational phases do not overlie one another as neatly as the proverbial archaeological "layer cake".

Temporally Diagnostic Artifacts

The nineteen projectile points recovered from 1992 and 1994 excavations date primarily to the Middle Archaic (5000 B.P.-1300 B.P.); two incomplete points may possibly represent the Late Archaic. Table 32 gives the vertical context of typeable points. In most cases, Level 1 contains the first 4 cm of soil, Level 2 extends 4-10 cm below the surface, and subsequent levels each represent 10 cm of deposit. Level 1 surface scrapes of 1992 removed 2 cm rather than 4 cm of fill. The quantity and distribution of point types in the deposits suggest that both mixing and deflation occurred.

Obsidian hydration measurements offer a relative measure of age; thin hydration rinds are younger and thick rinds are older. The hydrogen absorption rate varies with chemical composition of the material. Most (35 of 49 samples) of the analyzed obsidian from 26Ek5040 derives from the Paradise Valley source, one of the closest major sources to Tosawihi (Appendix A).

Table 32. Level Context and Time Frames for Projectile Point Types.

Type	Time Frame	Level Context Surface	Level 1	Level 2	Level 4	Level 5	Total
Gatecliff	(5000 B.P.-3300 B.P.)	5		1			6
Elko Series	(3300 BP.-1300 B.P.)	4	2		2	1	9
Humboldt	(5000 B.P.-1300 B.P.)	2					2
Large Side-Notch	(Pre-700 B.P.)	1				1	2
Total		12	2	1	2	2	19

Expressed as a dot plot (Figure 39), two groups of hydration absorption measurements are evident, one consisting of narrow rinds between 1.0-1.7 microns and another between 4.4 and 6.7 microns. Three measurements (7.8-8.1 microns), could represent even earlier occupation. The data suggest that most obsidian samples are not recent. The data also suggest a temporal gap between the two main occupations represented by obsidian. Even though site sediments are turbated, the stratigraphic distribution of rind measurements supports a similar scenario. Most of the rind measurements between 1 and 2 microns were recovered from surface or near-surface, while those measuring 4 microns or more were recovered from both surface and subsurface contexts (Table 33), with subsurface samples slightly more common. This suggests that the bulk of the deposits are mixed but not recent, and are capped by a later occupation.

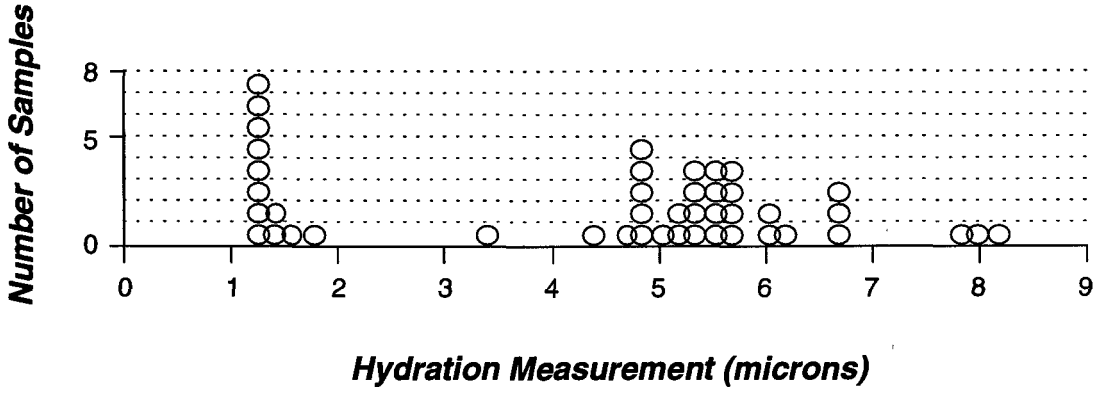


Figure 39. Dot plot of obsidian hydration measurements from 26Ek5040.

Table 33. Stratigraphic Context of Obsidian Hydration Measurements.

Rind Thickness (microns)	Surface	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Total
1-2 microns	7	3		2				12
3-4	1							1
4-5	2	1			2	3		8
5-6	4				3	6	2	15
6-7	3	1	1		1			6
7-8		1						1
8-9		1				1		2
Total	17	7	1	2	6	10	2	45

Artifact abundance in surface and subsurface contexts also suggests that while some deflation has occurred, subsurface deposits represent a significant portion of the occupation at 26Ek5040. Slightly more debitage, measured both by weight and count was recovered from levels below 4 cm than from the first 4 cm. When surface bifaces are discounted, the same pattern holds for biface weight (biface counts are very similar) (Table 34). This pattern is quite different from those of other non-quarry Tosawihi sites (Elston and Raven 1992a) and many other central Great Basin sites (e.g. Elston and Bullock 1994), where greatest artifact frequencies are close to the surface and deposition is shallow.

Table 34. Debitage and Biface Recovery, Surface and Subsurface Contexts.

	Surface (0-4 cm)	Level 1 (4-10 cm)	Subsurface (10+ cm)
Debitage weight	26,873	26,369	29,156
Debitage count	23,542	23,499	27,290
Biface weight	10,944	3,357	3,855
Biface Count	327	152	145

Three typeable obsidian points from 26Ek5040 exhibited readable hydration rinds. Two were Elko Series points with rinds of 4.4 microns and 6.1 microns, and one Large Side-notch/Northern Side-notch point has a rind of 4.8 microns. Obsidian points recovered elsewhere at Tosawihi are added to the sample (Table 35) for comparison of point types and mean hydration rinds. Both the typeable obsidian points and other tested obsidian from 26Ek5040 appear to (cf. Figure 15; Figure 40) predate the period represented by obsidian Elko and Gatecliff points from Tosawihi as a whole (c.f. Table 35).

Table 35. Mean Hydration Rinds for Tosawihi Point Types in Microns.

Point Type	Mean	Standard Deviation	Sample size
Desert	1.8	.65	22
Rosegate	2.9	1.3	5
Elko	4.3	1.0	8
Gatecliff	3.7	1.2	4
Humboldt	6.9	—	1
Large Side-Notch	4.1	2.1	4
Great Basin Stemmed	5.7	1.7	3

Using point type and hydration rind data from 26Ek5040, we can assume that the site represents multiple occupations, most of which probably date between about 4500 and 1300 years ago with an additional small component dating less than 1300 years ago (probably less than 700 years ago).

Our previous work at Tosawihi indicated that human use of the area began in the Pre-Archaic (Elston and Drews 1992) but its greatest use occurred in the Late Archaic, especially the latter half.

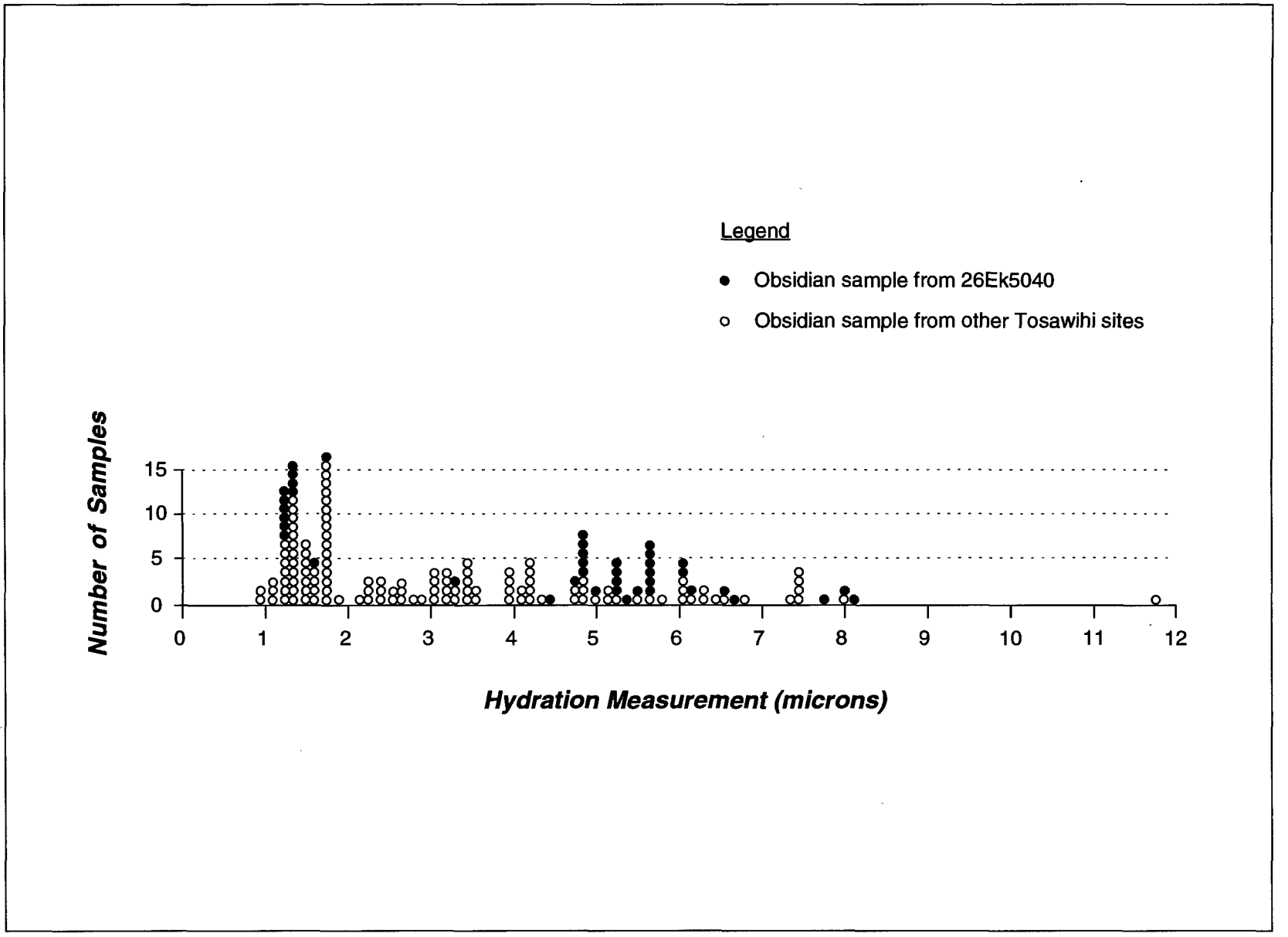


Figure 40. Dot plot of obsidian hydration measurements from Tosawihi sites.

Many Late Archaic sites also contain evidence of Middle Archaic occupation, but only four small sites with very small assemblages (26Ek3123, 26Ek3243, 26Ek3238, and 26Ek3516) appeared to be exclusively Middle Archaic (Elston and Drews 1992). The projectile point sample from 26Ek5040 is markedly different from the sample represented at other Tosawihi sites (Table 36), dating exclusively to the Middle Archaic.

Table 36. Comparative Point Type Proportions.

	26Ek5040		Other Tosawihi Sites	
	Frequency	Percent	Frequency	Percent
Desert		0.00	84	38.01
Rosegate		0.00	34	15.38
Elko	9	47.37	41	18.55
Gatecliff	6	31.58	20	9.05
Humboldt	2	10.53	13	5.88
Large Side-Notch	2	10.53	9	4.07
Stemmed		0.00	20	9.05
	19	100.00	221	100.00

Obsidian samples from the three areas of 26Ek5040 with the highest artifact densities show different rind thickness distributions (Figure 41). The samples from the northern ridge exhibit only very thin (1.0-1.7 microns) and very thick (6.0-8.1 microns) rinds. The southern ridge exhibits a mixed group of samples but includes very few thin rinds. The southern edge of the site, along the drainage on Terrace 1, contains primarily samples with thin rinds. These data suggest a scenario in which site occupation shifted from one area to another in time; the earliest occupation concentrated on the northern and central ridges; later, the densest occupation concentrated on the central ridge; and the very late surficial occupation occurred along the drainage on the south and on the high northern ridge.

The difference in temporal focus of occupation between 26Ek5040 and other Tosawihi sites we have studied raises questions about changes in technology, toolstone acquisition and extraction, subsistence, and so forth, which may have occurred between the Middle and Late Archaic and which could not be examined with the chronologically mixed data from previous excavations. Some of these questions can be addressed with data from 26Ek5040.

Patterns of Activity

Artifact distributions across the site are examined with an eye toward delimiting activity areas. We consider artifacts recovered by 1992 and 1994 excavations.

The highest densities of formed artifacts (cf. Figure 9) and debitage (Figure 42) occur along the high relatively flat surfaces of the three ridges running northwest/southeast where clusters of features occur (cf. Chapter 3). This distribution may have been affected somewhat by phases of deposition and erosion, but most soil movement during and since periods of occupation has been minimal and great horizontal movement of artifacts has been confined to areas immediately adjacent the drainages (cf. Chapter 3). It is likely that most of the human activity at this site occurred on the three relatively flat surfaces. Notwithstanding single event reduction features (see above and Figure 43), the material

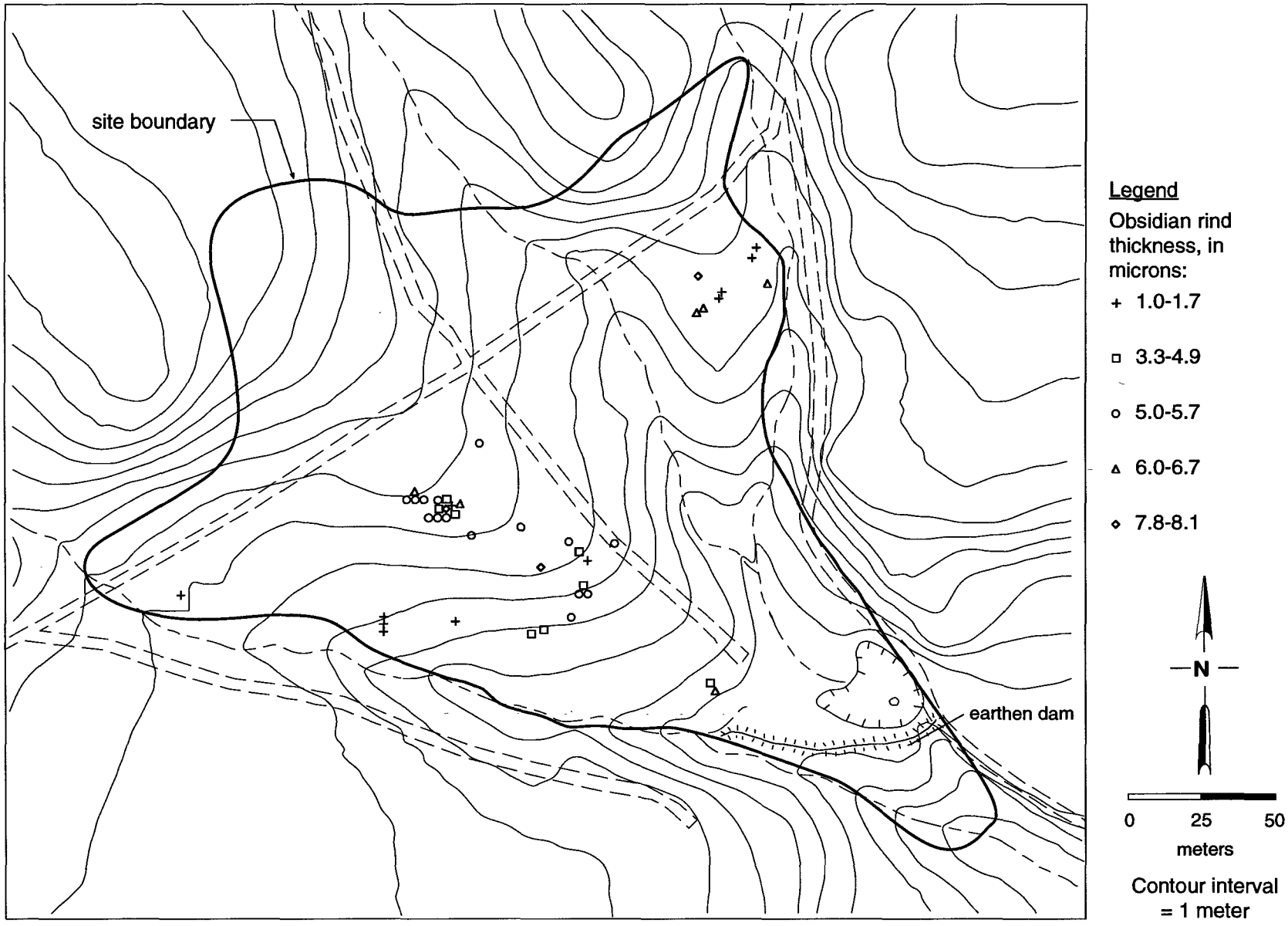


Figure 41. Horizontal distribution of obsidian hydration measurements at 26Ek5040.

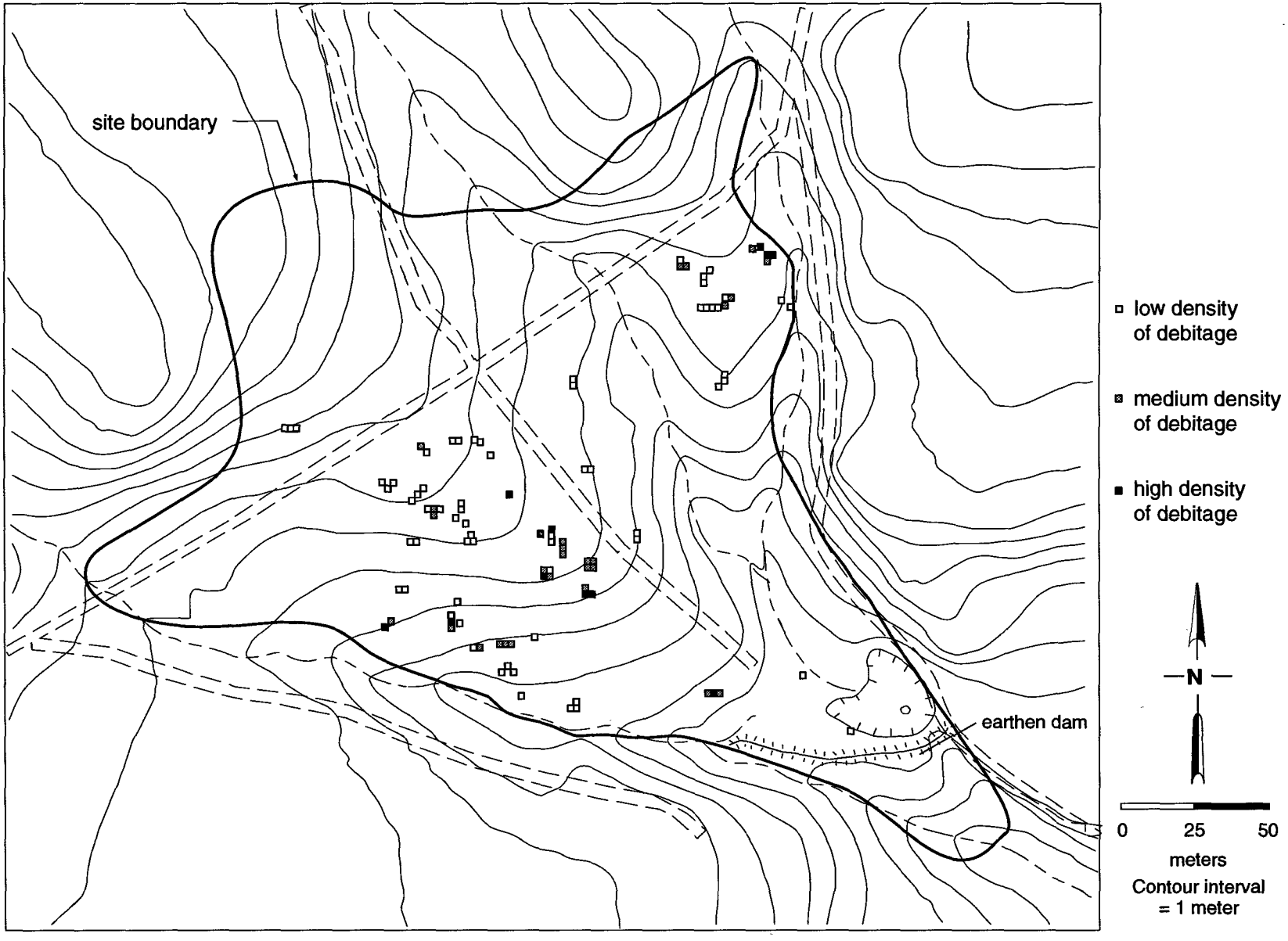


Figure 42. Density of debitage in 1992 and 1994 surface scrapes at 26Ek5040.

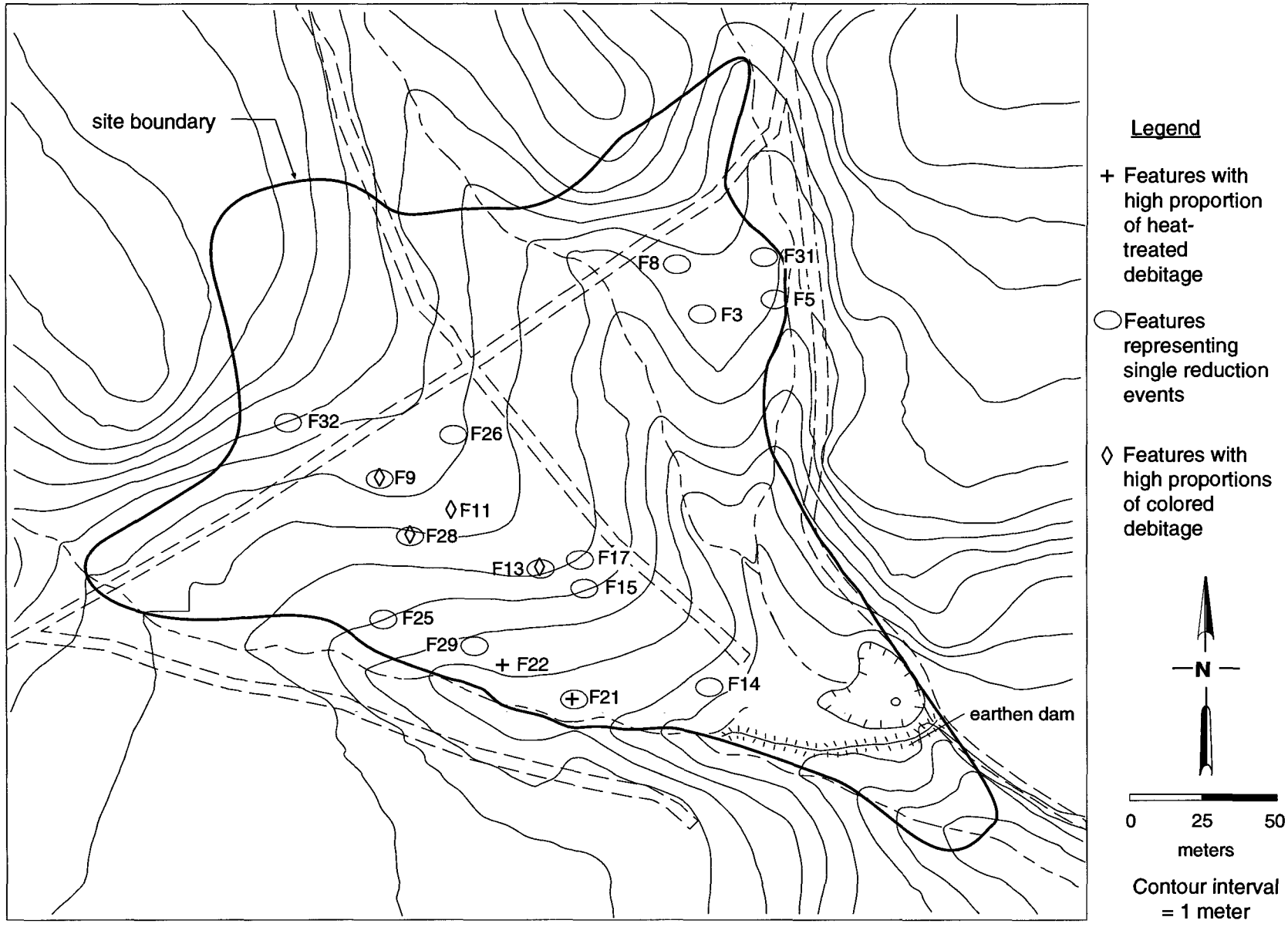


Figure 43. Characteristics of surface features at 26Ek5040.

on the present surface does not necessarily represent the latest occupation surface. Stratigraphic evidence for bioturbation and other post-depositional factors, as well as archaeological evidence (obsidian hydration and projectile point data), suggest that some surface material consists of mixed occupation debris.

Artifactual data recovered from the site suggest a number of activities which could have been undertaken. Individual features were described above; here we review the evidence for the site as a whole. High densities of debitage and broken tools (cf. Chapter 4) attest to lithic reduction. Groundstone and projectile point fragments evince food processing and consumption. Numerous flake tools indicate a variety of processing activities. The abundance of heat-treated debitage and broken tools, as well as heat-failed bifaces, suggests heat-treatment was common at the site.

Lithic Reduction

Lithic reduction at 26Ek5040 and at Tosawihi generally consists almost exclusively of biface manufacture. On-site evidence of biface reduction includes debitage, cores and modified chunks, hammerstones, and bifaces. Most bifaces were discarded due to breakage (cf. Chapter 4) and probably only late stage bifaces were discarded as a consequence of use failure rather than manufacturing failure. Bifaces are the most common formed artifact type recovered from the site; 474 were recovered in 1994 and 169 in 1992. The surface distribution of bifaces (Figure 44) reveals little more than the fact that lots of bifaces were produced in the same areas where most other activities took place.

If surface biface distribution is examined by reduction stage, we learn a little more; Figure 45 displays the distribution of early (Stage 2 and 3), middle (Stage 4), and late stage or nearly finished (Stage 5) bifaces. Early stage bifaces are found nearly everywhere, but three areas, on the northwestern extremes of the site and at its southeastern tip, have almost no other biface stages represented. Technological characterization of debitage from surface features in those areas reveals slightly more early stage debitage compared to other contexts and the bifaces recovered during feature excavation are primarily Early and Middle Stage 3, but the data are suggestive rather than definitive. Stage 5 bifaces appear to have been discarded most often in the areas where the widest range of other activities took place, along the southern margin of the central group of features and in the southern group of features, possibly indicating areas of biface use. Consideration of other indicators of lithic reduction activity are not very illuminating. The few hammerstones are also found on the central ridge, corresponding to the distribution of cores and modified chunks, where a variety of activities appears to have taken place (Figure 46).

As described above, some other characteristics of lithic reduction at 26Ek5040 reveal possible differences in site use (cf. Figure 43). The distribution of features which appear to be single reduction events is widespread, the distribution of features with high quantities of colored chert (as opposed to white opalite) is restricted to the center of the southern ridge, and the two features with the highest proportions of heat-treated debitage are along the southern edge of the site.

The distribution of obsidian is also patterned, as shown in Figure 46. The highest density is on the northern ridge, but a light scatter of obsidian is present over much of the site.

Projectile Point Manufacture, Reworking, Discard

Projectile point fragments and the debitage from point manufacture are morphologically distinctive. Projectile point fragment types in the absence of or in conjunction with debitage can be used to infer the location of point manufacture, reworking, game butchering and processing, and retooling (cf. Chapter 4). At 26Ek5040, evidence of point manufacturing is widespread across the site, but distributions of evidence for other point-related activity reveals no clear patterns (Figure 47).

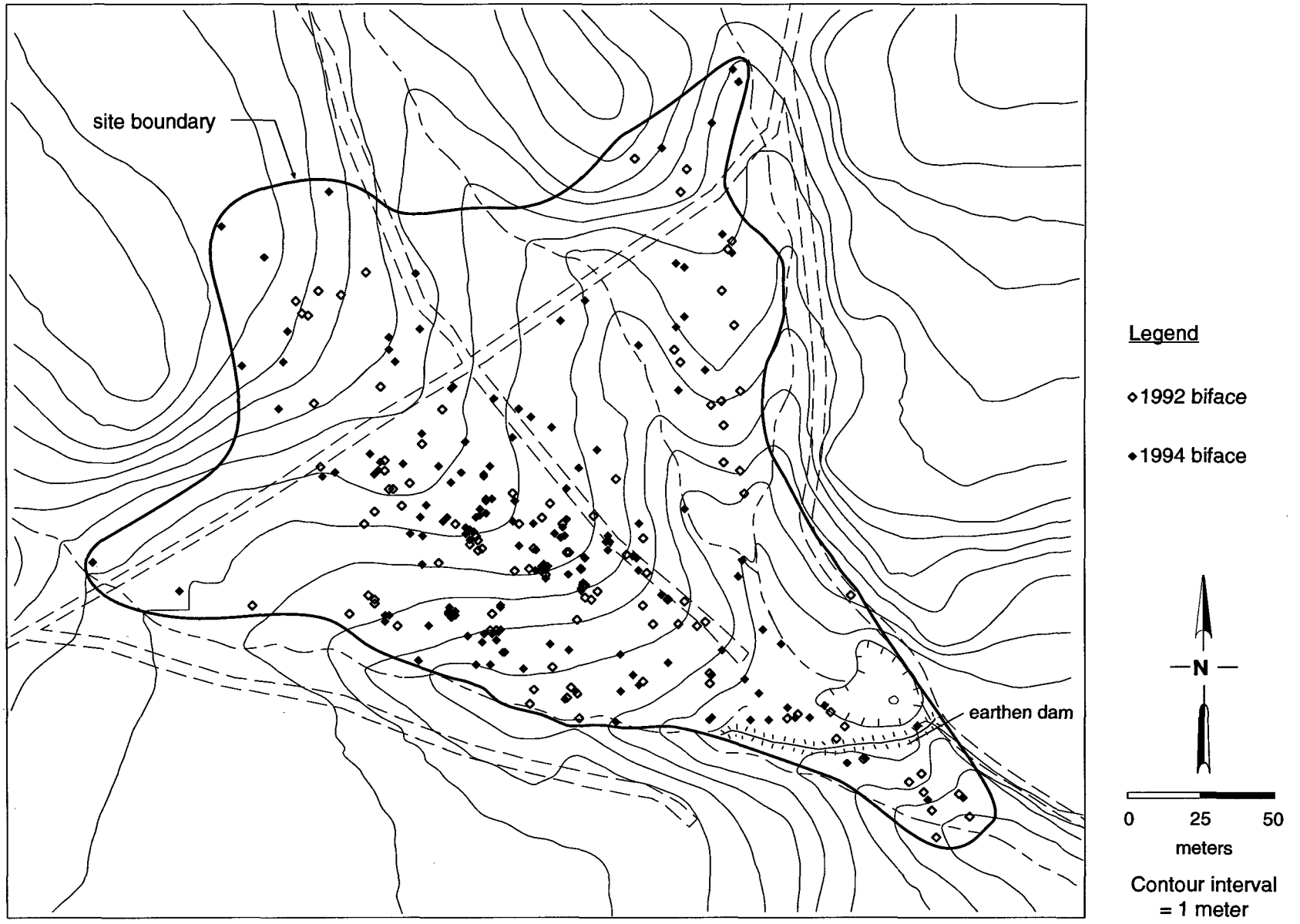


Figure 44. Surface distribution of bifaces at 26Ek5040.

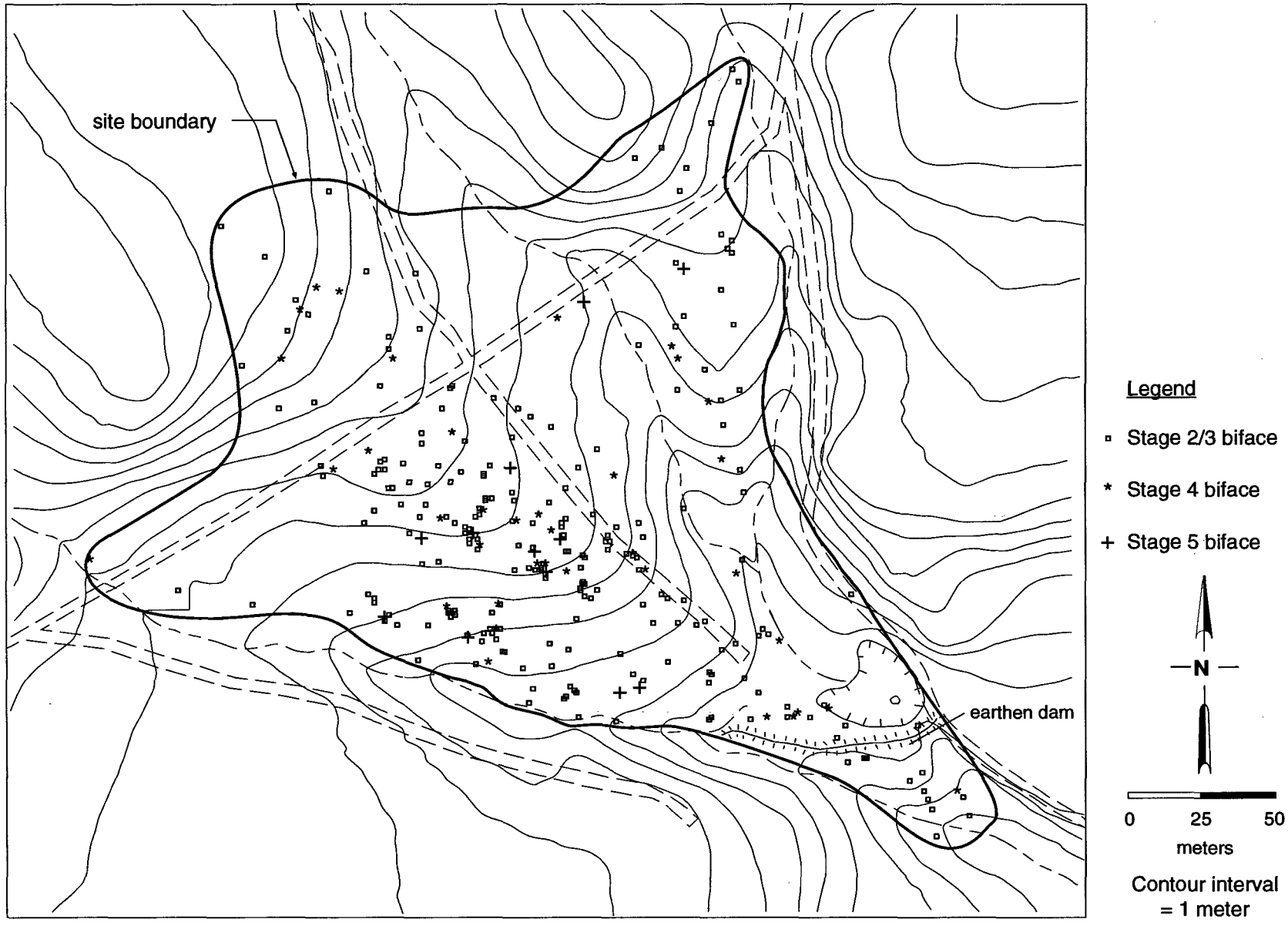


Figure 45. Biface distribution, by stage, at 26Ek5040.

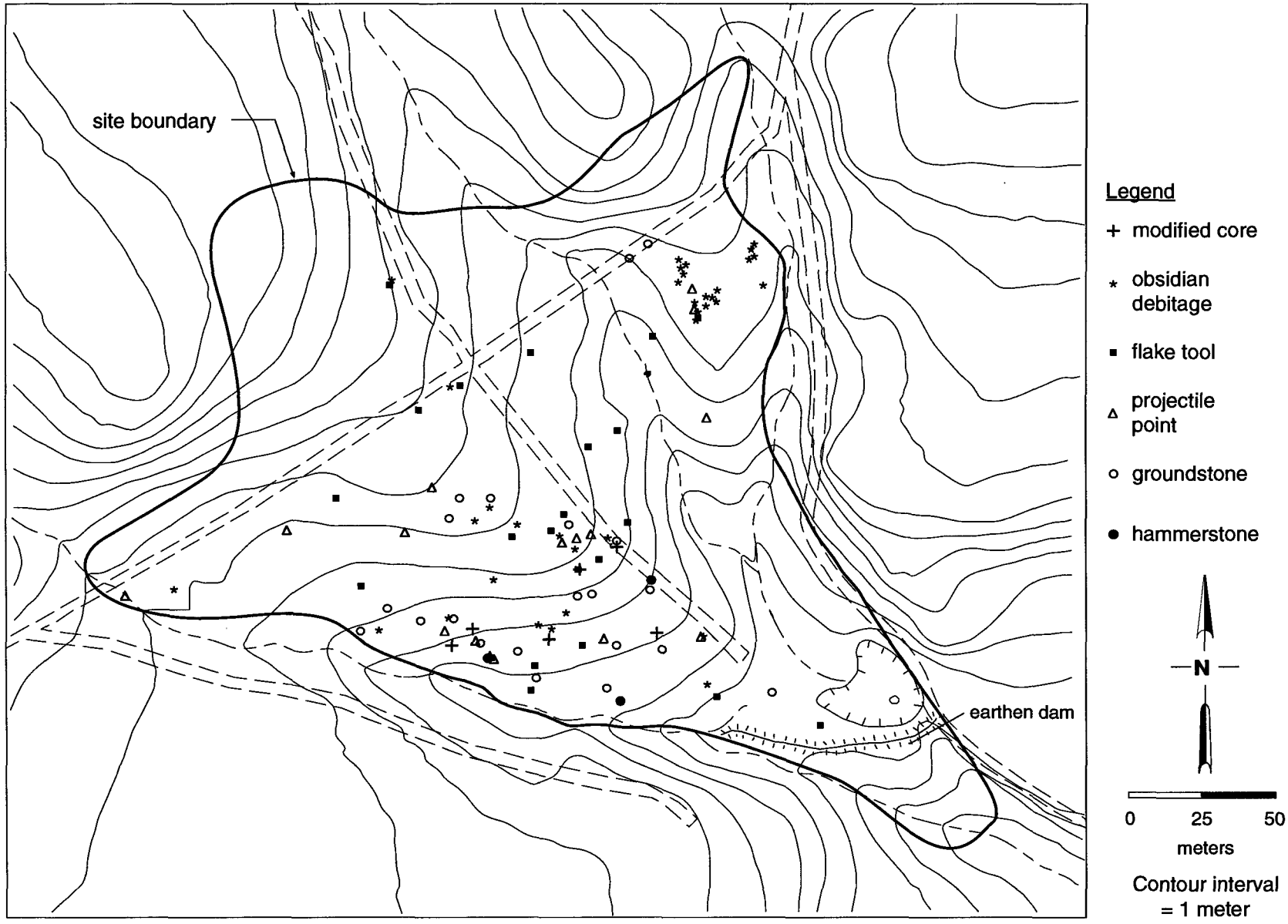


Figure 46. Surface distribution of artifact types at 26Ek5040.

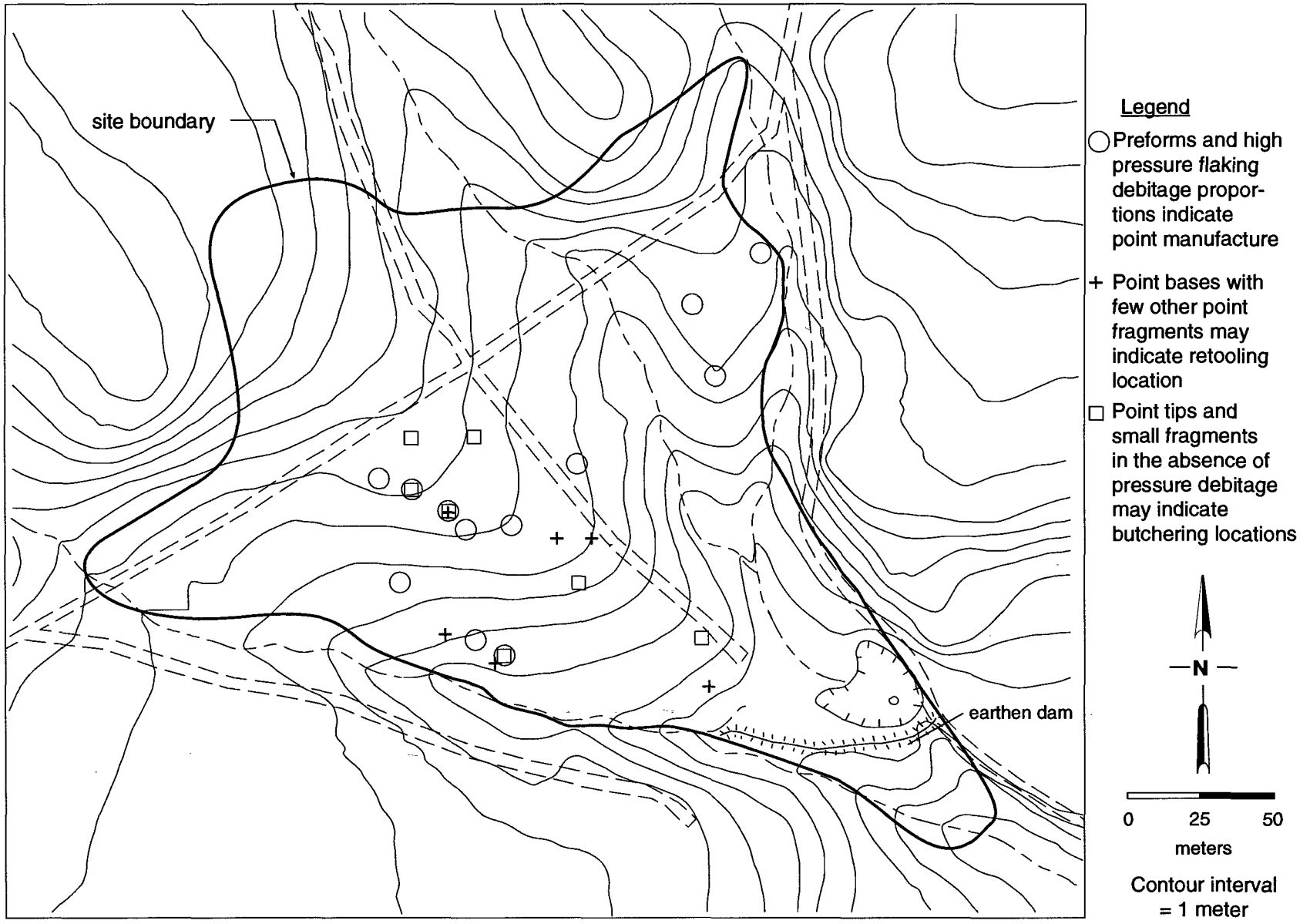


Figure 47. Projectile point manufacture and discard distribution at 26Ek5040.

Flake Tools

Although precise functions have not been proposed for the flake tools recovered from 26Ek5040, we presume these are implements for processing foodstuffs and other materials. Scrapers often are considered to be hide-processing tools, but other functions are possible; pointed tools could be applied to hide-processing, textile processing, or incising; notched and denticulated tools may be used as wood or plant processing tools; and bifacial flake tools are best suited to cutting tasks (Ataman 1992a). Flake tools are concentrated on the central ridge (Figure 48). This distribution suggests that activities identified in our analyses were located along the center of this ridge, the focus of site activity in almost all periods of occupation.

Hearths and Heat-Treatment Facilities

A high proportion of the bifaces and debitage recovered at 26Ek5040 were heat-treated (cf. Chapter 4). Because the site is located so close to a major opalite source and because in our experience at Tosawihi we have noted very little heat-treatment conducted at quarry sites (Bloomer, Ataman, and Ingbar 1992), we conclude that toolstone was brought to the site in unheated form and that bifaces were heat-treated there before their export from the site. The hearths and possible hearths revealed in excavations at 26Ek5040 which could have been used for heat-treating bifaces are all clustered at the northern end of the central ridge (Figure 49). This clustering may be a function of preservation since soils in this part of the site are deep and the surface is flat. This area is also where the heaviest concentration of other activities is observed. The features in Blocks AM and Q were those most likely to have been hearths (cf. Chapter 3), but the other possible hearth features are plausible, if rather disturbed.

Heat-treatment hearths may be recognized most easily by heat-treatment failure. When opalite is over-heated, it will fracture into angular fragments unlike those produced during biface reduction. Soil samples were collected from Block Q where large numbers of very tiny opalite flakes were observed in the soil matrix. The morphology of these flakes, however, did not suggest the presence of a heat-treatment hearth (cf. Chapter 5).

Quantities of heat-failed bifaces also can be possible indicators of in-situ heat-treatment. Heat-treatment is a risky process because temperature is difficult to control; over-heated bifaces are prone to failure (Ataman and Bloomer 1990). Over-heated bifaces are likely to be discarded near locations of heat-treatment, since the costs incurred in the transport of bifaces which may fail is unacceptably high (Elston 1992b). Most bifaces recovered at 26Ek5040 have been heat-treated (cf. Chapter 4); some (n=38) show evidence of failure due to over-heating. A concentration of heat-failed bifaces might suggest a locus of heat-treatment (i.e., a hearth), but heat-failed bifaces are widely distributed at 26Ek5040 (cf. Figure 49).

Considering the apparent intensity of activity at the site, and the degree of heat-treatment observed, it is likely that numerous hearths used during the occupation of the site, whether for heat-treatment or other purposes, have been so severely disturbed that no evidence remains.

Plant Processing

If groundstone is taken as an indicator of food processing, a relatively clear pattern of processing activity can be seen. Neither manos nor metates were found on the northern ridge. Most groundstone was recovered from the central ridge (cf. Figure 46) and the terrace below the ridge, along the major drainage on the site. When charged, this drainage may have supported economic plants to which the distribution of groundstone probably is related.

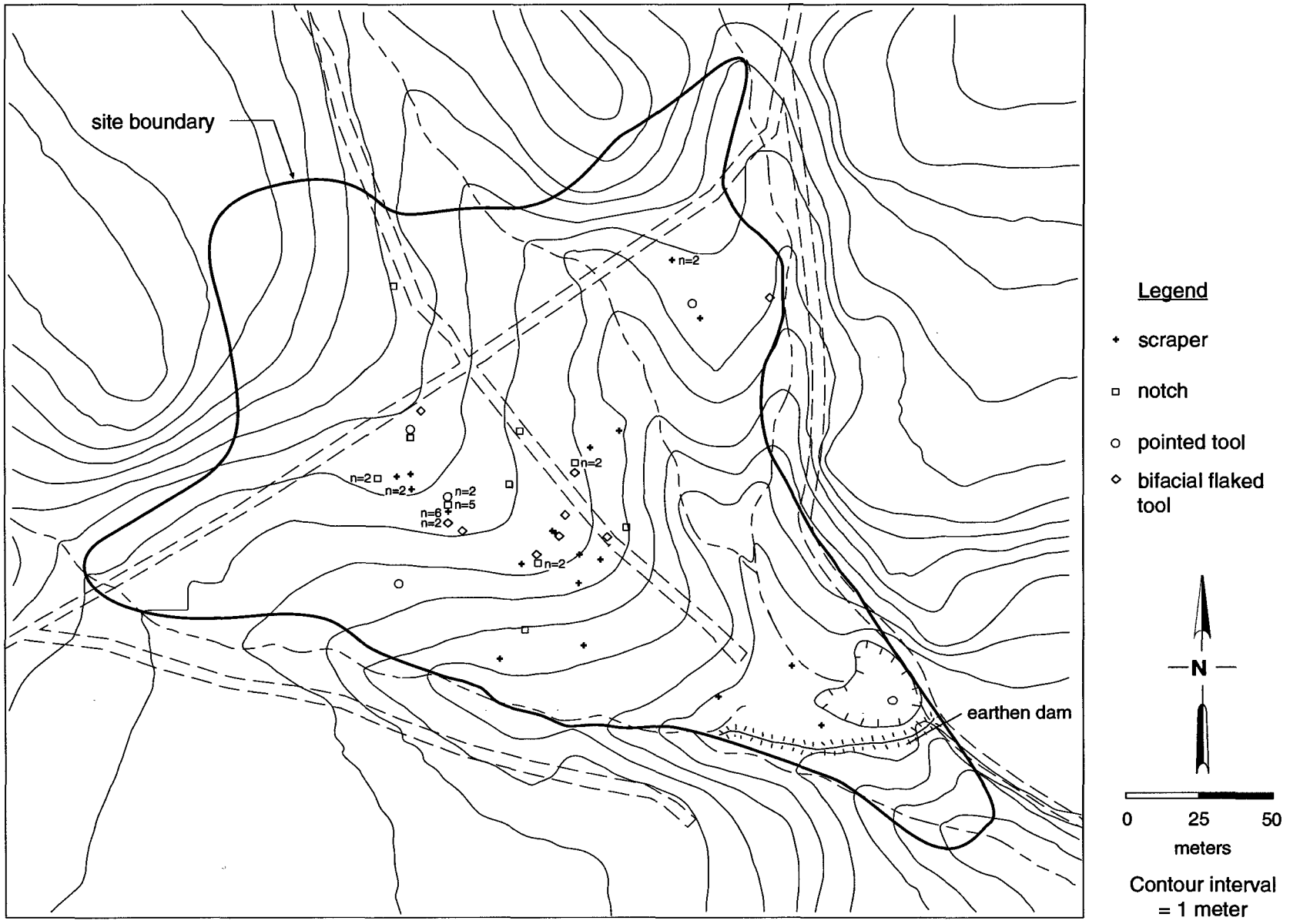


Figure 48. Surface and subsurface distribution of flake tool types at 26Ek5040.

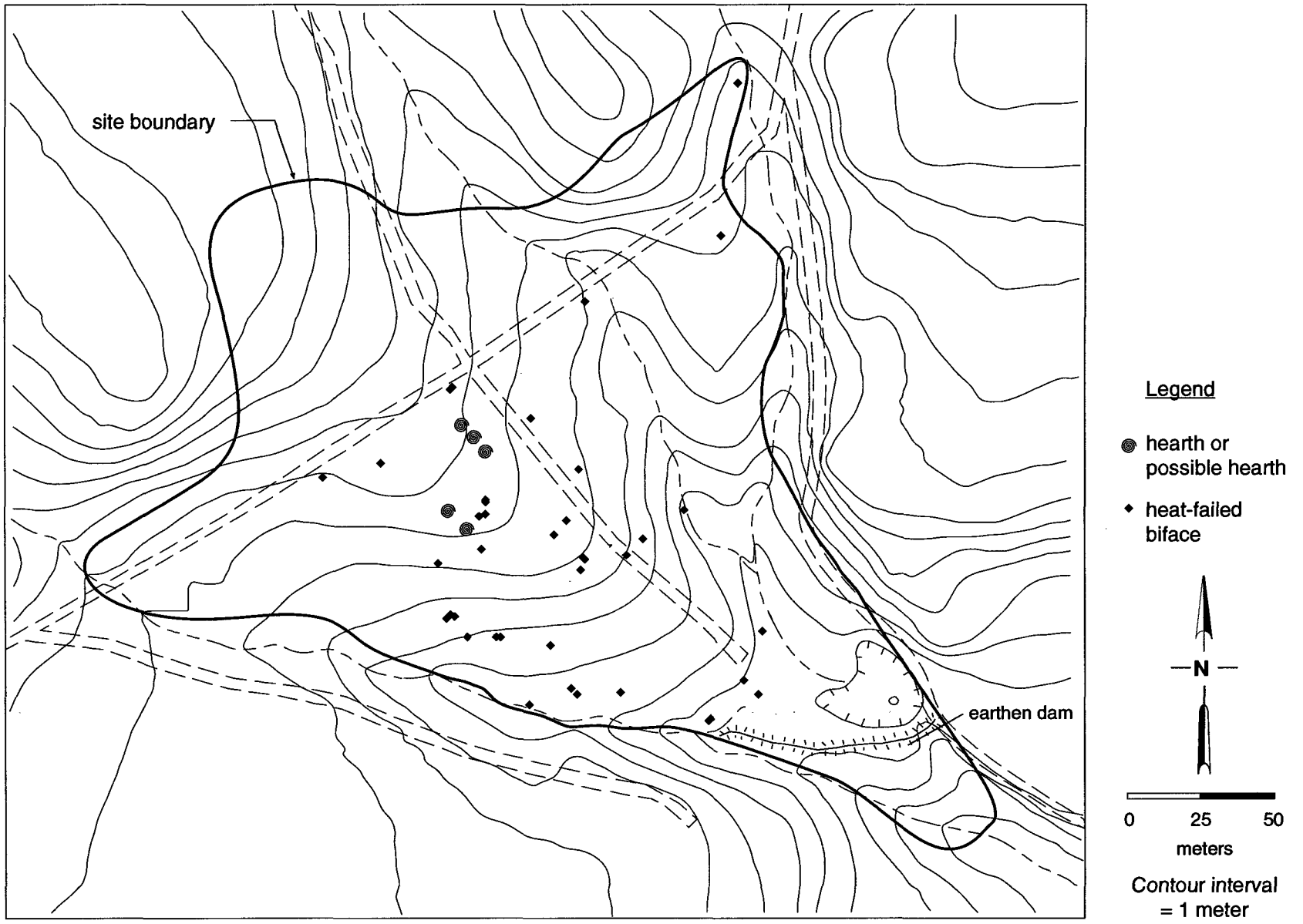


Figure 49. Distribution of hearths and heat-failed bifaces at 26Ek5040.

Biface Reduction and Temporal Change

The basic elements of biface manufacture in the Tosawihi region appear to remain the same during the whole of the Archaic; flake blanks, cobbles, and blocks are edged, thinned, heat-treated, further thinned, then finished. But details of manufacture and technique changed somewhat from the Middle Archaic occupation of 26Ek5040 and the Late Archaic intensification in use of Tosawihi Quarries.

Technologically, a slightly greater reliance on flake blanks is documented in the Middle Archaic, while the use of stream cobbles remained constant in both periods. The sequence of reduction remained similar from the Middle to the Late Archaic; in most cases, both sides of a biface were reduced equally through the reduction process. Heat-treatment was initiated during a wider range of stages at 26Ek5040, an indication of a less standardized approach to this phase of biface manufacture.

The biface assemblage at 26Ek5040 includes examples from a wide range of reduction stages (cf. Table 13); most other sites investigated at Tosawihi Quarries evince a more restricted range (Bloomer, Ataman, and Ingbar 1992:109; Figure 50). Again, this is evidence of reliance on less standardized biface manufacturing techniques and possibly more use of bifaces at Middle Archaic 26Ek5040 compared to other Tosawihi sites of the Late Archaic. At 26Ek5040, a greater number of near-finished bifaces and fewer early stage bifaces were recovered with correspondingly more heat-treatment than seen elsewhere at Tosawihi (Figure 51). The higher proportion of indeterminate stage bifaces in the 26Ek5040 assemblage is likely related to the greater proportion of later stage bifaces, which are more likely to break in manufacture.

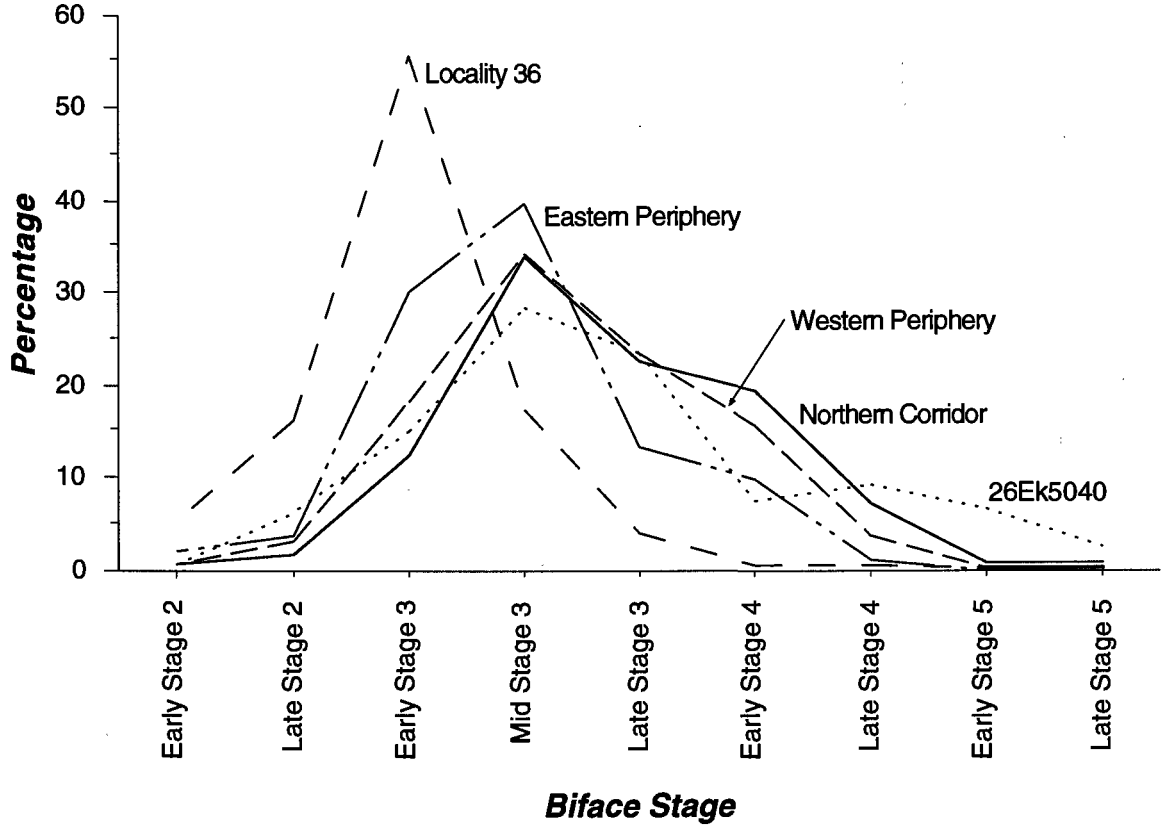


Figure 50. Biface stages in selected Tosawihi assemblages.

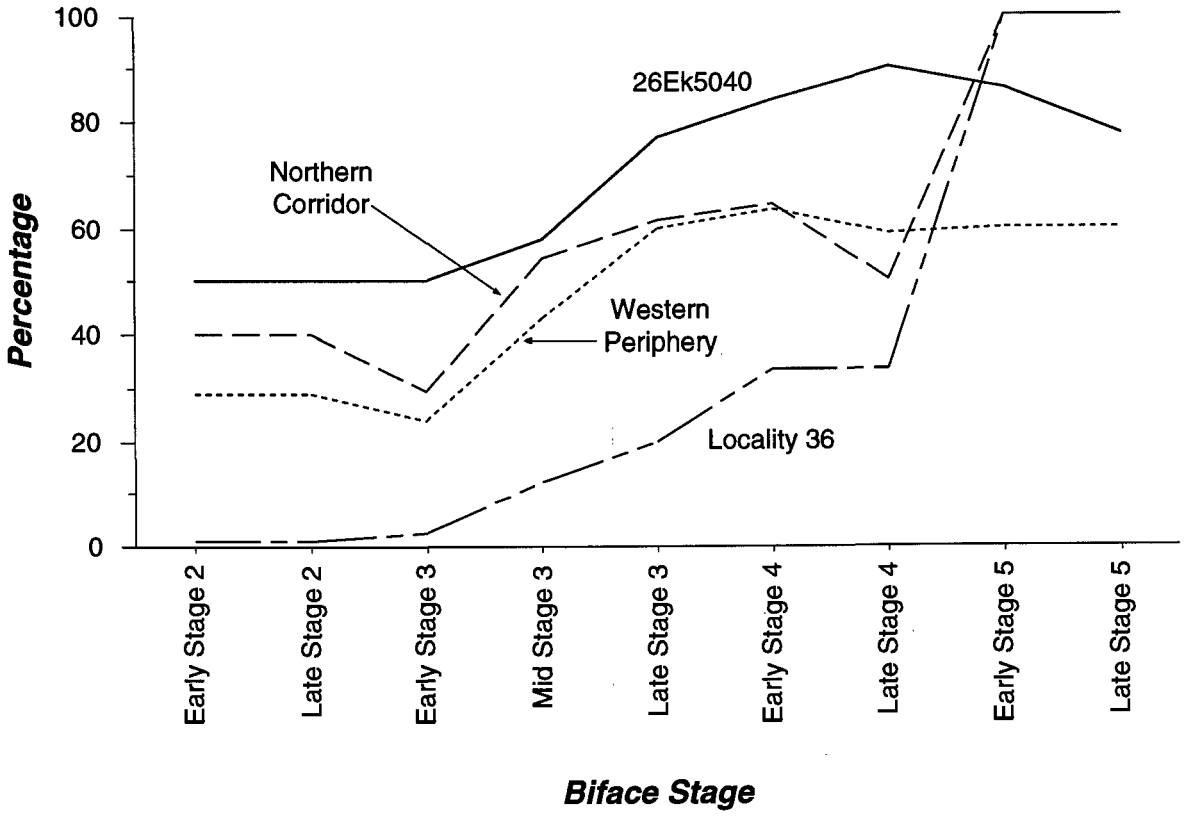


Figure 51. Heat-treated biface stages in selected Tosawihi assemblages.

Modeling biface export (Ataman and Botkin 1991; Ataman 1992b:100-102; cf. Chapter 4) revealed what may be the greatest difference in biface manufacture between the two time periods. At other Tosawihi sites, one half the bifaces were assumed exported at Middle Stage 3 and half in Late Stage 3 and Stage 4 (Ataman and Botkin 1991). At 26Ek5040, most bifaces appear to have left the site at Middle or Late Stage 3 (more in Late Stage 3), some in Stage 4, and some as finished tools.

In general, differences in biface manufacture between 26Ek5040 and other Tosawihi sites suggest that a less uniform approach to biface manufacture in the Middle Archaic gave way to a more rigid, standardized method of manufacture in the Late Archaic, and hint at a transition from a more residential to a more industrial use of the area.

26Ek5040 and the Tosawihi Distance Model

Tosawihi opalite was used widely in what is now north-central Nevada, between the north fork of the Humboldt and Iron Point. The relative proportion of debris from late stage lithic reduction as well as the proportion of heat-treated bifaces increases with distance from the center of the quarry complex, consistent with a model of toolstone procurement derived from economic behavior theory (Elston 1992b). The farthest distances at which opalite artifacts are reported suggests that some Tosawihi material no doubt was traded, but because opalite is found in quite large quantities many kilometers from Tosawihi, much of it probably was acquired though direct access to the quarries (Ataman and Bloomer 1992; Ataman and Ingbar 1994).

Tosawihi Quarries is an 800+ acre complex of quarry sites, peripheral to which is a complex of workshops and campsites encompassing an area of more than 125 square kilometers. Tosawihi opalite was extracted from outcrop quarries, adits, and subsurface quarry pits, providing high quality toolstone for at least 8000 years (Elston and Drews 1992; Elston and Raven 1992b). People came to Tosawihi to quarry toolstone, stayed to manufacture bifaces and to heat-treat them, and left taking middle stage bifaces with them; no evidence has appeared suggesting long term residential activity. Survey investigations (Leach and Botkin 1992) have defined a Tosawihi Production Sphere within which the major prehistoric activity during the whole of the Archaic was the processing of toolstone.

We compared groups of sites progressively distant from the center of the quarries to examine progressive reduction with distance. The groups, from closest to farthest, are the Quarries proper, the Eastern Periphery, the Western Periphery, and the Northern Corridor (Bloomer, Ataman, and Ingbar 1992; Ataman and Bloomer 1992). Locality 36, the only major quarry site which has been excavated, was used to represent the quarry group. Bifaces from sites close to the quarries were the least reduced, bifaces from sites far from the quarries were the most extensively reduced. Heat-treatment patterns were similar. This pattern must be influenced most by remains from the Late Archaic when use of the quarries was extensive. Such influence may have obscured any difference in the pattern from earlier times.

When proportions of bifaces in each reduction stage and proportions of heat-treated bifaces in each reduction stage from Site 26Ek5040 are compared to those from the four groups of sites, some differences are evident (cf. Figures 50, 51). Although Middle Stage 3 is the most frequent stage represented for all groups with the exception of Locality 36, the higher proportions of late stage bifaces and heat-treatment at 26Ek5040 suggest that the site may have experienced a higher degree of biface *use* than the other sites. High proportions of heat-treated bifaces in Stage 5 in the Western Periphery and the Northern Corridor are represented by extremely small samples.

Bifaces used at Tosawihi may have served primarily as knives (Ataman and Bloomer 1990), but use-wear analysis has provided some evidence for multiple functions (Bloomer, Ataman, and Ingbar 1992:100-101). Thus, greater biface use may signify either greater emphasis on cutting tasks, or use for more varied tasks, suggesting that periods of residence could have been longer or more intensive. This contrasts with interpretations of occupation at Tosawihi dominated by Late Archaic time-markers (Elston and Raven 1992a) when intensified quarrying was accomplished with short-term occupations of limited activity.

Obsidian and the Question of Trade and Access to the Quarries

Of the 179 pieces of obsidian recovered at 26Ek5040, 49 were characterized as to source; seven points and point fragments, two bifaces, and a core were examined in addition to debitage (Appendix A). Most of the 26Ek5040 material derives from the Paradise Valley source, 90 km northwest of Tosawihi, with a few samples deriving from Brown's Bench, Mount Majuba, and Pinto Peak/Double H Mountains. These sources were also identified in samples analyzed during previous work at Tosawihi (Table 37). Since the occupation of 26Ek5040 predates occupations represented in the bulk of analyzed obsidian samples from Tosawihi (cf. Figures 39, 41) patterns of obsidian source use at Tosawihi appear long-lived.

Table 37. Comparative Obsidian Source Characterizations.

	26Ek5040	Other Tosawihi Samples
Paradise Valley, NV	36	71
Brown's Bench, NV	3	37
Mount Majuba, NV	3	1
Pinto Peak/HH Mtns., NV	3	5
Timber Butte, ID	0	1
Bordwell Spring, NV	0	1
Malad, ID	0	3
Fox Mtn, NV	0	1
Unknown	4	26
Total	49	146

All the obsidian sources represented at Tosawihi are north of the Humboldt River (Figure 52). When obsidian source data from nearby sites are compared, a pattern emerges wherein sites located north of the Humboldt River contain obsidian derived only from obsidian sources north of the river, while sites south of the river contain obsidian derived from more sources which are located both north and south of the river (Dugas, Bullock, and Elston 1994; Ataman 1994).

An obsidian data set from the Middle Humboldt region exhibits a similar pattern to that seen at Tosawihi (A. Schroedl, personal communication, March 1995). Ongoing work in the Little Boulder Basin southeast of Tosawihi about 20 km, and just north of the Humboldt River, has sourced 118 samples, only two of which are south of the river. Obsidian source data south of the Humboldt was obtained from the Mule Canyon area, near Beowawe (Elston and Bullock 1994). There, the pattern of prehistoric obsidian source utilization is distinctly different from that observed from sites north of the Humboldt River; the 287 sourced pieces of Mule Canyon derive from a geographically wider group of sources which lie both north and south of the river (cf. Figure 52).

The economic model of behavior which has been used to describe the nature of opalite tool and debitage distribution (Elston 1992b) does not apply to the observed patterns of obsidian source use, because nearest sources are not always exploited. Numerous factors may affect obsidian source distribution, including a temporal one. The temporal focus of prehistoric activity differs between Tosawihi and Mule Canyon. Tosawihi saw an increase in activity in Rosegate times and greater intensification in Desert times (Elston and Drews 1992). In contrast, at Mule Canyon the Middle Archaic is more strongly represented with an increased intensification during Rosegate times (Elston 1994). Until recently we assumed that the observed patterns of obsidian source utilization could be influenced by changes in mobility patterns and range, which may have become more restricted at the end of the Middle Archaic around 700 A.D. (Elston 1986:146), but the 26Ek5040 data argue against temporal change in the use of sources as a likely explanation for the different utilization patterns north and south of the Humboldt.

While explanations involving social or ideological preferences for particular sources cannot be discounted, there is no evidence for non-utilitarian use of obsidian in this part of the Great Basin. At both Tosawihi and Mule Canyon, small quantities of cores and cortical flakes as well as a small number of bifaces and other tools occur in obsidian assemblages, but the obsidian from both projects consists overwhelmingly of pressure flaking debitage, most likely produced in the course of manufacturing, reworking, and rejuvenating projectile points. The preference for obsidian in projectile point

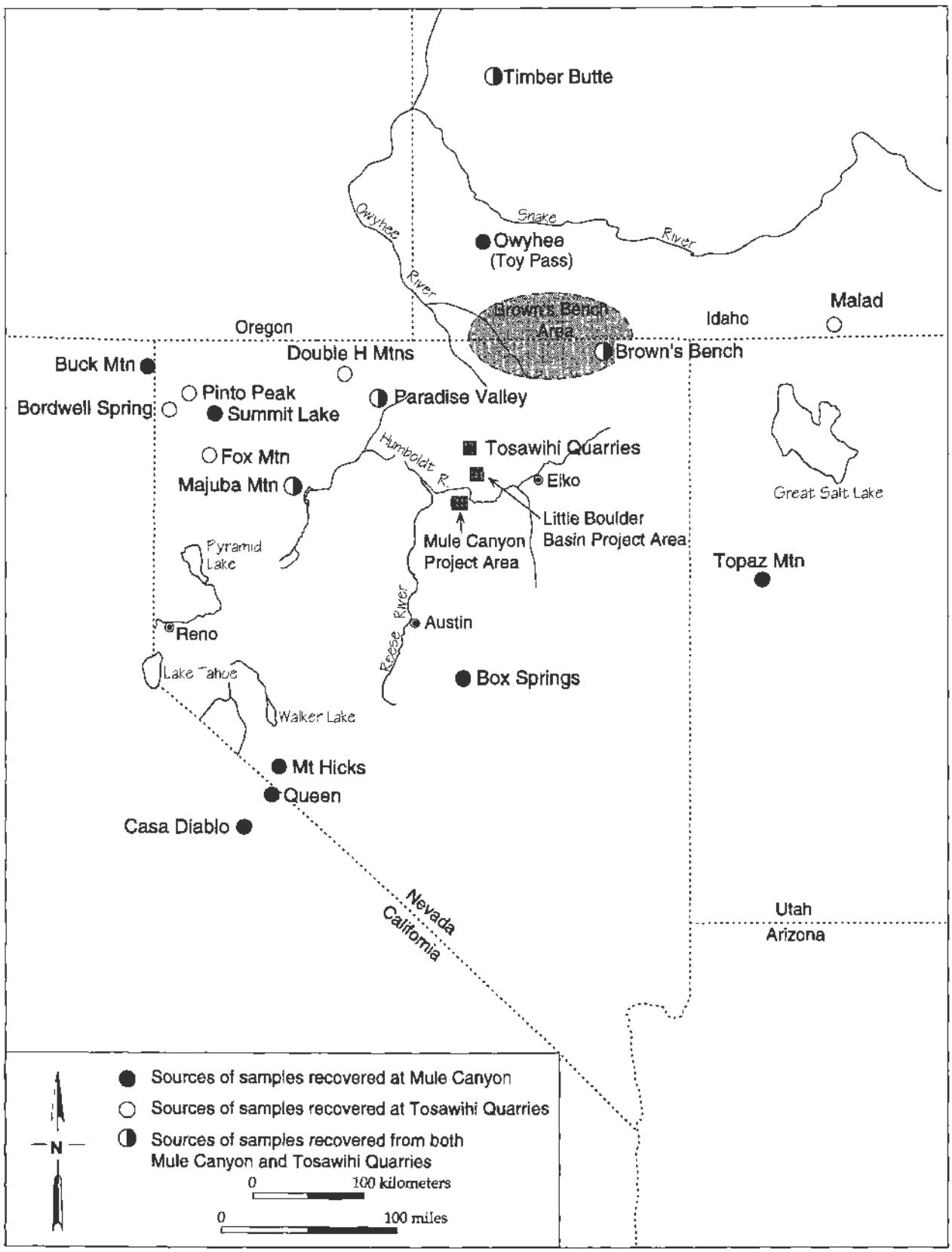


Figure 52. Distribution of Tosawihi Quarries and Mule Canyon obsidian sources.

manufacture may be due simply to flaking ease of that material. No statistically significant source differences for debitage vs. points were noted between the few most important sources or between close and distant sources for either study area.

An obvious explanation for the pattern is that the Humboldt River may have functioned as some sort of territorial boundary. If so, the contradiction in the pattern of opalite and obsidian source access is curious. If, as seems likely from the quantities of opalite recovered from sites south of the river, the prehistoric inhabitants of the Mule Canyon area had direct access to the Tosawihi Quarries, why did they leave no trace of obsidian from sources they exploited south of the river? And if trade mechanisms allowed obsidian from the north to reach Mule Canyon, why didn't obsidian from the south reach Tosawihi?

In attempting to understand the factors that may have produced this pattern, the well known historic and proto-historic boundary between Western Shoshone and Northern Paiute territory (Steward 1937, 1938), which corresponds to dominant lithic raw material utilization zones (Stephenson and Wilkinson 1969:50-52)(cf. Figure 7), comes to mind. With lithic material consisting primarily of Tosawihi opalite east of the line in Shoshone territory, and primarily obsidian on the west in Paiute territory, the lithic resource boundary represents an enduring pattern of raw material use which we assume to be an economic one, based on least cost of acquisition effort. However, as it also reflects a sociopolitical and linguistic boundary, perhaps in this part of the Great Basin social boundaries may also be long-lived.

The coincidental raw material and cultural boundary, and the possibility of the existence of a territorial boundary centered on the Middle Humboldt region south of Tosawihi argues for cultural continuity in the region whether the territories defined are ethnic, political, or economic. It is possible that the large number of unidentified obsidian sources observed in both study areas is significant enough to affect the presently observed pattern. This will become clearer as additional obsidian sources are identified and characterized. It may be that combinations of economic and social factors create persistent patterns on the ground, but the limited nature of prehistoric material culture in the Great Basin renders archaeological explanation of such patterns rather difficult.

Summary

Excavations at 26Ek5040 have revealed a biface manufacturing site with a certain residential character occupied intermittently from as early as pre-Mazama times to the Late Archaic. A pre-Mazama occupation is presented only as a possibility. Mixing of deposits by mechanical and biological processes has obscured the stratigraphic context; for example, a nearly complete metate appearing within a layer of Mazama ash attests to dramatic soil movement rather than to cultural deposition.

Most cultural material on site however, points to the Middle Archaic. Very few intact subsurface features were discovered; thus, most temporal inferences are based on projectile points and uncalibrated obsidian hydration measurements. The bulk of subsurface deposits appear to be Middle Archaic; the somewhat deflated surface is mixed Middle and Late Archaic. There is the possibility of a temporal gap between Middle and Late Archaic occupations. The Late Archaic occupation may have been rather ephemeral; it is represented only by hydration measurements and a near-surface hearth (no Late Archaic points were recovered). Hydration measurement distribution across the site indicates that occupation may have shifted temporally from one part of the site to another.

While there is no significant water source on site today, there once may have been during at least part of the year when the site was occupied. Soils indicate that waterlogged deposits were present at

some time in the past. The distribution of groundstone along the main drainage on the site suggests the availability of economically useful plants not seen today. A large source of high quality white opalite toolstone is located approximately 1 km from the site; the opalite material recovered from 26Ek5040 resembles it. The source is a quarry complex which has yet to be investigated.

The focus of site activity is along the central ridge (Feature Group 2). While single reduction events are dispersed across the site, debitage density and most activities unrelated to lithic reduction are more concentrated on the central ridge. The distribution of groundstone tools, which appear along the southern edge of the site, is the exception to this pattern. No heat-treatment hearths were identified with certainty, but the number of heat-failed bifaces and the high proportion of heat-treated debitage at a site within 1 kilometer of a good toolstone source leads us to believe that heat-treatment was common at 26Ek5040

Several factors contribute to the impression of 26Ek5040 as a more residential place than other workshop sites at Tosawihi: the biface industry appears less standardized (perhaps less industrial), more biface use is indicated, biface export form includes finished bifaces, and more flake tools and groundstone were recovered. Perhaps visits to Tosawihi in the Middle Archaic were of longer duration or were undertaken by larger groups than during the Late Archaic.

The obsidian sources used by visitors to Tosawihi in the Middle and Late Archaic were the same. The barrier posed by the Humboldt River south of which obsidian was not acquired may represent a territorial boundary of long standing. Further research in this part of north central Nevada could benefit from close attention to trade patterns through extensive sourcing and hydration analyses and examination of quantities and forms of Tosawihi opalite found outside the Tosawihi production sphere.

Finally, excavation at 26Ek5040 has indicated that certain changes in prehistoric exploitation of the Tosawihi area may have developed between the Middle and Late Archaic. These changes are manifest in material remains in the form of techniques of biface manufacture, export products, and type and variety of tools used at 26Ek5040. These conclusions derive however, from only one site. Future research in the Tosawihi area focused directly on the excavation of sites with single component or stratified occupations, could provide useful data to address issues of temporal change.

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Appendix A

Obsidian Sourcing

August 8, 1994

Ms. Kathryn Ataman
Laboratory Director
Intermountain Research
Drawer 'A'
Silver City, Nevada 89428

Dear Ms. Ataman:

Enclosed with this letter you will find a three-page table presenting x-ray fluorescence (xrf) data generated from the analysis of 50 artifacts (10 tools, 40 debitage samples) from site 26Ek5040 in the Tosawihi opalite quarries area of Elko County, Nevada. This research was conducted pursuant to a letter request from Margaret Bullock, dated July 5, 1994, for IMR project 768.

Laboratory investigations were performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a rhodium (Rh) x-ray tube, a 50 kV x-ray generator, with microprocessor controlled pulse processor (amplifier) and bias/protection module, a 100 mHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30 mm^2 area. The x-ray tube was operated at 35.0 kV, .25 mA, using a .127 mm Rh primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity data for the trace elements zinc (Zn Kα), gallium (Ga Kα), rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα) and niobium (Nb Kα). Barium (Ba Kα) intensities were generated by operating the x-ray tube at 50.0 kV, .35 mA, with a .63 mm copper (Cu) filter at 300 seconds livetime, and iron vs. manganese (Fe Kα/Mn Kα) ratios were computed from data generated by operating the x-ray tube at 12.0 kV, .30 mA, with a .127 mm aluminum (Al) filter at 300 seconds livetime. X-ray intensities were converted to concentration estimates employing a least-squares calibration line established for each element from analysis of up to 26 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology (formerly National Bureau of Standards), the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France). Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988, 1994).

Trace element measurements on the xrf data tables (except Fe/Mn ratios) are expressed in quantitative units (i.e. parts per million [ppm] by weight), and matches between unknowns and known obsidian chemical groups were made on the basis of correspondences (at the 2-sigma level) in diagnostic trace element concentration values (in this case, ppm values for Rb, Sr, Y, Zr, Nb and, when necessary, Ba, and Fe/Mn ratios) that appear in Hughes (1983, 1984, 1985, 1986, 1990, n.d.), Jack and Carmichael (1969), Nelson (1984), Nelson and Holmes (1979) and certain other unpublished data in my possession on other northern Nevada obsidians. Artifact-to-obsidian source (geochemical type) correspondences were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards. I use the term "diagnostic" to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations show low intra-source variability and marked variability across sources. In short, diagnostic elements are those whose concentration values allow one to draw the clearest geochemical distinctions between sources (Hughes 1990, 1993a; Hughes and Lees 1991). Although Zn, Ga and Nb ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they don't usually vary significantly across obsidian sources (see Hughes 1982, 1984). This is particularly true of Ga, which occurs

in concentrations between 10-30 ppm in nearly all parent obsidians in the study area. Zn ppm values are infrequently diagnostic; they are always high in Zr-rich, Sr-poor peralkaline volcanic glasses, but otherwise they do not vary significantly between sources in the study area.

The trace element composition measurements are reported to the nearest ppm to reflect the calibration-imposed resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. The resolution limits of the present x-ray fluorescence instrument for the determination of Zn is about 3 ppm; Ga about 2 ppm; for Rb about 4 ppm; for Sr about 3 ppm; Y about 2 ppm; Zr about 5 ppm; and Nb about 3 ppm (see Hughes [1988, 1994] for other elements). When counting and fitting error uncertainty estimates (the "±" value in the table) for a sample are greater than element-specific resolution limits given above, the larger number is a more conservative indicator of composition variation and measurement error due to differences in sample size, surface and x-ray reflection geometry.

The artifact-to-source (geochemical type) attribution for each specimen appears on the data tables, so I will not repeat ascriptions for individual samples. Because I do not have temporal ascriptions for these samples, I have not attempted a breakdown by artifact class, time period and obsidian source (chemical type); informative patterning may emerge when you do this in conjunction with source-specific obsidian hydration rim readings.

Most of these artifacts were fashioned from obsidians of the Paradise Valley chemical type (n=36; cf. Hughes 1990), with Brown's Bench (n=3; Hughes 1990, cf. Hughes and Smith 1993) and Majuba Mountain (n= 3; cf. Hughes 1985) obsidians represented by smaller frequencies. Three samples are have the high-Zr concentration and Fe/Mn ratios within range of geologic samples in my possession from south of Pinto Peak, Summit Lake and Double H Mountains, all west northwest of the project area (these are identical to the samples termed Group 3 in Hughes 1993b, c). Four samples, labelled simply Unknown on the data table, appear to represent a chemically distinct, but geographically unknown, variety of obsidian. While superficially similar to Brown's Bench in Zr composition, these samples contain significantly less Rb and Sr than Brown's Bench. Interestingly, only one example (sample no. 989 from site EU1997) of obsidian of this latter chemical type has been identified in previous analyses of artifacts from the Tosawihi area (Hughes 1993c). One sample (94.8) was fashioned from a non-obsidian parent material.

I hope this information will help in your analysis of these site materials. Please contact me at my laboratory ([916] 364-1074) if I can be of further assistance. As you requested, I have forwarded all samples to Tom Origer for obsidian hydration analysis.

Sincerely,

Richard E. Hughes, Ph.D.
Director, Geochemical Research Laboratory

encl.

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Specimen Number	Trace Element Concentrations							Ratio		Obsidian Source (Chemical Group)
	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Fe/Mn*	
94.8	28 ±6	0 ±4	0 ±3	11 ±3	4 ±2	14 ±4	0 ±2	nm	nm	Not obsidian
94.17	61 ±5	22 ±3	197 ±4	45 ±3	65 ±2	411 ±4	43 ±2	nm	nm	Browns Bench
94.21	97 ±4	24 ±3	113 ±3	19 ±3	66 ±2	442 ±4	29 ±2	837 ±13	nm	Unknown
94.63	70 ±5	22 ±3	340 ±4	1 ±3	75 ±2	74 ±3	19 ±2	nm	nm	Paradise Valley
94.69	79 ±5	20 ±4	382 ±4	3 ±3	83 ±2	82 ±3	18 ±2	nm	nm	Paradise Valley
94.83	70 ±4	20 ±3	323 ±4	3 ±3	73 ±2	71 ±3	15 ±2	nm	nm	Paradise Valley
94.93	72 ±4	16 ±3	373 ±4	2 ±3	85 ±2	78 ±3	16 ±2	nm	nm	Paradise Valley
94.142	69 ±4	20 ±3	355 ±4	1 ±6	77 ±2	76 ±3	14 ±2	nm	nm	Paradise Valley
94.145	85 ±5	26 ±4	404 ±5	4 ±3	87 ±2	82 ±4	18 ±2	nm	nm	Paradise Valley
94.147	63 ±4	23 ±3	336 ±4	2 ±3	73 ±2	69 ±3	13 ±2	nm	nm	Paradise Valley
94.149	90 ±5	21 ±4	402 ±5	3 ±3	87 ±2	83 ±4	14 ±2	nm	nm	Paradise Valley
94.151	79 ±5	23 ±3	386 ±4	3 ±3	84 ±2	80 ±3	16 ±2	nm	nm	Paradise Valley
94.152	69 ±4	19 ±3	350 ±4	2 ±3	74 ±2	73 ±3	14 ±2	nm	nm	Paradise Valley
94.164	71 ±5	25 ±3	367 ±5	3 ±3	78 ±2	76 ±4	16 ±2	nm	nm	Paradise Valley
94.166	72 ±4	20 ±3	340 ±4	3 ±3	77 ±2	74 ±3	14 ±2	nm	nm	Paradise Valley
94.243	67 ±4	14 ±3	338 ±4	2 ±3	72 ±2	72 ±3	15 ±2	nm	nm	Paradise Valley
94.244	60 ±4	18 ±3	340 ±4	2 ±3	75 ±2	74 ±3	18 ±2	nm	nm	Paradise Valley

Trace element values (except Fe/Mn ratios) in parts per million (ppm); ± = estimate (in ppm) of x-ray counting uncertainty and regression fitting error at 200 and 300 (*) seconds livetime; nm = not measured.

Specimen Number	Trace Element Concentrations							Ratio		Obsidian Source (Chemical Group)
	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Fe/Mn*	
94.246	66 ±4	20 ±3	355 ±4	2 ±3	79 ±2	72 ±3	15 ±2	nm	nm	Paradise Valley
94.258	65 ±4	21 ±3	366 ±4	2 ±3	85 ±2	80 ±3	16 ±2	nm	nm	Paradise Valley
94.262	74 ±6	26 ±4	361 ±5	2 ±3	82 ±3	77 ±4	14 ±2	nm	nm	Paradise Valley
AG1-2-1.1	60 ±5	19 ±4	198 ±4	48 ±3	63 ±2	432 ±5	43 ±2	nm	nm	Browns Bench
AJ1-5-1.1	78 ±4	20 ±3	348 ±4	2 ±3	76 ±2	75 ±3	12 ±2	nm	nm	Paradise Valley
AM1-4-1.1	76 ±5	21 ±4	357 ±5	1 ±4	80 ±2	77 ±4	13 ±2	nm	nm	Paradise Valley
AN1-4-1.1	82 ±5	22 ±4	401 ±5	3 ±3	86 ±2	80 ±4	14 ±2	nm	nm	Paradise Valley
AN1-4-1.3	188 ±7	23 ±4	212 ±4	4 ±3	98 ±2	513 ±5	29 ±2	nm	76	Pinto Peak or Double H Mtns.
K1-1-1.1	77 ±5	30 ±3	364 ±4	3 ±3	81 ±2	74 ±3	18 ±2	nm	nm	Paradise Valley
P1-4-1.2	56 ±4	12 ±4	146 ±3	106 ±3	20 ±2	156 ±4	11 ±2	nm	35	Majuba Mountain
P1-4-1.3	81 ±5	22 ±3	363 ±4	4 ±3	79 ±2	80 ±3	15 ±2	nm	nm	Paradise Valley
P1-5-1.1	81 ±6	25 ±4	367 ±5	4 ±3	81 ±3	80 ±4	15 ±2	nm	nm	Paradise Valley
P1-5-1.2	48 ±5	14 ±4	145 ±3	106 ±3	19 ±2	153 ±4	10 ±2	nm	36	Majuba Mountain
Q5-4-1.1	207 ±6	25 ±4	219 ±4	3 ±3	101 ±2	537 ±5	27 ±2	nm	73	Pinto Peak or Double H Mtns.
Q5-5-1.2	87 ±5	18 ±4	384 ±5	3 ±3	82 ±2	79 ±4	17 ±2	nm	nm	Paradise Valley
Q5-5-1.3	60 ±5	13 ±3	164 ±3	122 ±3	25 ±2	175 ±4	10 ±2	nm	37	Majuba Mountain
Q5-6-1.2	79 ±5	26 ±4	374 ±4	3 ±3	82 ±2	79 ±3	10 ±2	nm	nm	Paradise Valley

Trace element values (except Fe/Mn ratios) in parts per million (ppm); ± = estimate (in ppm) of x-ray counting uncertainty and regression fitting error at 200 and 300 (*) seconds livetime; nm = not measured.

Specimen Number	Trace Element Concentrations							Ratio		Obsidian Source (Chemical Group)
	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba*	Fe/Mn*	
Q6-1-1.1	87 ±5	25 ±4	394 ±5	4 ±3	85 ±2	82 ±4	14 ±2	nm	nm	Paradise Valley
Q6-6-1.2	77 ±5	20 ±4	402 ±5	2 ±3	89 ±2	81 ±4	15 ±2	nm	nm	Paradise Valley
Q7-2-1.2	78 ±5	24 ±4	383 ±5	3 ±3	83 ±2	79 ±4	18 ±2	nm	nm	Paradise Valley
Q7-5-1.1	60 ±6	19 ±4	388 ±5	3 ±3	85 ±2	80 ±4	14 ±2	nm	nm	Paradise Valley
Q8-1-1.1	78 ±5	20 ±4	397 ±5	4 ±3	85 ±2	83 ±4	16 ±2	nm	nm	Paradise Valley
Q8-5-1.4	75 ±5	14 ±4	222 ±4	47 ±3	65 ±2	431 ±5	48 ±2	nm	nm	Browns Bench
R1-1-1.1	83 ±6	23 ±4	408 ±5	0 ±5	86 ±2	83 ±4	15 ±2	nm	nm	Paradise Valley
S1-1-1.1	81 ±5	28 ±3	382 ±5	2 ±3	85 ±2	79 ±4	14 ±2	nm	nm	Paradise Valley
S2-5-1.1	150 ±7	25 ±4	180 ±4	4 ±3	92 ±2	489 ±5	28 ±2	nm	71	Pinto Peak or Double H Mtns.
T2-4-1.1	84 ±6	24 ±4	390 ±5	4 ±3	86 ±2	84 ±4	17 ±2	nm	nm	Paradise Valley
T2-5-1.1	74 ±5	18 ±4	355 ±5	3 ±3	80 ±2	78 ±4	14 ±2	nm	nm	Paradise Valley
T2-5-1.2	72 ±4	19 ±3	344 ±4	2 ±3	80 ±2	73 ±3	16 ±2	nm	nm	Paradise Valley
V3-1-1.1	90 ±6	30 ±4	382 ±5	4 ±3	81 ±3	81 ±4	18 ±2	nm	nm	Paradise Valley
Y1-1-1.1	98 ±5	22 ±3	118 ±3	20 ±3	64 ±2	463 ±5	35 ±2	931 ±13	nm	Unknown
Y1-3-1.3	108 ±5	27 ±4	120 ±3	24 ±3	69 ±2	457 ±5	31 ±2	958 ±14	nm	Unknown
Y1-3-1.4	87 ±6	20 ±4	113 ±3	18 ±3	66 ±2	432 ±5	30 ±2	975 ±14	nm	Unknown

Trace element values (except Fe/Mn ratios) in parts per million (ppm); ± = estimate (in ppm) of x-ray counting uncertainty and regression fitting error at 200 and 300 (*) seconds livetime; nm = not measured.

Appendix B

Obsidian Hydration

SONOMA STATE UNIVERSITY
ACADEMIC FOUNDATION, INC.

ANTHROPOLOGICAL STUDIES CENTER
CULTURAL RESOURCES FACILITY
707 664-2381 FAX 707 664-4155

Foundation Center, Bldg. 300
1801 East Cotati Avenue
Rohnert Park, California 94928-3609

Ms. Kathryn Ataman
Intermountain Research
Drawer A
Silver City, Nevada
89428

September 2, 1994

Dear Kathryn:

This letter reports hydration band measurements obtained from 49 obsidian specimens from site 26EK5040 in the Tosawihi opalite quarries in Elko County, Nevada. This hydration work was completed according to your request following source determination of the specimens by Richard Hughes who forwarded the items to us. Note that only 49 specimens were analyzed because Richard Hughes determined that one was not obsidian.

The analysis was completed at the Sonoma State University Obsidian Hydration Lab, an adjunct of the Anthropological Studies Center, Department of Anthropology. Procedures used by our hydration lab for preparation of thinsections and measurement of hydration bands are described below.

Each specimen was examined to find one or more surface facets that would yield edges which would be perpendicular to the microslide when preparation of the thin section was completed. Generally, two small parallel cuts are made at the selected location along the edge of the specimens with a four-inch diameter circular saw blade mounted on a lapidary trimsaw. The cuts result in the isolation of a small sample with a thickness of about one millimeter. Samples are removed from the specimen and mounted with Lakeside Cement onto a permanently etched petrographic microslide.

The thickness of each sample was reduced by manual grinding with a water based slurry of #500 silicon carbide abrasive on a glass plate. The grinding was completed in two steps. The first grinding was stopped when a sample's thickness was reduced by about one-half. This eliminated any micro-chips created by the saw blade during the cutting process. Each slide was then reheated, which liquefied the Lakeside Cement, and the samples inverted. Newly exposed surfaces were then ground until the proper thickness was attained.

The correct thin section thickness was determined by the "touch" technique. A finger was rubbed across the slide, onto the sample, and the difference (sample thickness) was "felt." The second technique employed for arriving at proper thin section thickness is termed the"transparency" test. Each microslide was held up to a strong source of light and the translucency of the thin section observed. Samples were sufficiently reduced in thickness

when the thin sections readily allowed the passage of light. A coverslip was affixed over the thin sections when grinding was completed. Completed microslides are curated at our hydration lab under File No. 94-H1360.

Hydration bands were examined and measured with a strainfree 40 power objective and a Bausch and Lomb 12.5 power filar micrometer eyepiece on a Nikon petrographic microscope. Six measurements were taken at locations along the edge of the thin section, and the mean of the measurements was calculated and listed on the enclosed table with other information. Note, the hydration measurements have a range of +/- 0.2 due to normal limitations of the equipment.

The abbreviations "DH" and "NVB" on the enclosed pages under the "Mean" column mark specimens having diffuse hydration or no visible hydration band, respectively.

If you have questions regarding this hydration work, please do not hesitate to contact me.

Sincerely,

Thomas M. Origer, Director
Obsidian Hydration Laboratory

26EK5040 Submittor: K. Ataman - Intermountain Research September 6, 1994

Lab#	Catalog#	Description	Unit	Level	Remarks	Measurements	Mean	Source
1	0-0-94.17	Rosegate/Elko?		surface	none		NVB	
2	0-0-94.69	Biface fragment		surface	none	5.1 5.1 5.1 5.3 5.4 5.5	5.3	
3	0-0-94.142	Elko?		surface	none	6.0 6.0 6.0 6.0 6.1 6.1	6.0	
4	0-0-94.262	Point fragment		surface	none		DH	
5	P1-4-1.3	Point fragment	P1	4	none	6.0 6.0 6.0 6.0 6.1 6.1	6.1	
6	P1-5-1.2	Core	P1	5	none	5.1 5.1 5.1 5.1 5.3 5.4	5.2	
7	Q5-4-1.1	Biface fragment	Q5	4	none	4.7 4.8 4.8 4.8 4.9 4.9	4.8	
8	S2-5-1.1	Point fragment	S2	4	none	4.7 4.7 4.7 4.8 4.8 4.8	4.8	
9	T2-4-1.1	Point fragment	T2	4	none	4.5 4.5 4.7 4.7 4.7 4.8	4.7	
10	AJ1-5-1.1	Point	AJ1	5	none	4.4 4.4 4.4 4.4 4.5 4.5	4.4	
11	0-0-94.21	Debitage		surface	none	1.2 1.2 1.2 1.2 1.2 1.3	1.2	
12	0-0-94.63	Debitage		surface	none	4.7 4.8 4.8 4.8 4.8 4.8	4.8	
13	0-0-94.83	Debitage		surface	none	5.3 5.3 5.4 5.4 5.4 5.5	5.4	
14	0-0-94.93	Debitage		surface	none	5.6 5.7 5.7 5.7 5.8 5.8	5.7	
15	0-0-94.145	Debitage		surface	none	6.7 6.7 6.7 6.7 6.8 6.8	6.7	
16	0-0-94.147	Debitage		surface	none		NVB	
17	0-0-94.149	Debitage		surface	none	1.3 1.3 1.3 1.3 1.4 1.4	1.3	
18	0-0-94.151	Debitage		surface	none	1.1 1.2 1.2 1.2 1.3 1.3	1.2	
19	0-0-94.152	Debitage		surface	none	1.2 1.2 1.2 1.2 1.3 1.3	1.2	
20	0-0-94.164	Debitage		surface	none	5.4 5.4 5.4 5.5 5.6 5.6	5.5	
21	0-0-94.166	Debitage		surface	none	1.7 1.7 1.7 1.7 1.8 1.8	1.7	
22	0-0-94.243	Debitage		surface	none	6.3 6.4 6.4 6.4 6.7 6.8	6.6	
23	0-0-94.244	Debitage		surface	none	1.2 1.3 1.3 1.4 1.4 1.6	1.4	
24	0-0-94.246	Debitage		surface	none	1.3 1.3 1.3 1.4 1.4 1.4	1.4	
25	0-0-94.258	Debitage		surface	none	3.2 3.2 3.3 3.3 3.3 3.5	3.3	
26	K1-1-1.1	Debitage		surface	none	7.6 7.6 7.8 7.8 7.9 7.9	7.8	
27	P1-4-1.2	Debitage		surface	none	5.6 5.6 5.6 5.6 5.7 5.8	5.7	
28	P1-5-1.1	Debitage		surface	none	5.6 5.6 5.6 5.7 5.8 5.8	5.7	
29	Q5-5-1.2	Debitage		surface	none	5.4 5.5 5.5 5.6 5.6 5.7	5.6	
30	Q5-5-1.3	Debitage		surface	none	5.0 5.1 5.1 5.3 5.3 5.4	5.2	
31	Q5-6-1.2	Debitage	Q5	6	none	5.3 5.4 5.4 5.5 5.5 5.5	5.4	
32	Q6-1-1.1	Debitage	Q6	1	none	1.2 1.2 1.2 1.2 1.2 1.4	1.2	
33	Q6-6-1.2	Debitage	Q6	6	none	5.1 5.3 5.3 5.3 5.3 5.3	5.3	
34	Q7-2-1.2	Debitage	Q7	2	none	6.7 6.7 6.7 6.7 6.8 6.8	6.7	
35	Q7-5-1.1	Debitage	Q7	5	none	4.7 4.8 4.9 4.9 5.0 5.0	4.9	
36	Q8-1-1.1	Debitage	Q8	1	none	4.7 4.7 4.8 4.8 4.8 4.9	4.8	
37	Q8-5-1.4	Debitage	Q8	5	none	7.9 7.9 8.0 8.0 8.1 8.2	8.0	
38	R1-1-1.1	Debitage	R-1	1	none	8.0 8.1 8.1 8.1 8.1 8.2	8.1	
39	S1-1-1.1	Debitage	S-1	1	none	5.8 5.8 6.0 6.0 6.0 6.1	6.0	
40	T2-5-1.1	Debitage	T-2	5	none	5.4 5.5 5.5 5.5 5.6 5.7	5.5	
41	T2-5-1.2	Debitage	T-2	5	none	5.6 5.6 5.6 5.6 5.8 5.8	5.7	
42	V3-1-1.1	Debitage	V3	1	none	1.4 1.4 1.6 1.7 1.7 1.7	1.6	
43	Y1-1-1.1	Debitage	Y1	1	none	1.2 1.2 1.2 1.2 1.2 1.3	1.2	
44	Y1-3-1.3	Debitage	Y1	3	none	1.2 1.2 1.3 1.3 1.3 1.3	1.3	
45	Y1-3-1.4	Debitage	Y1	3	none	1.1 1.2 1.2 1.2 1.2 1.2	1.2	
46	AG1-2-1.1	Debitage	AG1	2	none		NVB	
47	AM1-4-1.1	Debitage	AM1	4	none	5.5 5.5 5.6 5.6 5.6 5.6	5.6	

26EK5040 Submittor: K. Ataman - Intermountain Research September 6, 1994

Lab#	Catalog#	Description	Unit	Level	Remarks	Measurements	Mean	Source
48	AN1-4-1.1	Debitage	AN1	4	none	4.9 4.9 5.0 5.0 5.0 5.0	5.0	
49	AN1-4-1.3	Debitage	AN1	4	none		DH	

Lab Accession No.: 94-H1360 Technician: Thomas M. Origer

Appendix C

Radiocarbon Assays

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dr. Robert G. Elston

Intermountain Research

DATE RECEIVED: March 10, 1994

DATE REPORTED: April 6, 1994

SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS: Radiometric

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	C13/C12	C13 adjusted age
eta-71239	26EK5040-UP (Organic Sediment)	4380 ± 90 BP	-25.0* o/oo	4380 ± 90* BP

ESTIMATED C13/C12 ratio and adjusted age (used in calendar calibration). Ratio assumed to be identical to the reference standard (age does not change).

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

RADIOCARBON DATING SERVICES

Dr. JERRY J. STIPP
Dr. MURRY A. TAMERS
CO-DIRECTORS

DARDEN G. HOOD, P.G.
Laboratory Manager
RONALD E. HATFIELD
CHRISTOPHER PATRICK
TERESA A. ZILKO-MILLER
Associate Managers

Dr. Robert G. Elston
Intermountain Research
Drawer A
Silver City, Nevada 89428

April 6, 1994

Dear Dr. Elston:

Please find enclosed the result on the organic sediment sample (26EK5040-UP) submitted for radiocarbon dating analysis on March 10, 1994. It was necessary to use the entire sample for the analysis.

The sample was saturated with de-ionized water, sieved of rootlets, and rinsed in hot acid to remove carbonates. After drying and final inspection, aliquots were repeatedly combusted to obtain a sufficient quantity of carbon dioxide gas, which was synthesized to benzene and analyzed for C14 content. The date represents the total organic content of the sediment.

Also included is the dendrocalibration of the date. This graphic representation allows for experimentation to illustrate changes in the calibrated age with changes in the radiocarbon age. We've used the same international data base as in other programs but the mathematical treatment is more appropriate. It is presented in collaboration with the Quaternary Dating Research Unit in Pretoria, South Africa, directed by Dr. John Vogel, to whom we credit the calibration. For interpretation purposes, note the caveats and our recommendation to use the two sigma range. Please report the original data in the form of a table in publications so that future refinement of calibration data can be applied to your research. Hopefully the attached cover sheets will answer your questions.

A discussion of calibrating radiocarbon dates calculated with estimated C13/C12 ratios is included on the back of the calibration explanation page. We have refined the date report format to include estimated C13/C12 ratios and adjusted ages for the purposes of calibration and completing your tables. You will notice the uncorrected and corrected ages are the same since a constant was used.

Our invoice is enclosed. Would you please forward it to your purchasing department for payment. As always, if you have any questions, do not hesitate to contact us. We are sending this report by both mail and fax. This sample is number 17 in this year's discount period, valid through June 1994.

Sincerely,

Darden Hood

4985 S.W. 74 COURT, MIAMI, FL, 33155 U.S.A.
TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / BITNET: XNRBET22@SERVAX

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-mail: beta@analytic.win.net

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dr. Robert G. Elston
Intermountain Research

DATE RECEIVED: Auth. August 19, 1994
DATE REPORTED: September 16, 1994

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
Beta-74722	850 +/- 200 BP	-25.0* o/oo	850 +/- 200* BP

SAMPLE #: 26Ek5040-AM1-3-6.1
ANALYSIS: radiometric-standard
MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid
COMMENT: the small sample was given extended counting time

NOTE: One additional sample (26Ek5040-Q5-2-3.4) was submitted but not analyzed as instructed.

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

Appendix D

Tephra Analysis

Washington State University
Department of Geology
Pullman, WA 99164-281
509-335-300
FAX: 509-335-781

September 2, 1994

Dan Dugas, Geoarchaeologist
Intermountain Research
Drawer A
Silver City, Nevada 89428

Dear Dan,

We analyzed the sample you provided and the results are given in the attached table. As you can see (and I believe as you expected) it matches Mazama Climactic glass to a T.

Sorry this took longer than usual. Just as your sample arrived the sample preparation technician left for vacation.

Sincerely,

Nick

Franklin F. (Nick) Foit, Jr.
Professor and Director of Microbeam Lab

TABLE 1. GLASS CHEMISTRY OF INTERMOUNTAIN RESEARCH SAMPLE

Oxide	26EK5040AH2-25
SiO2	72.90(0.22)
Al2O3	14.50(0.16)
Fe2O3	2.16(0.07)
TiO2	0.42(0.03)
Na2O	5.01(0.10)
K2O	2.68(0.07)
MgO	0.49(0.04)
CaO	1.67(0.06)
Cl	0.17(0.02)
Total**	100
Number of shards analyzed	16
Probable Source	Mazama Climactic 6850 BP
Similarity Coefficient	0.98-0.99

* Standard deviations of the analyses given in parentheses
** Analyses normalized to 100 weight percent

Sample name: Dugas Intermountain Research 26EK5040AH2-25

SiO2	TiO2	Al2O3	MgO	CaO	BaO	MnO	Fe2O3	Na2O	K2O	Cl	Total
72.90	0.42	14.50	0.49	1.67	0.00		2.16	5.01	2.68	0.17	100.00
1.00	0.25	1.00	0.25	1.00	0.00	0.00	1.00	1.00	1.00	weighting factor (only for oxides in bold type)	

Similiarity Coefficients for 15 closet matches

SiO2	TiO2	Al2O3	MgO	CaO	Fe2O3	Na2O	K2O	sim coef weighted avg	rec#	Std	Date	State	Source/Age	Notes	weighted av
1.000	0.977	0.996	0.980	0.988	0.977	0.994	0.993	0.990	705		31-Jan-94	OR	Mazama 6850 BP	Sample 913-01-P7-ASH recovered from Unit N196E174 at a depth of 30-35 cm from Site 35KL2101 (La Sere Site) in Drews Valley, roughly 17 miles west of Lakeview, OR, Dennis Jenkins, OR Museum of Anthropology, O of O	
0.997	1.000	0.994	0.959	0.964	0.986	0.998	1.000	0.989	216			WA	Mazama/6850	Sample #1, IHS Clinic near Yakima Indian Agency, G. Cleveland, Yakima Indian Nation	
0.999	1.000	0.996	0.959	0.958	0.995	0.988	0.989	0.987	707		1-Mar-94	ID	Mazama 6850 BP	Sample #2, soil B horizon, 20 cm depth, Selkirk Mountains, Boundary County, Idaho; Paul McDaniels, Dept of Plant, Soil & Entomological Sciences, U of Idaho	
0.999	1.000	0.995	1.000	0.971	0.991	0.960	0.996	0.987	346			OR	Mazama/6850	Willowdale	
0.997	0.976	0.999	0.918	0.964	0.995	0.986	0.996	0.986	457			OR	Mazama 6850 ?	Sample 35JE283, 398-2; Infotec, Willowdale Quad.	
1.000	0.955	0.997	0.959	0.958	0.995	0.982	1.000	0.986	698		31-Jan-94	OR	Mazama 6850 BP	Sample 35UN82-33-1 from site 35UN82, TU-1, depth 66-71 cm in Union County, just south of La Grande, OR in the foothills above the Grand Ronde Valley, Archaeological Investigations NW, Portland, Doug Wilson	
0.998	0.976	0.992	0.939	0.964	0.977	1.000	0.993	0.985	549			WA	Mazama 6850 BP ????	Sample 45FR54-05A, Palouse Canyons, B. Hicks, BOAS, Inc., Seattle	
0.998	0.976	0.996	0.898	0.982	0.977	0.982	0.996	0.985	316			OR	Mazama/6850	10BY309, SON-12-75-1, INFOTEC, North Central Idaho near Meadow Creek	
1.000	0.977	0.999	0.898	0.982	0.977	0.986	0.985	0.985	699		31-Jan-94	OR	Mazama 6850 BP	Sample 35UN82-36-1 from site 35UN82, TU-1, depth 86-91 cm, in Union County, just south of La Grande, OR in the foothills above the Grand Ronde Valley, Archaeological Investigations NW, Portland, Doug Wilson	
0.999	0.977	0.997	0.939	0.964	0.977	0.990	0.993	0.984	319			OR	Mazama/6850	35JE51B, SOX-6-130-1, Ash #1, INFOTEC, North Central OR north of Willowdale	
0.998	0.952	0.999	0.939	0.964	0.991	0.984	0.989	0.984	188			ID	Mazama/6850	101H1639 Pittsburg Landing, B. Cochran, Pittsburg Arch. Project, USFS	
1.000	1.000	0.996	0.939	0.970	0.981	0.979	0.985	0.984	709		1-Mar-94	MT	Mazama 6850 BP	Sample SCT-1, NWSE S15,0-110cm depth along Cow Creek, Fort Connah 7.5" Quad. (Lake County., MT), Daniel Levish, D-3611, Bur. of Reclamation, Denver, CO 80225-0007	
0.997	1.000	0.990	0.898	0.958	0.977	0.998	1.000	0.984	449			ID	Mazama 6850 BP ?	Idaho Historical Research Society, B. Cochrane, locality not given	
0.997	0.976	0.990	0.837	0.988	1.000	0.998	0.964	0.983	531			WA	Mazama ???	EWU #2 (glass 2) from site 45AD-104, along HWY in Lind SW USGS Quad, 7.5' Series, SE Washington, Vera Morgan, Archaeological & Histotical Services	
0.999	1.000	0.988	0.939	0.970	0.956	0.994	1.000	0.983	448			OR	Mazama 6850 BP ?	Site/Sample 35JA222, Hyatt Lk Quad, E 1/2 Sec. 10, 53 mi SW Crater Lk, 55 mi NW Mt Shasta, Nan Hannon, So. Or. Historical Soc.	

number of records searched: 735

Appendix E

List of Illustrated Artifacts

Figure 24. Selected Stage 3 bifaces.
a. N3-3-1-4
b. 0-0-94-39
c. 0-0-94-216

Figure 25. Selected Stage 4 bifaces.
a. 0-0-94-235
b. 0-0-94-203
c. 0-0-94-44
d. 0-0-94-190
e. 0-0-94-168
f. 0-0-94-4

Figure 26. Selected Stage 5 bifaces.
a. MS3-0-1-5
b. T2-1-1-2
c. N3-3-1-5
d. 0-0-94-248
e. 0-0-94-102
f. 0-0-94-209

Figure 28. Selected projectile points.
a. 0-0-94-229
b. 0-0-94-279
c. Q6-1-1-7
d. 0-0-94-17
e. 0-0-94-257
f. Q6-4-5-1
g. 0-0-94-132
h. AO1-1-1-14
i. Q7-1-1-2
j. 0-0-94-2
k. 0-0-94-142
l. AJ1-5-1-1
m. Q6-4-1-4
n. 0-0-94-197
o. S2-5-1-1
p. 0-0-94-13
q. 0-0-94-223
r. 0-0-94-259

Figure 29. Selected scrapers and pointed tools.
a. Q8-1-1-10
b. AA2-1-1-19
c. Q5-1-2-8
d. L4-1-1-5
e. AH1-1-1-3
f. 0-0-94-66
g. 0-0-94-253
h. 0-0-94-277
i. AD3-1-1-11
j. AK1-3-2-1
k. MS4-0-1-1

Figure 30. Selected notched tools, miscellaneous retouched flakes, and bifacial flake tools.

a. AG1-7-1-6
b. 0-0-94-185
c. Q6-1-1-18
d. O3-1-1-6
e. 0-0-94-378
f. 0-0-94-202
g. 0-0-94-9
h. Q5-4-1-4
i. 0-0-94-73
j. 0-0-94-6
k. N3-1-1-9
l. 0-0-94-87
m. 0-0-94-192

Figure 31. Hammerstone.

a.TC-0-1-1

Figure 32. Battered slabs.

a. MS1-0-1-5
b. MS1-0-1-3

Figure 33. Other battered artifacts.

a. MS2-0-1-7
b. 0-0-94-254

Figure 34. Selected manos.

a. Q7-3-2-1
b. 0-0-94-271/0-0-94-270

Figure 35. Pestle.

a. TD-0-1-1

Figure 37. Selected cores.

a. P1-5-1-2
b. AN1-3-1-14
c. Q6-5-4-1
d. R3-1-1-9

Figure 38. Selected modified chunks.

a. AN1-3-1-14
b. 0-0-94-57
c. 0-0-94-121
d. 0-0-94-85

Appendix F

Projectile Point Measurements

Appendix F. Projectile Point Measurements.

Unit	Level	Lot	Spec	Feature	Thickness	Weight	Baseth	Lt	La	Lm	Wm	Wb	Neckw	DSA	PSA	DSA/ PSA	Lalt	WbWm	LtWm	LmLt	Type	Material
0	0	94	2	0	4.9	3.2	3.4	0.0	0.0	0.0	0.0	15.7	13.3	165	124	41	0.00	0.00	0.00	0.00	4	9
0	0	94	13	0	5.5	2.9	4.6	33.2	31.7	10.0	19.6	12.4	9.6	180	100	80	0.95	0.63	3.32	0.30	5	4
0	0	94	17	0	5.5	1.7	4.5	22.9	20.0	0.3	19.3	8.2	0.9	169	112	57	0.88	0.42	0.84	0.01	9	2
0	0	94	54	0	3.5	1.8	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
0	0	94	132	0	7.4	4.6	6.4	39.3	35.5	12.0	19.0	15.4	13.0	241	118	123	0.90	0.81	2.00	0.31	4	4
0	0	94	142	0	4.1	1.6	3.2	26.2	19.2	0.8	20.7	12.9	1.1	165	113	52	0.73	0.62	1.26	0.30	4	2
0	0	94	197	0	7.5	3.2	4.4	30.3	29.2	0.0	0.0	12.3	9.6	152	122	30	0.96	0.00	0.00	0.00	4	4
0	0	94	223	0	3.8	1.4	2.0	0.0	0.0	0.0	21.9	11.9	12.2	165	68	97	0.00	0.55	0.00	0.00	5	4
0	0	94	229	0	6.7	7.5	3.8	0.0	0.0	0.0	17.8	13.8	0.0	0	0	0	0.00	0.77	0.00	0.00	6	9
0	0	94	232	0	5.1	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
0	0	94	257	0	7.2	5.7	6.7	36.5	25.6	10.9	21.2	17.8	16.0	0	0	0	0.70	0.85	1.72	0.30	9	4
0	0	94	259	0	6.3	4.4	3.9	35.1	33.5	35.6	0.0	11.1	12.9	145	85	60	0.95	0.00	0.00	1.00	5	4
0	0	94	260	0	6.2	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
0	0	94	262	0	3.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	2
0	0	94	279	0	6.6	4.4	3.6	40.2	38.3	0.0	15.0	5.5	0.0	0	0	0	1.00	0.70	2.28	0.00	6	4
AA2	1	1	20	27	2.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	9
AD1	1	1	4	30	5.6	2.4	3.9	0.0	0.0	0.0	0.0	13.0	10.7	176	114	62	0.00	0.00	0.00	0.00	4	4
AJ1	5	1	1	0	3.9	1.9	3.1	30.4	25.0	0.5	18.6	10.1	8.9	166	136	30	0.82	0.54	1.60	0.02	4	2
AM1	3	1	3	0	3.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
P1	4	1	3	0	6.7	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	2
P2	1	1	10	10	2.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
Q5	6	1	4	0	4.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
Q6	1	1	7	0	4.1	1.0	3.3	18.1	14.1	0.0	14.2	14.0	0.0	0	0	0	0.00	0.98	0.00	0.00	9	4
Q6	4	1	4	33	5.5	2.4	4.0	0.0	0.0	0.0	0.0	0.0	9.6	0	110	0	0.00	0.00	0.00	0.00	4	9
Q6	6	1	12	0	5.7	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
Q6	4	5	1	33	4.8	3.0	3.7	36.7	34.9	6.2	25.0	12.6	11.6	172	118	54	0.95	0.50	1.46	0.16	4	4
Q7	4	1	8	0	4.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
Q8	3	1	6	11	7.2	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
S2	5	1	1	0	3.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	7	2
T2	4	1	1	0	4.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	2
V4	1	1	9	17	6.2	4.4	5.1	30.7	27.1	0.0	5.1	5.1	0.0	0	0	0	0.00	1.00	0.00	0.00	10	4
Q7	1	1	2	11	6.1	2.2	3.5	0.0	26.2	0.0	0.0	14.5	10.2	145	119	26	0.00	0.00	0.00	0.00	4	4
R1	1	1	6	0	5.8	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4
X2	1	1	5	22	5.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0.00	0.00	0.00	0.00	10	4

Type Key: 4=Elko Series; 5=Gatecliff Series; 6=Humboldt Series; 7=Large Side-notch Series; 9=Out of Key; 10=Fragment
Material Key: 2=Obsidian; 4=Tosawihi Opalite; 9=Exotic Chert.

Measurement abbreviations follow Thomas (1981).

Appendix G

Macrofossil Analysis

Botanical Analysis of Flotation Samples from Site 26Ek5040, near Tosawihi Quarries

Nancy A. Stenholm

Introduction

The study of vegetable materials found in archaeological matrices, termed archaeobotany or paleoethnobotany, provides valuable information about the resource base of peoples inhabiting a site. Botanical material, with lithic and faunal data, gives archaeologists means to infer patterns of subsistence, to interpret site features, and to suggest seasonality or site function.

Methods

Although vegetable materials utilized by prehistoric people decay rapidly, evidence of plant gathering preparation and use is often preserved as charred, microscopically identifiable particles contained in soil samples. Because these materials are seldom recovered *in situ* or during routine screening, general processing procedures for botanical samples are different from those used for faunal material and lithics. Methods used for recovery of charred plant remains from 26EK5040 are described in Chapter 2 of the site report.

Identification of floated residues is done with the aid of a zoom binocular microscope with continuous magnification to 150 x. Weights are taken in milligrams rounded to the nearest hundredth of a gram. Tabulation and recording are made on the botanical scan sheet. A primary distinction is made between charred (or semi-charred) material and non-charred material since the carbonized material resists decay for considerable periods of time. The non-charred material is more likely to represent recent materials incorporated into the sample matrix through bioturbation. The uncharred floral material is identified and noted.

Microscopic analysis begins with manual separation of charred and semi-charred botanical materials from all other materials in the subsample. Both groups are weighed, and the amount of archaeobotanical charcoal is recorded. This figure aids in estimating the total carbon or the total uncarbonized flora in the sample (the "carbon/uncarbonized flora percentage or carbon/flora content"). A check of the float sample may confirm the possibility through presence of insect parts, modern flora or rodent remains.

Analysis proceeds with identification of carbonized material to taxa. The material is divided into woody material, seeds, surface and subsurface fruit, root, and stem tissue, and dissociated tissue types. For the most part, family and genus identifications can be made from wood and seeds, some bark and certain portions of stem tissue (including bud, flower, leaf, and fruit fragments). For instance, conifer needles preserve well, and they are relatively easy to identify compared with the more fragile leaves of hardwood species. Species identification is more difficult. Tissues rarely can be identified taxonomically, but the distinction of general tissue types can be important in assessing preservation factors as well as presence of processing and technological activities. Presence of fibers and bark tissues, for instance, may indicate cordage production. Seed coat fragments may indicate fruit or seed processing associated with grinding or pounding. Other tissues may be remnants from processing soft parts of foods and medicines. Such dissociated tissues can be divided into groups. A glassy or shiny material may represent plant saps, juices, or resins. It is amorphous black or dark brown material with bubble or steam cavities. When it is found with wood cells it is most likely to be wood pitch or conifer resin. When it is

associated with other softer tissue types, such as starchy parenchymoid or fruity epithelioid tissues, it may processed edible tissue (PET). At the moment, the PET category is divided into two groups: tissue which resembles sugar-laden fruit or berry tissue with (PET fruity) or without the seeds (PET other); and, tissue with starchy storage cells (PET starchy), likely from edible roots.

Analysis of a flotation sample ends after the remainder of the light fraction and all of the heavy fraction have been scanned for diagnostic pieces of charcoal, lithics, bone, shell, and other cultural material. Diagnostic floral material is added to the data sheet and its presence in the flot is registered as a trace (less than 0.01 g). Lithics, bone, and shell are weighed and they may be counted as well. The presence of burned earth, pigment, and historic materials is noted. Modern rodent, insect, and plant remains are kept in order to determine species active in the environment influencing bioturbation. Ancient bioturbation is indicated by charred insect dissemules.

The Study

This report concerns 10 flotation samples (which are derived from 5 archaeological features) from 26Ek5040 , a site adjacent to Tosawihi Quarries. Table 1 shows the flotation samples by weight, volume, carbon content in grams, and as percentages of the sample weight. The flotation samples produced 10 plant taxa from 2 g of archaeobotanical materials extracted from approximately 27.5 kg of site matrix (cf. Table 1). The botanical array is shown in Table 2.

Table 1. Flotation Sample Summary Weight, Volume, and Carbon Content including Carbon Content, Lithic Flakes, and Bone.

Feature Number	Catalog Number	Weight g	Carbon g	Carbon C%	Lithics #	Lithics g	Bone g
33	Q5-2.3.3	604	0.50	0.08%	55	1.6	0.00
34	AM2-1.1.1	3600	0.02	<0.01%	254	11.9*	0.00
34	AM2-1.1.2	3200	0.12	<0.01%	169	8.0*	0.01
34	AM1-3.3.1	3200	0.04	<0.01%	227	13.7	0.00
34	AM1-3.4.1	3000	0.02	<0.01%	164	9.9*	0.00
34	AM1-3.5.1**	2200	0.37	0.02%	131	2.3*	0.00
39	AN1-1.2.1	2800	0.04	<0.01%	704	41.2*	0.09
39	AN1-3.2.1	2200	0.05	<0.01%	3000	373.2*	0.00
40	MS7A-1.2.1	3000	0.77	0.03%	162	13.9*	0.03
41	MS7B-1.1.1	3600	0.01	<0.01%	167	31.4*	0.00
Total		27404	1.94	>0.13%	5033	507.1	0.13

* one to two obsidian flakes present
** sample sorted by Intermountain Research

All flotation samples contained scanty charcoal; several were pre-sorted to collect radiocarbon samples.

All samples have large arrays of CCS flakes and chunks. Most are white, and some appear heat-treated. Obsidian flakes (N=14) appear in all Features but Feature 33.

Unburned bone appears in two samples, and calcined bone appears in Feature 40.

All flotation samples have insect dissemules (mostly ant and beetle parts); and, all contained modern uncharred floral material (such as, wood, leaf tissue, monocot and herbaceous stem tissues, seeds). Three contained ancient charred insect dissemules.

The Tosawihi archaeobotanical array is shown below.

Table 2. The Botanical Assemblage of site 26Ek5040 by Flotation Weight (g) and Number of Appearances (#).

	Feat 33 (N=1)		Feat 34 (N=5)		Feat 39 (N=2)		Feat 40 (N=1)		Feat 41 (N=1)		Total (N=10)	
	g	#	g	#	g	#	g	#	g	#	g	#
Hardwood (99%)												
Sage	0.03	1	<0.01	4	<0.01	2	0.01	1			0.04	8
Other wood			<0.01	1	<0.01	1					<0.01	2
Other Tissue (1%)												
Seeds, 13	<0.01	1	<0.01	3	<0.01	1					<0.01	5
Grass	<0.01	1	<0.01	3	<0.01	1	<0.01	1			<0.01	6
Monocot stem			<0.01	1					<0.01	1	<0.01	2
Herbaceous stem			<0.01	2					<0.01	1	<0.01	3
Root			<0.01	2	<0.01	1	<0.01	1	<0.01	1	<0.01	5
Paryenchymoid			<0.01	1							<0.01	1
Epithelioid			<0.01	2							<0.01	2
Total	0.03		<0.01		<0.01		0.01		<0.01		0.04	34

Hardwood

Hardwoods contribute 99 percent of the assemblage weight. Two hardwood species are represented: sagebrushbrush (*Artemisia* sp.), and an hardwood which cannot further identified. A little sagebrush appears in 80 percent of the samples, and it is clearly the most important taxon at the site.

Other Tissue

Grass stem tissue is second most important plant at the site. Six flots have a grass tissue. In addition, some of the monocot tissue may be grass tissue. Several samples have herbaceous root and stem tissue from basal area of plants. Two samples contained three tiny charred lily family bulbs, approximately 5 to 7 mm tall, and 3 mm in diameter. This suggests floral burning in place, as might be the case under wildfire conditions.

Seeds

The flotation array contains at least 14 seeds from two features (Feature 34 and Feature 39). There are at least 5 goosefoot or chenopodium (*Chenopodium* spp.) seeds present (Table 3). Two species are represented: a larger one, approximately 1.3 mm in diameter with slightly rugulose surface coat; and, a smaller one, 0.9 mm in diameter with a oval to compressed oval outline. Both appear without adherent chaffy coat (the pericarp)--an important diagnostic trait. The two most likely candidates are Fremont' goosefoot (*C. fremontii*) for the first, and linear-leafed goosefoot (*C. leptophyllum*) for the last.

The array has two plantago (*Plantago* sp.) seeds, a large bunchgrass seed (*Festuca/Agropyron* sp. likely), two grass seeds which could not be further identified, a chickweed (*Stellaria* sp.) seed, a tiny legume seed (locoweed, *Astragalus* probably), and portions of two seed coats from two other plant taxa.

Table 3. Seed Identifications.

	Feature 34			Feature 39	Total
	upper fill	middle fill	lower fill		
Goosefoot (*Chenopodium* spp.)			5		5
Plantago (*Plantago* sp.)	1		1		2
Bunchgrass (*Agropyron/Festuca* sp.)	1				1
Grass seeds			1	1	2
Chickweed (*Stellaria* sp.)	1				1
Locoweed (*Astragalus* sp.)			1		1
Unidentified seeds			2		2
Totals	3	0	10	1	14

The array has two seeds which may be considered edible: the seeds of large bunch grass (wheatgrass, *Festuca* and *Agropyron* sp.), and the larger of the two chenopods species.

Fowler mentions that wheatgrass was collected by the northern Paiute (1986:76). Ray lists bunchgrass among food and fiber plants gathered by the Modoc (1963: 218-219), although he does not mention these particular genera by name. This is understandable because these genera are hard to distinguish on the basis of incomplete seeds.

Chenopodium seeds are common in central Nevada flora. Since some chenopodium species are weedy and prefer disturbed habitats, fresh seeds from plants blown into the site could be charred accidentally. In this case, the charring may be accidental. Four seeds is not enough to posit deliberate collection.

Summary

The feature samples from 26Ek5040 have a low taxal diversity and exceedingly low carbon content (the latter is affected by pre-sorting for radiocarbon assay). At least one woody fuel (sagebrush) is present in nearly every sample. This may be associated with lithic heat-treatment, cooking, casual warming, or brushfires.

There not much in the array that could be considered edible in faunal or floral categories. There is very little burned or calcined bone present. Two seeds (bunch grass and chenopod) that could be considered edible may be intrusive. The lily family roots, are too small to be considered objects of deliberate collection.

The seeds indicate fires at the site occured in summer.

Sample Analysis

A description of each sample follows, and comments are added where appropriate. The samples are uniformly 99% sagebrush with traces of seeds and other tissues present. Identifiable seeds were recovered from only two features, all but one derived from Feature 34 (interpreted during excavation as a small pit hearth, see Chapter 3, this volume).

Feature 33

A single flotation sample (Q5-2.3.3.) produced 0.5 g of archaeobotanical materials from matrix for a carbon content of 0.08% The archaeobotanical array is 100% sagebrush by weight. The sample shows

signs of moderate modern bioturbation. Charcoal was removed from the sample for a radiocarbon dating. The carbon content is under-represented in this flot, again it was pre-sorted for radiocarbon assay.

Feature 34

There are five samples from this feature which weighed 15.2 kg. The samples contained 0.57 g of charred material, for a very low carbon content of 0.0004% (mostly removed by hand). Most samples are replete with modern rootlets, insect, and floral dissemules, and bioturbation is severe.

The feature is associated with a date of 850±200 BP.

Upper Feature Fill

A flotation sample from the first 5 cm of the feature fill matrix (AM2-1.1.1.) also contained little charcoal. There are three taxa represented: sagebrush, another hardwood which could not be identified, and a grass caryopsis (*Agropyron/Festuca* sp.).

Past and present bioturbation is heavy, and it includes burned and unburned insect dissemules, sagebrush wood, unburned grass, and several fresh weed seeds.

A second sample from the top of the feature (AM2-1.1.2) had little charcoal. At least five taxa were identified. The sample contains sagebrush, a plantago seed, a chickweed seed, two tiny lily family roots, as well as herbaceous stem tissue and monocot stem and rhizomes.

Moderately heavy bioturbation is indicated by charred and uncharred insect dissemules, grass, modern uncharred seeds, and a few bits of uncharred bone which are likely from a small mammal or rodent.

Middle Feature Fill

The feature sample (AM1-3.3.1) from Level 3, had 0.04 g of charred materials pulled by hand, for a charcoal content of 0.001%. Grass stem was identified. Moderate bioturbation is indicated by modern insect and floral dissemules.

Another sample also from feature fill (AM1-3.4.1) has less charcoal than the sample above, 0.02 gram s of charcoal. Charcoal for dating has been removed so that its frequency is underestimated. The sample has traces of sagebrush and herbaceous stem tissue. Moderate bioturbation is indicated by modern floral and insect dissemules.

Lower Feature Fill

This sample (AM1-3.5.1.) was sorted before arrival, and charcoal has been removed for dating. Approximately 0.37 g was recovered. This is a high amount for the site. There are a minimum of 7 taxa present for an excellent taxal yield of 3.2.

Plants present include sagebrush, grass stem tissue, a grass seed which cannot be further identified (it is not Ag/Fe), a small lily family root (same as the two above), a plantain seed, a partial legume

seed (locoweed, probably *Astragalus* sp.), a minimum of four large chenopod seeds (two coats, and two embryos), a second small chenopod seed, two partial seeds fragments which cannot be further identified, and traces of paryenchymoid and epitheloid tissues. Bioturbation is moderately low.

The sample looks as if most of the charred material is charred local floral material which may have been incorporated in the feature by accident. All the seeds are weedy, and the edible seeds (larger chenopods) are not present in sufficient numbers to indicate consumption.

Feature 39

A sample from the top of the feature (An1-1.2.1) with 0.04 g of pulled charcoal for a content of 0.001%. The sample has traces of sagebrush twigs, other hardwood, and grass stem, a grass seed, and rhizome tissue.

There is unburned bone, including fragments of tiny rodent (?) vertebrae. Evidence of bioturbation is heavy and consists of modern insect and floral dissemules.

Sample An1-3.2.1., has 0.04 g of charcoal; sagebrush is present.

Feature 40

The flotation sample from this feature (MS7A-1.2.1) has an estimated charcoal content of 0.03% from a standard subsample. The material is 99% sagebrush by weight, with a trace of herbaceous stem and grass tissue. Bioturbation is moderate.

Feature 41

Sample MS7B-1.1.1 has 0.01 g of charred material. Monocot (some may be grass) tissue and herbaceous stem and root tissue are present. Bioturbation is moderate.

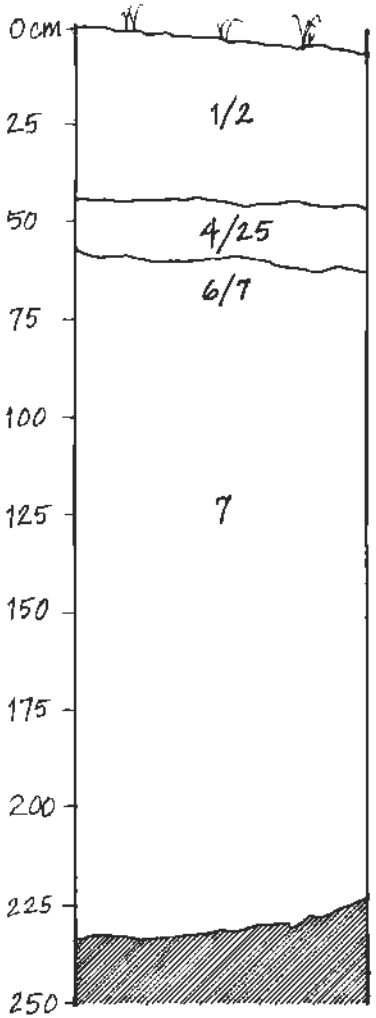
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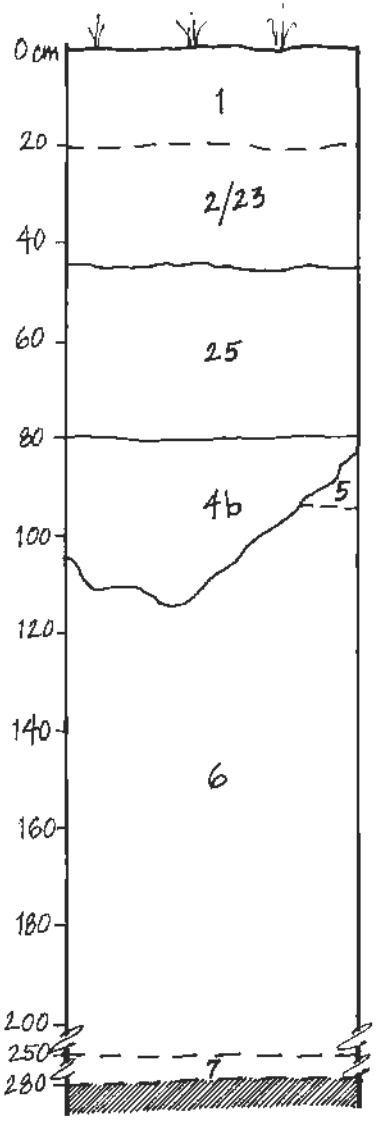
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1963 *Primitive Pragmatists: The Modoc Indians of Northern California*. Seattle: University of Washington Press.

Appendix H

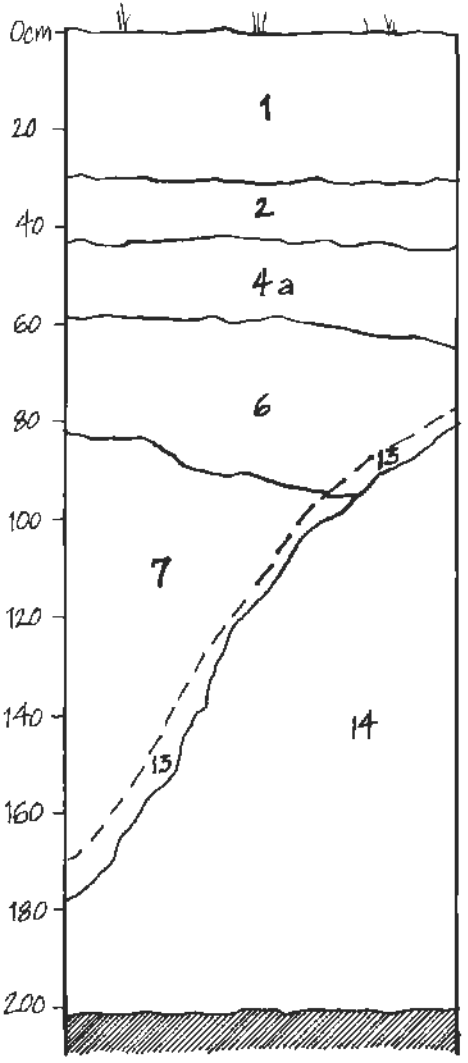
Stratigraphic Profiles



a. Trench A, north wall.



b. Trench B, north wall.



c. Trench c, north wall.

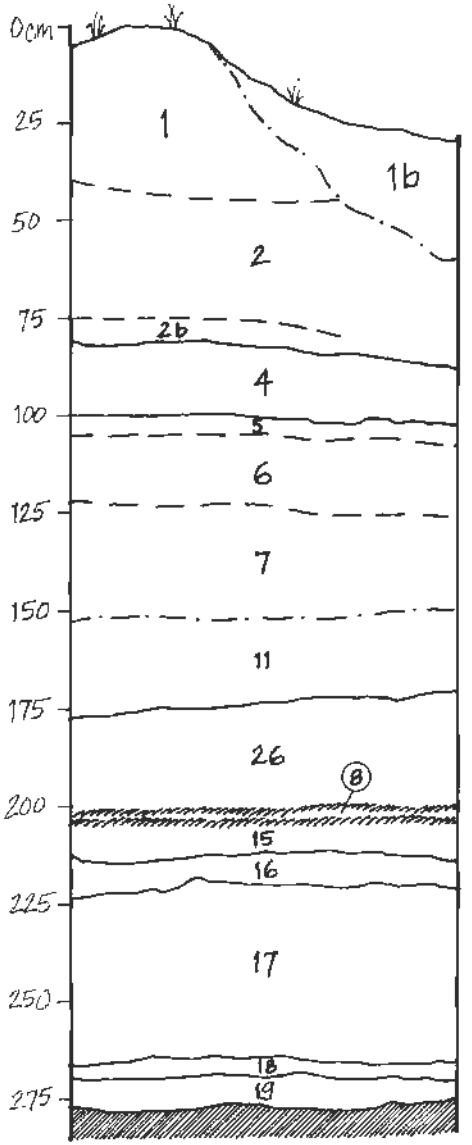
Legend

- - - soil horizon boundary

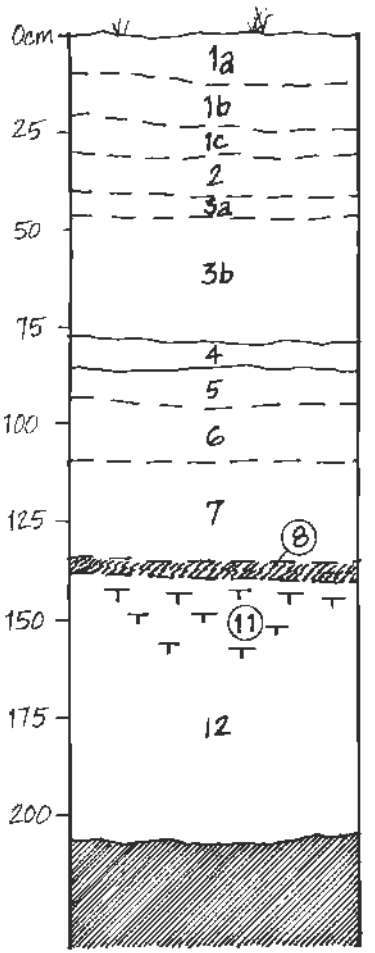
—— depositional or erosional contact

4a numbers refer to soil descriptions found in Table 2

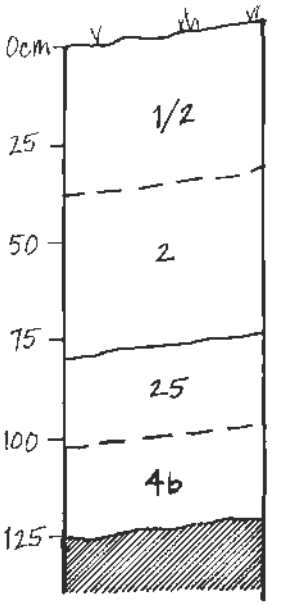
Figure H.1. Selected trench profiles.



a. Trench D, northwest wall.



b. Trench E, north wall.

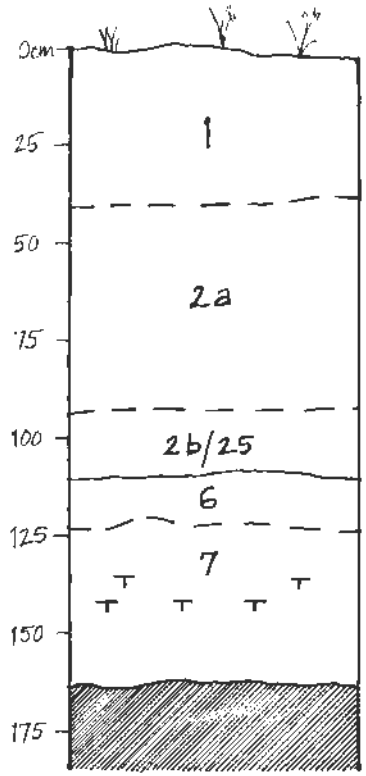


c. Trench G, south wall.

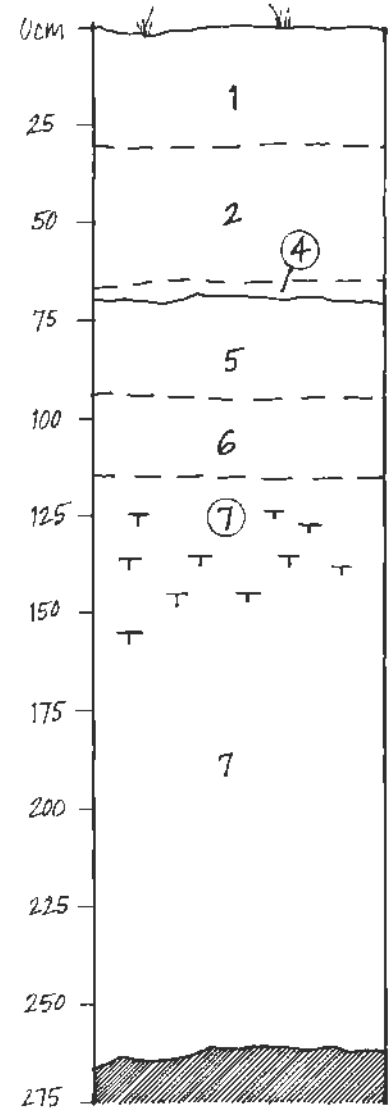
Legend

- soil horizon boundary
- depositional or erosional contact
- opalite flake
- soil carbonates
- krotovina
- rock
- 3b numbers refer to soil descriptions found in Table 2

Figure H.2. Selected trench profiles.



a. Trench H, north wall.

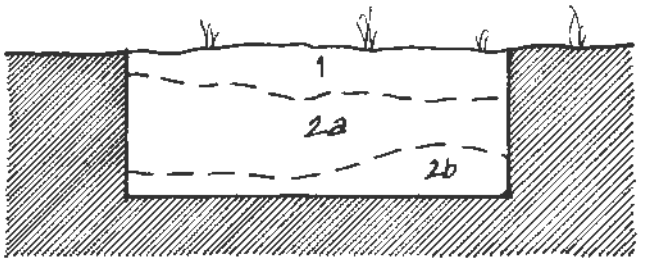


b. Trench I, north wall.

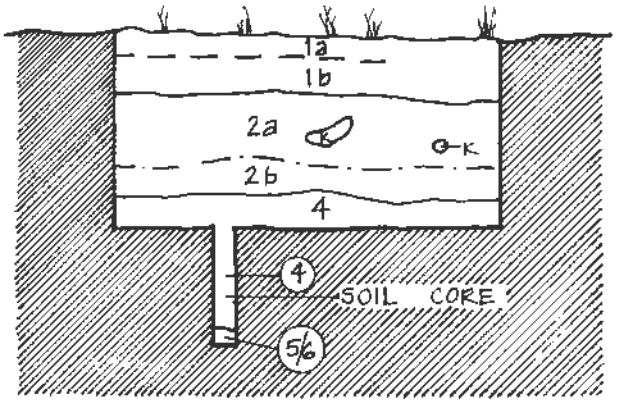
Legend

- – – soil horizon boundary
- —— depositional or erosional contact
- ⊤ ⊤ soil carbonates
- 2a numbers refer to soil descriptions found in Table 2

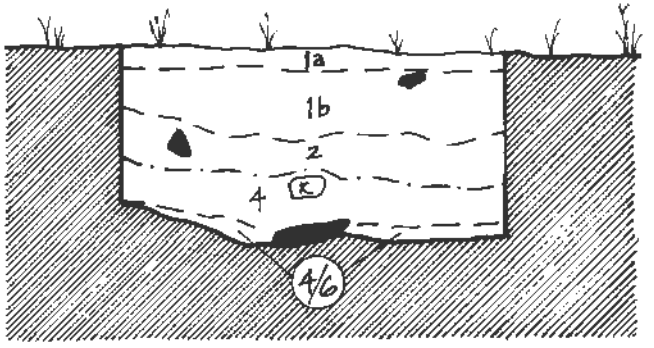
Figure H.3. Selected trench profiles.



a. J3, east wall.



b. N3, east wall.



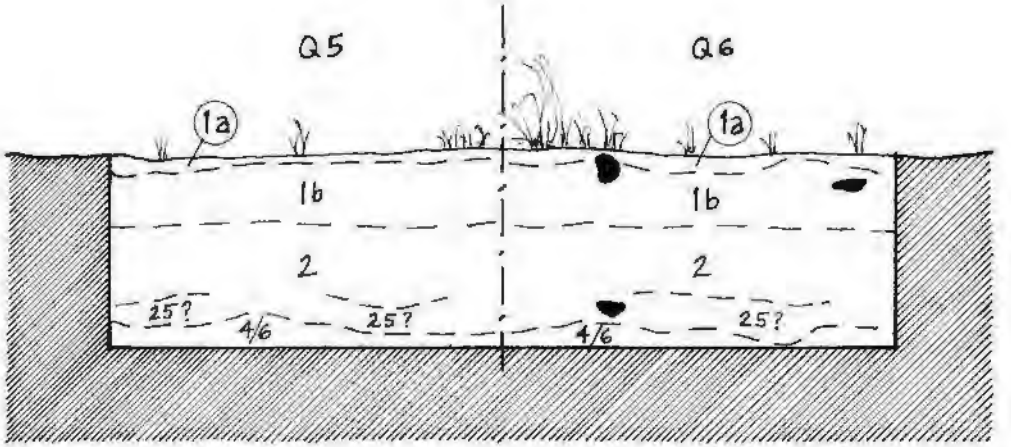
c. P1, south wall.

Legend

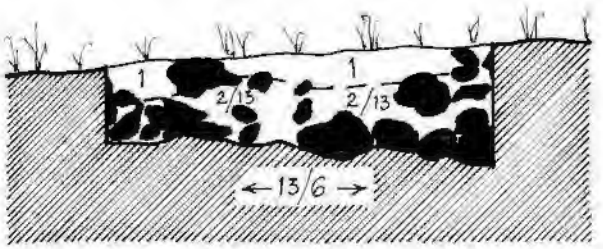
- soil horizon boundary
- depositional or erosional contact
- opalite flake
- soil carbonates
- K krotovina
- rock
- 2a numbers refer to soil descriptions found in Table 2

0 25 50 75 100
centimeters

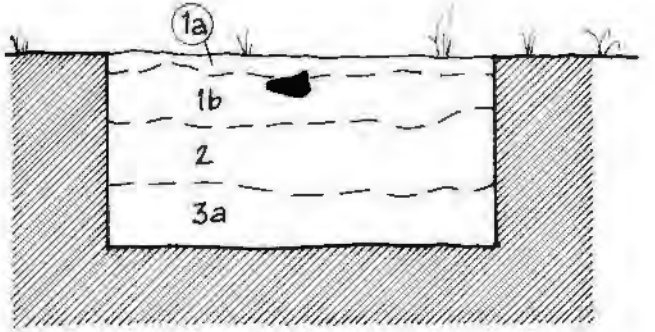
Figure H.4. Unit profiles.



a. Q5, Q6, north wall.



b. R2, east wall.



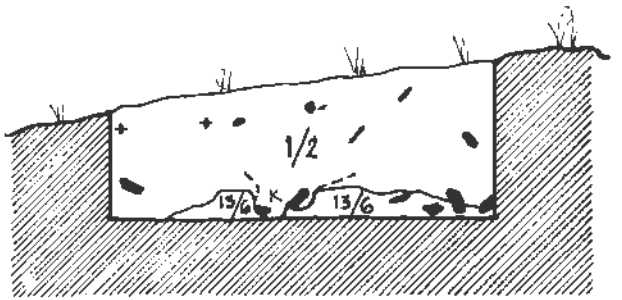
c. S2, north wall.

Legend

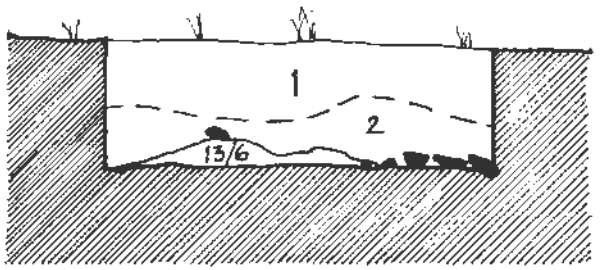
- soil horizon boundary
- depositional or erosional contact
- opalite flake
- soil carbonates
- krotovina
- rock
- 3a numbers refer to soil descriptions found in Table 2

0 25 50 75 100
centimeters

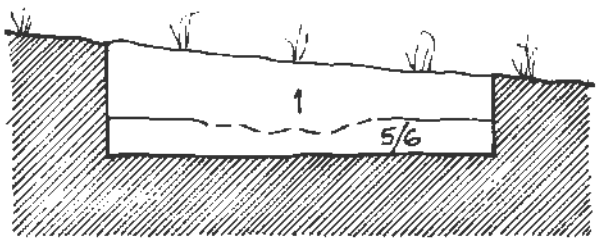
Figure H.5. Unit profiles.



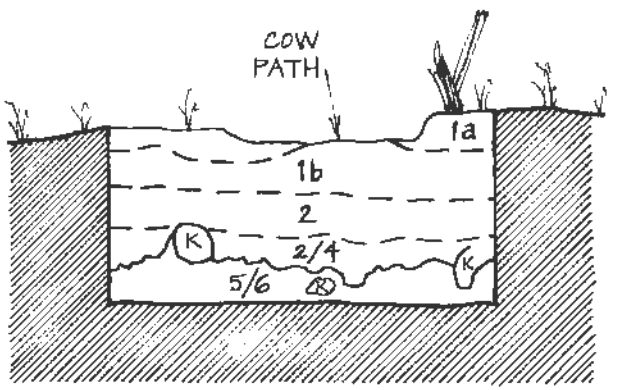
a. T2, east wall.



b. V2, north wall.



c. X1, east wall.



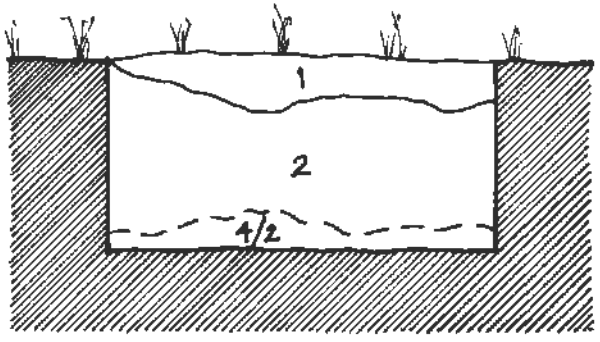
d. Y1, west wall.

Legend

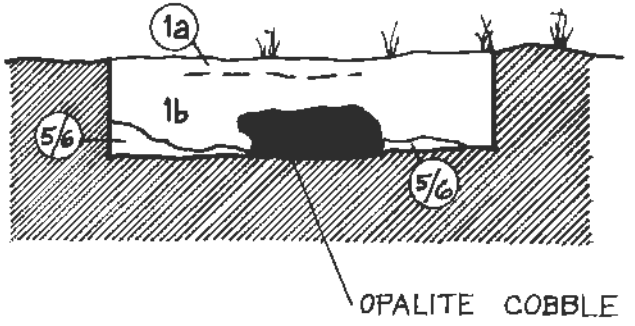
- soil horizon boundary
- depositional or erosional contact
- \+ opalite flake
- soil carbonates
- (K) krotovina
- rock
- 5/6 numbers refer to soil descriptions found in Table 2

0 25 50 75 100
centimeters

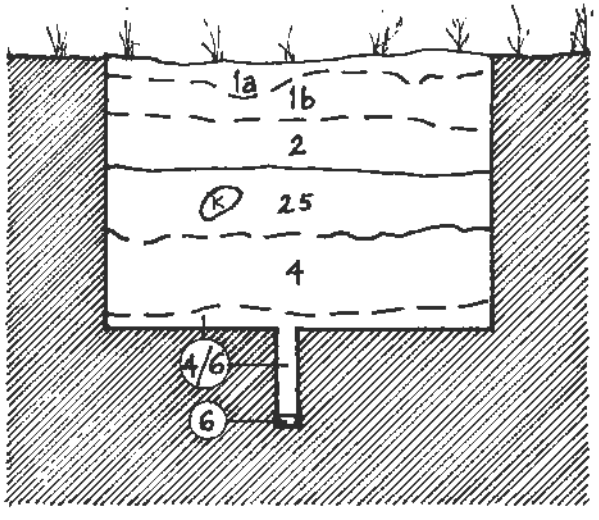
Figure H.6. Unit profiles.



a. AE2, west wall.

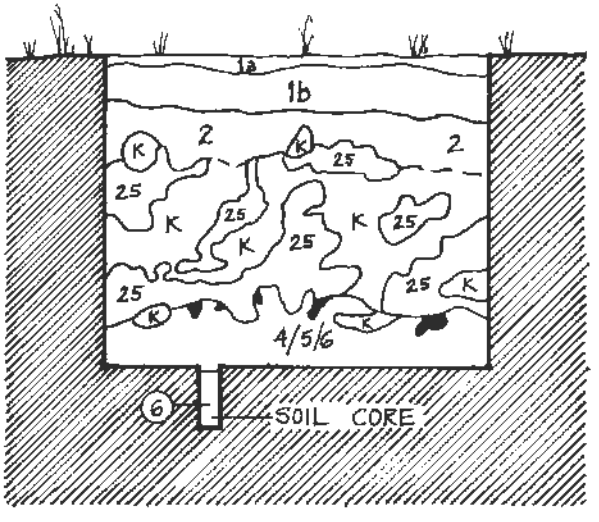


b. AF1, north wall.



c. AG1, west wall.



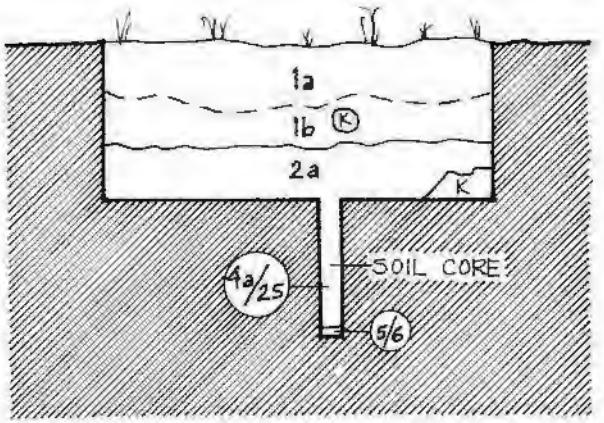


d. AH2, east wall.

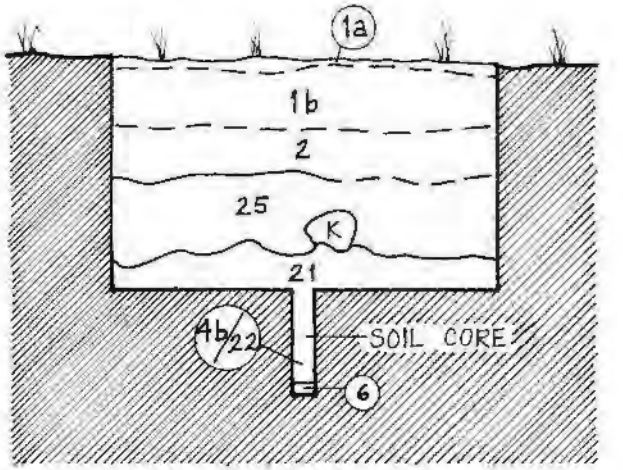
Figure H.7. Unit profiles.

Legend

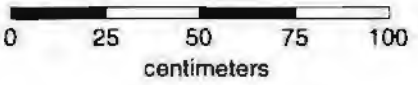
- soil horizon boundary
- depositional or erosional contact
- \+ opalite flake
- soil carbonates
- (K) krotovina
- rock
- 1b numbers refer to soil descriptions found in Table 2



a. AI1, east wall.



b. AJ1, north wall.



Legend

- soil horizon boundary
- depositional or erosional contact
- \+ opalite flake
- soil carbonates
- K krotovina
- rock
- 2 a numbers refer to soil descriptions found in Table 2

Figure H.8. Unit profiles.

Appendix I

Soil Core Stratigraphy

Soil Core Stratigraphy at 26Ek5040

Soil Core	Depth (BS)	Stratum
SC-1	0-30 cm	1
	30-45	25
	45-70	24/4b
	70-105	21
	105-110	21/5
	110-125	5
	125-135 TD	6
SC-2	0-30 cm	1
	30-70	2/4/23/5/6? (bioturbated)
	70-76 TD	7?
SC-3	0-25 cm	1
	25-40	2/23
	40-55	25?/24
	55-85 TD	5
SC-4	0-25 cm	1
	25-37 TD	5
SC-5	0-20 cm	1
	25-35	2a
	35-45	3a
	45-65	3b
	65-70	4a
	70-80 TD	5
SC-6	0-30 cm	1
	30-40	2
	40-53	25
	53-62	4a
	62-66	5
	66-77 TD	6
SC-7	0-10 cm	1
	10-30	2
	30-38	25
	38-65	5/6/7
	65-68	tuff clast
	68-71	6/7
	71-73	tuff clast
	73-90 TD	7

SC-8	0-23 cm	1
	23-30	2
	30-52	23
	52-60	25?
	60-63	24
	63-69	21
	69-72 TD	5
SC-9	0-8 cm	1
	08-29	2
	29-46	25
	46-51	24
	51-68	21
	68-73 TD	5/6
SC-10	0-24 cm	1
	24-38	2(1c)
	38-50	3a/3b
	50-65	4b
	65-73 TD	5/6
SC-11	0-22 cm	1
	22-40	2
	40-50	3b?
	50-60	4b?
	60-65	5/6
	65-86 TD	7?
SC-12	0-20 cm	1/2a
	20-41	2b
	41-45	5/6
	45-59 TD	7
SC-13	0-36 cm	1
	36-60	2
	60-76	25?
	76-90	4a
	90-105 TD	6/7
SC-14	0-28 cm	1
	28-50	2
	50-65 TD	23?
SC-15	0-27 cm	1
	27-38	2
	38-136	25
	136-142 TD	6
SC-16	0-29 cm	1
	29-35	2
	35-68	25
	68-74 TD	4a?/25

SC-17	0-28 cm	1
	28-40	2
	40-75	4a/25
	75-80	4
	80-85 TD	6
SC-18	0-25 cm	1/2
	25-30	2/4b
	30-32 TD	6
SC-19	0-20 cm	1
	20-45	2
	45-60	23
	60-65	4a/25
	65-80 TD	6
SC-20	0-20 cm	1/2
	20-35 TD	6

Appendix J

Technological Debitage Data

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
0	0	94	8	OB	0	0	0	3	0
0	0	94	21	OB	0	0	0	0	0
0	0	94	28	OB	0	3	0	0	0
0	0	94	35	OB	0	0	0	0	3
0	0	94	43	OB	0	0	3	0	0
0	0	94	63	OB	0	0	0	0	0
0	0	94	68	OB	0	0	0	0	0
0	0	94	83	OB	3	0	0	0	0
0	0	94	93	OB	0	0	3	0	0
0	0	94	141	OB	3	0	0	0	0
0	0	94	143	OB	0	0	0	3	0
0	0	94	144	OB	0	0	0	0	0
0	0	94	145	OB	0	3	0	0	0
0	0	94	146	OB	3	0	0	0	0
0	0	94	148	OB	0	0	0	0	0
0	0	94	149	OB	0	0	0	0	0
0	0	94	151	OB	0	0	0	0	0
0	0	94	152	OB	0	0	0	0	0
0	0	94	156	OB	0	0	0	0	0
0	0	94	157	OB	0	0	0	0	3
0	0	94	164	OB	3	0	0	0	0
0	0	94	166	OB	0	0	0	0	0
0	0	94	186	OB	0	0	0	0	0
0	0	94	231	OB	0	0	0	0	3
0	0	94	233	OB	0	0	0	0	0
0	0	94	243	OB	3	0	0	0	0
0	0	94	244	OB	3	0	0	0	0
0	0	94	245	OB	0	0	0	0	0
0	0	94	246	OB	3	0	0	0	0
0	0	94	247	OB	0	0	0	0	0
0	0	94	249	OB	0	0	0	3	0
0	0	94	250	OB	0	0	0	0	0
0	0	94	258	OB	0	0	0	0	0
3	1	1	3	EX	0	0	0	3	0
3	1	1	4	BA	0	0	0	0	0
AA1	1	1	1	OP	1	2	2	1	1
AA1	1	1	2	CT	1	1	2	1	0
AA2	1	1	2	OP	0	1	3	2	1
AA2	1	1	3	CT	0	0	0	0	1
AA2	1	1	4	BA	0	0	0	0	0
AB1	1	1	1	OP	0	1	3	1	1
AB1	1	1	2	CT	0	0	0	0	0
AB1	1	1	3	BA	0	0	0	0	0
AB1	1	1	4	OB	0	0	0	0	3
AB2	1	1	1	OP	0	2	2	1	0
AB2	1	1	2	CT	0	0	0	0	1
AC1	1	1	1	OP	0	1	1	1	1
AC1	1	1	2	BA	3	0	0	0	0
AC2	1	1	1	OP	0	1	1	2	2
AC2	1	1	2	BA	3	0	0	0	0

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
AD1	1	1	1	OP	0	2	3	2	1
AD1	1	1	2	CT	0	0	1	0	1
AD1	1	1	3	OB	0	0	0	0	3
AD2	1	1	1	OP	0	2	3	2	1
AD2	1	1	2	CT	2	0	0	0	1
AD2	1	1	3	BA	0	0	0	0	0
AD2	1	1	4	OB	0	0	0	0	3
AD3	1	1	1	OP	1	1	2	2	1
AD3	1	1	2	CT	1	1	1	0	1
AD3	1	1	3	BA	0	3	0	0	0
AD3	1	1	4	OB	0	0	0	2	2
AE1	1	1	1	OP	0	1	3	1	1
AE1	1	1	2	CT	0	0	0	0	0
AE2	1	1	1	OP	0	1	3	1	1
AE2	2	1	1	OP	0	1	3	1	1
AE2	3	1	1	OP	0	1	3	2	2
AE2	4	1	1	OP	0	1	2	3	2
AE2	5	1	1	OP	0	0	0	0	0
AE2	5	1	2	CT	0	0	3	0	0
AE2	6	1	1	OP	0	0	0	3	1
AE3	1	1	1	OP	0	1	3	1	1
AF	4	1	1	OP	0	0	0	2	0
AF1	1	1	1	OP	0	0	2	2	0
AF1	2	1	1	OP	0	0	2	3	0
AF1	3	1	1	OP	0	0	2	3	0
AF1	3	1	2	CT	0	0	3	0	0
AF2	1	1	1	OP	0	0	2	2	0
AF3	1	1	1	OP	0	0	0	2	0
AF3	1	1	2	CT	0	0	0	0	0
AG1	1	1	1	OP	0	1	1	1	0
AG1	1	1	2	CT	0	1	0	0	0
AG1	2	1	2	OP	0	1	1	2	2
AG1	2	1	3	CT	0	2	0	1	0
AG1	3	1	1	OP	0	1	2	3	2
AG1	3	1	2	CT	0	1	0	0	0
AG1	3	1	3	BA	0	0	0	0	0
AG1	4	1	1	OB	0	0	0	0	0
AG1	4	1	2	OB	0	0	0	0	3
AG1	4	1	3	OP	0	1	3	2	1
AG1	4	1	4	CT	0	0	0	0	1
AG1	4	1	5	BA	0	0	0	0	0
AG1	5	1	1	OP	0	1	3	2	1
AG1	5	1	2	CT	0	0	0	0	3
AG1	5	1	3	BA	0	0	0	0	0
AG1	6	1	1	OP	0	0	2	2	1
AG1	6	1	2	CT	0	0	2	0	0
AG1	7	1	1	OP	0	1	3	2	1
AG1	8	1	1	OP	0	0	0	0	0
AG1	8	1	2	CT	0	0	0	0	3
AG2	1	1	1	OP	0	0	0	1	1

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
AH1	1	1	1	OP	0	1	1	2	0
AH1	1	1	2	CT	0	0	0	0	0
AH2	1	1	1	OP	0	2	2	2	0
AH2	2	1	1	OP	0	0	1	3	0
AH2	2	1	1	OB	0	0	0	0	3
AH2	2	1	2	CT	0	0	0	0	0
AH2	3	1	1	OP	0	2	3	1	0
AH2	3	1	2	CT	0	2	0	0	0
AH2	4	1	1	OP	1	3	1	1	0
AH2	4	1	2	CT	0	0	0	0	0
AH2	5	1	1	OP	0	0	2	0	0
AH2	6	1	1	OP	0	2	2	2	1
AH2	6	1	2	BA	0	0	0	0	0
AH2	6	1	3	CT	0	0	0	0	0
AH2	7	1	1	OP	0	1	0	2	0
AH2	7	1	2	BA	0	0	0	0	0
AH2	7	1	3	CT	0	2	0	0	0
AH2	7	2	1	OP	0	0	1	0	0
AH2	7	2	2	CT	0	1	1	1	0
AH2	8	1	1	OP	0	1	3	1	0
AH2	9	1	1	OP	0	1	2	2	0
AH2	10	1	1	OP	0	1	2	1	1
AH2	10	1	2	CT	1	0	0	0	0
AI1	1	1	1	OP	0	0	0	0	0
AI1	1	1	2	CT	0	0	0	0	0
AI1	2	1	1	OP	0	1	0	3	0
AI1	3	1	1	OP	0	1	1	3	0
AI1	4	1	1	OP	0	0	0	3	0
AI1	5	1	1	OP	0	1	0	1	0
AJ1	1	1	1	OP	0	1	2	1	0
AJ1	2	1	1	OP	0	1	1	2	0
AJ1	3	1	1	OP	0	1	2	3	1
AJ1	3	1	2	CT	0	0	0	0	0
AJ1	4	1	1	OB	0	3	0	0	0
AJ1	4	1	2	OP	0	0	1	3	0
AJ1	4	1	3	CT	0	0	0	0	0
AJ1	5	1	2	OB	0	0	0	0	0
AJ1	5	1	3	OP	0	0	1	3	1
AJ1	5	1	4	CT	1	1	0	0	0
AJ1	6	1	1	OP	0	1	3	2	0
AJ1	7	1	1	OP	0	2	0	1	0
AJ1	7	1	2	CT	0	2	0	0	0
AK1	1	1	1	OP	0	1	1	0	0
AK1	2	1	1	OP	0	0	2	2	1
AK1	3	1	1	OP	0	1	3	2	2
AL1	1	1	1	OP	0	1	1	1	1
AL1	1	1	2	CT	0	0	1	0	0
AL1	2	1	1	OP	0	0	1	3	1
AL1	2	1	3	CT	0	0	1	0	0
AL1	3	1	1	OP	0	0	1	3	1

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
AL1	3	1	3	CT	0	0	3	0	0
AL1	4	1	1	OP	0	1	2	3	2
AL1	4	1	1	OB	0	0	0	0	0
AL1	4	1	2	OB	0	0	0	0	3
AL1	4	1	5	CT	1	1	0	0	0
AL1	5	1	1	OP	2	2	2	1	1
AL1	5	1	2	CT	0	0	0	0	0
AL1	6	1	1	OP	0	1	1	3	1
AL1	6	1	2	CT	0	2	0	0	0
AL1	7	1	1	OP	1	1	1	3	1
AL1	7	1	4	CT	0	0	0	1	0
AL1	8	1	1	OB	0	0	0	0	3
AL1	8	1	2	OP	0	2	1	3	0
AL1	8	1	4	CT	0	0	0	0	1
AM1	1	1	1	OP	1	0	2	2	1
AM1	1	1	2	CT	0	2	1	0	0
AM1	2	1	1	OP	0	1	1	1	0
AM1	3	1	1	OP	1	2	2	2	2
AM1	3	1	4	CT	0	2	0	0	0
AM1	3	2	1	OP	0	0	2	1	1
AM1	3	2	2	CT	0	3	0	0	0
AM1	4	1	1	OB	0	0	0	0	0
AM1	4	1	4	CT	2	2	2	0	0
AN1	1	1	1	OP	0	2	3	2	1
AN1	1	1	3	CT	0	1	0	0	3
AN1	1	1	4	OB	0	0	0	0	3
AN1	2	1	1	OP	0	2	3	2	1
AN1	2	1	7	CT	0	1	0	0	0
AN1	3	1	1	OP	1	2	2	3	1
AN1	3	1	17	CT	0	2	2	2	0
AN1	3	1	19	BA	0	0	0	0	0
AN1	3	1	20	OB	0	0	0	0	3
AN1	4	1	1	OB	0	3	0	0	0
AN1	4	1	2	OB	0	0	0	0	3
AN1	4	1	3	OB	0	0	0	0	0
AN1	4	1	4	OP	1	2	2	2	0
AN1	4	1	11	CT	0	0	0	0	3
J1	1	1	1	OP	0	1	3	2	2
J2	1	1	1	OP	0	0	2	1	0
J3	1	1	1	OB	0	0	0	0	3
J3	1	1	2	OP	0	1	0	1	0
J3	2	1	1	OP	0	0	0	3	0
J3	3	1	1	OP	0	0	0	2	1
J3	3	1	2	CT	0	0	0	3	0
J3	4	1	1	OP	0	0	0	2	0
J3	5	1	1	OP	0	1	1	2	0
K1	1	1	1	OB	0	0	3	0	0
K1	1	1	2	OP	0	0	1	1	1
K2	1	1	1	OP	0	0	0	0	0
K3	1	1	1	OP	0	1	2	1	0

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
K3	1	1	2	CT	0	0	0	3	0
L1	1	1	1	OB	0	0	0	0	3
L1	1	1	2	OP	0	1	1	1	2
L1	1	1	3	CT	0	0	0	0	0
L2	1	1	1	OB	0	0	0	3	0
L2	1	1	2	OB	0	0	0	3	0
L2	1	1	3	OP	0	0	0	1	3
L2	1	1	4	CT	1	0	0	0	0
L3	1	1	1	OB	0	0	0	0	3
L3	1	1	2	OP	0	0	2	1	2
L3	1	1	3	CT	0	0	1	0	0
L3	1	1	3	OB	0	0	0	0	3
L4	1	1	2	OP	0	0	1	1	2
L4	1	1	3	CT	3	0	0	0	0
M1	1	1	1	OP	0	2	2	2	0
M2	1	1	1	OP	0	1	2	3	1
MS7A	1	1	1	OB	0	0	0	0	3
MS7A	1	1	2	OP	0	2	2	2	0
MS7A	1	1	3	CT	0	2	0	2	1
MS7B	1	2	1	OP	0	1	2	2	0
MS7B	1	2	2	CT	0	0	0	1	2
MS7B	1	2	3	BA	0	0	0	0	0
N1	1	1	1	OP	1	2	2	1	1
N2	1	1	1	OP	1	2	2	3	1
N3	1	1	1	OP	1	2	2	3	1
N3	2	1	1	OB	0	0	0	3	0
N3	2	1	3	OP	0	2	1	2	0
N3	3	1	1	OP	1	1	2	3	1
N3	4	1	2	CT	0	1	0	0	0
N3	5	1	1	OP	0	1	1	1	1
N3	5	1	2	EX	0	0	0	3	0
N3	6	1	1	OP	0	0	0	2	2
O	0	94	81	OB	0	0	0	0	3
O	0	94	147	OB	3	0	0	0	0
O1	1	1	1	OP	0	1	1	2	2
O2	1	1	1	OP	1	0	2	1	1
O2	1	1	2	CT	0	1	0	1	2
O3	1	1	1	OP	1	2	2	2	1
O3	1	1	2	CT	2	2	1	0	0
P1	1	1	1	OP	1	2	2	1	1
P1	1	1	7	CT	0	0	0	0	0
P1	2	1	1	OP	1	1	2	2	1
P1	2	1	3	CT	2	0	0	1	0
P1	3	1	1	OB	0	0	0	2	0
P1	3	1	2	OP	1	1	2	3	2
P1	3	1	5	CT	0	2	2	2	2
P1	4	1	1	OB	0	0	0	1	2
P1	4	1	2	OB	0	0	0	0	0
P1	4	1	4	OP	1	1	2	3	2
P1	4	1	9	CT	0	3	2	1	2

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
P1	5	1	1	OB	0	0	0	0	0
P1	5	1	3	OP	0	2	1	3	1
P1	5	1	6	CT	1	0	2	2	1
P1	6	1	1	OP	0	1	1	3	1
P1	6	1	2	CT	0	1	1	0	0
P2	1	1	1	OB	0	0	0	2	2
P2	1	1	3	CT	0	0	0	0	2
P3	1	2	2	CT	0	0	0	0	1
Q1	1	1	1	OB	0	0	0	0	3
Q1	1	1	2	OB	0	0	0	0	3
Q1	1	1	3	OP	1	2	2	2	1
Q1	1	1	4	CT	0	0	0	0	1
Q2	1	1	1	OP	1	2	2	1	1
Q2	1	1	2	CT	0	0	0	0	0
Q3	1	1	1	OP	0	1	3	1	1
Q3	1	1	6	CT	1	1	1	0	0
Q4	1	1	1	OB	0	0	0	0	3
Q4	1	1	2	OP	1	1	3	1	1
Q4	1	1	4	CT	0	0	0	2	0
Q5	1	2	1	OB	0	0	0	2	0
Q5	1	2	2	OB	3	0	0	0	0
Q5	1	2	3	OP	1	1	2	2	1
Q5	1	2	10	CT	0	2	1	0	1
Q5	2	1	1	OB	0	0	0	0	3
Q5	2	1	2	OP	1	1	2	1	1
Q5	2	1	3	CT	0	1	0	2	0
Q5	3	1	1	OB	0	0	0	3	0
Q5	3	1	2	OP	2	2	3	2	2
Q5	3	1	7	CT	1	2	2	0	0
Q5	4	1	2	OP	1	2	2	2	2
Q5	4	1	5	CT	0	2	2	3	2
Q5	5	1	1	OB	0	0	0	0	0
Q5	5	1	2	OB	3	0	0	0	0
Q5	5	1	3	OB	3	0	0	0	0
Q5	5	1	4	OP	2	2	2	2	1
Q5	5	1	7	CT	0	2	1	2	1
Q5	6	1	1	OB	0	0	0	0	0
Q5	6	1	2	OB	0	0	0	3	0
Q5	6	1	3	OP	1	2	1	2	1
Q5	6	1	7	CT	1	0	0	0	1
Q6	1	1	1	OB	0	0	0	3	0
Q6	1	1	2	OB	0	0	0	0	0
Q6	1	1	3	OB	0	0	0	3	0
Q6	1	1	4	OB	0	0	0	0	0
Q6	1	1	5	OB	0	0	0	0	3
Q6	1	1	6	OP	0	1	2	1	1
Q6	1	1	17	CT	0	1	0	1	0
Q6	2	1	1	OP	2	1	2	1	1
Q6	2	1	3	CT	0	0	0	0	1
Q6	3	1	1	OB	3	0	0	0	0

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
Q6	3	1	2	OB	0	3	0	0	0
Q6	3	1	3	OP	1	1	2	3	2
Q6	3	1	11	CT	0	3	1	1	1
Q6	4	1	1	OB	3	0	0	0	0
Q6	4	1	2	OB	0	0	0	0	3
Q6	4	1	3	OP	2	2	1	2	2
Q6	4	1	15	CT	0	3	0	2	0
Q6	5	1	1	OB	0	0	0	0	0
Q6	5	1	2	OB	0	0	0	0	3
Q6	5	1	3	OB	0	0	0	0	0
Q6	5	1	4	OP	2	2	2	1	1
Q6	5	1	6	CT	1	2	1	2	1
Q6	5	1	6	BA	0	0	0	0	0
Q6	6	1	1	OB	0	0	0	0	3
Q6	6	1	2	OB	0	0	0	0	0
Q6	6	1	3	OB	0	0	0	0	3
Q6	6	1	4	OB	0	0	0	0	3
Q6	6	1	5	OB	0	0	0	0	0
Q6	6	1	6	OB	0	0	0	0	0
Q6	6	1	7	OB	0	0	0	0	3
Q6	6	1	8	OP	0	1	2	2	1
Q6	6	1	11	CT	0	0	0	3	0
Q7	1	1	1	OP	0	1	2	2	1
Q7	1	1	5	CT	0	1	0	2	0
Q7	2	1	1	OB	0	0	0	0	0
Q7	2	1	2	OB	0	0	0	0	0
Q7	2	1	3	OB	0	0	0	3	0
Q7	2	1	4	OB	0	0	0	0	0
Q7	2	1	5	OP	1	2	1	3	1
Q7	2	1	8	CT	0	2	2	1	1
Q7	3	1	1	OP	1	1	1	3	1
Q7	3	1	7	CT	0	0	1	2	0
Q7	4	1	1	OB	3	0	0	0	0
Q7	4	1	2	OP	1	1	1	2	1
Q7	4	1	7	CT	0	2	1	2	3
Q7	4	1	10	BA	0	3	0	0	0
Q7	5	1	1	OB	0	0	0	0	3
Q7	5	1	3	OB	0	0	0	0	0
Q7	5	1	4	OB	0	0	0	0	3
Q7	5	1	5	OP	1	2	2	3	1
Q7	5	1	11	CT	1	2	2	2	2
Q7	5	1	13	BA	3	0	0	0	0
Q8	1	1	1	OB	0	0	0	3	0
Q8	1	1	2	OP	0	3	2	2	1
Q8	1	1	7	CT	0	1	1	1	2
Q8	2	1	1	OB	0	0	0	0	3
Q8	2	1	2	OP	0	1	2	2	1
Q8	3	1	1	OB	0	3	0	0	0
Q8	3	1	2	OB	0	0	0	0	0
Q8	3	1	3	OP	1	2	2	3	1

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
Q8	3	1	3	OB	0	0	0	0	3
Q8	3	1	4	OB	0	0	0	0	0
Q8	3	1	9	CT	0	1	0	1	1
Q8	4	1	1	OB	0	0	0	0	0
Q8	4	1	2	OP	1	2	3	2	1
Q8	4	1	5	CT	0	1	0	1	2
Q8	5	1	1	OB	0	0	0	0	3
Q8	5	1	2	OB	0	0	0	0	3
Q8	5	1	3	OB	0	0	0	0	0
Q8	5	1	4	OB	0	0	0	0	0
Q8	5	1	5	OB	0	0	0	0	3
Q8	5	1	6	OB	0	0	0	0	3
Q8	5	1	7	OP	1	1	1	2	2
Q8	5	1	18	CT	0	1	1	2	2
R1	1	1	1	OB	0	3	0	0	0
R1	1	1	2	OB	0	0	0	0	3
R1	1	1	3	OP	1	2	1	2	1
R1	1	1	4	BA	0	3	0	0	0
R1	1	1	5	CT	3	0	0	0	0
R2	1	1	1	OP	1	1	2	2	1
R2	2	1	1	OP	0	1	2	1	1
R2	3	1	1	OP	1	1	2	1	1
R2	4	1	1	OP	1	0	2	1	1
R2	4	1	2	CT	0	0	0	0	0
R3	1	1	1	OB	0	0	0	0	3
R3	1	1	2	OP	1	1	2	1	1
R4	1	1	1	OP	1	1	2	1	1
R4	1	1	2	CT	2	0	0	0	0
S!	1	1	2	OP	1	1	3	2	1
S1	1	1	1	OB	0	0	0	0	0
S2	1	1	1	OP	1	1	2	2	1
S2	2	1	1	OP	1	1	2	1	1
S2	3	1	1	OP	0	1	2	1	1
S2	4	1	1	OP	1	1	2	1	1
S2	5	1	2	OB	0	0	0	0	3
S2	5	1	3	OB	0	0	0	0	0
S2	5	1	4	OB	0	0	0	0	0
S2	5	1	5	OP	0	0	2	1	1
S2	6	1	1	OP	1	1	2	2	0
S2	6	1	2	OP	0	0	0	0	0
S2	6	1	2	BA	0	0	0	0	0
S3	1	1	1	OP	0	1	2	1	1
T1	1	1	1	OP	1	1	2	1	1
T2	1	1	1	OP	1	1	2	2	1
T2	2	1	1	OP	1	0	2	1	1
T2	3	1	1	OP	1	1	2	2	1
T2	4	1	2	OP	1	1	3	2	1
T2	5	1	1	OB	0	0	0	0	0
T2	5	1	2	OB	3	0	0	0	0
T2	5	1	3	OP	1	1	2	1	1

Unit	Level	Lot	Specimen	Material	Core Reduction	Edge/Blank Preparation	Early Thinning	Late Thinning	Retouch
T3	1	1	1	OP	1	1	2	2	1
U1	1	1	1	OP	1	1	2	1	0
U2	1	1	1	OP	1	1	2	1	1
U2	1	1	2	CT	0	0	0	0	0
U3	1	1	1	OP	1	2	3	2	0
V1	1	1	1	OP	1	1	2	1	1
V2	1	1	1	OB	0	0	0	0	0
V2	1	1	2	OP	1	1	2	2	1
V2	2	1	1	OP	1	1	2	1	1
V2	3	1	1	OP	0	1	2	1	1
V2	4	1	1	OP	0	1	2	2	1
V3	1	1	1	OB	0	3	0	0	0
V4	1	1	1	OB	0	0	0	0	3
V4	1	1	2	OP	1	1	3	1	1
W1	1	1	1	OP	0	1	2	2	1
W2	1	1	1	OP	1	1	2	2	1
W3	1	1	1	OP	0	1	2	2	1
X1	1	1	1	OP	1	2	3	2	0
X1	2	1	1	OP	0	0	2	2	0
X1	3	1	1	OP	0	1	1	3	2
X1	4	1	1	OP	0	2	2	2	0
X2	1	1	1	OP	0	1	2	3	1
X3	1	1	1	OP	0	0	2	3	0
X4	1	1	1	OP	0	1	3	1	1
Y1	1	1	1	OB	0	0	0	3	0
Y1	1	1	2	OB	0	0	0	0	0
Y1	1	1	3	OB	0	0	0	0	3
Y1	1	1	4	OP	0	3	2	1	1
Y1	2	1	1	OP	0	1	3	2	0
Y1	3	1	1	OB	0	0	0	0	3
Y1	3	1	2	OB	0	0	0	0	0
Y1	3	1	3	OB	0	0	0	3	0
Y1	3	1	4	OB	0	0	0	0	0
Y1	3	1	5	OP	1	2	2	2	1
Y1	4	1	1	OB	0	0	0	0	3
Y1	4	1	2	OP	0	1	3	1	1
Y1	5	1	1	OP	1	1	1	3	1
Y1	6	1	1	OP	0	1	2	1	1
Y2	1	1	1	OB	0	0	0	0	0
Y2	1	1	2	OP	0	3	2	1	1
Z1	1	1	1	OB	0	0	0	0	0
Z1	1	1	2	OP	1	1	2	2	0
Z2	1	1	1	OP	1	2	2	1	1

Material Key:
CT=Local Chert; OB=Obsidian; OP=Opalite; EX=Exotic Chert; BA=Basalt

The Current Status of the Tosawihi Quarries: Significance Beyond Lithic Procurement

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INTRODUCTION

Rusco (1983) wrote that Stephenson and Wilkinson (1969) were the first to note that archaeological sites located east of Winnemucca (east of the Osgood Mountains) and north of Battle Mountain were dominated by a white chert or opalite material. Thirty years earlier, Steward (1938:162) noted that:

> People who wintered on the Humboldt River above Battle Mountain were called Tosawi (tosa, white+ wi, knife) because they procured a high quality of white flint for knives in the mountains to the north. This name, unfortunately, became prominent and led to the fiction that all the Shoshoni in a large area around Battle Mountain had comprised a band by this name. Because, like other Shoshoni group names, Tosawi did not designate a definitely bounded linguistic, political, cultural, or even geographical division, no two writers have agreed in its use.
>
> Holeman (1852, p.152) applied "White Knives" to people of the Humboldt River and Goose Creek Mountains. Hurt (1856, pp.228-229) restricted To-sow-witches or White Knives to about 250 people living near Stony Point. Burton (1862, p. 481) extended the terms to include even the Shoshoni in the vicinity of Diamond Valley. Powell and Ingallis (1874, p. 12) used it for people in the vicinity of Battle Mountain and Simpson (1876, pp. 34-35) considered the To-sa-witches to be a separate division of "Sho-sho-nee" who ranged along the Humboldt River in small parties between the Un-gowe-ah and Cooper's Ranges.
>
> The hunting and gathering area of the people most often called Tosawi was in the mountains around Rock Creek. Many of them often wintered on the Humboldt River below Battle Mountain.

And, according to Steward (1938:248):

> The much publicized Tosawi or White Knife people of the Battle Mountain region are so called because an excellent grade of white flint occurs in that country. But neither

> informants nor early writers agreed as to the boundaries of people so named. They had no organization and were not a band.

Harris (1940:39) added the "hi" to the end of "Tosawi" in the following manner, and generally agreed with Steward that the "White Knives" were not a band in the political sense of the term:

> Before the advent of the Whites, the *Tosawi*^{hi} Shoshoni ranged over that portion of the Great Basin now included in the northeastern section of the state of Nevada.
>
> *Tosawi*^{hi}, or "White Knives", was the term loosely applied to all Indian camps in this area. It appears, however, that this term was restricted at one time to those camps in the immediate vicinity of Tuscarora and Battle Mountain where white flint for knives and other artifacts is found. The White Knives are not to be considered as having a band organization with the traditional ethnological connotations of restriction and cohesiveness.

More recently, the Inter-Tribal Council of Nevada (1976:82-83) noted that:

> The Newe called the area seventy miles southwest of Elko *Tonomudza*, naming it after a greasewood-covered peak north of the valley. This land, near the boundary between the Newe and the Northern Paiutes, received the modern name "Battle Mountain" after a conflict between an emigrant train and an Indian group. Several Newe groups, concentrated in four main areas, once lived in the fertile valley...The Tosawi or White Knives, named after the white flint they made into knives and arrow points, lived north of Battle Mountain.

From an archaeological standpoint, surveys by professional archaeologists began at the Tosawihi Quarries in the early-to-mid 1970s. The first BLM survey occurred in 1977 (Waski 1977). This survey was in conjunction with the proposed development of a spring in support of

cattle grazing. Although Mary Rusco had earlier visited the Quarries, between 1977 and 1980, Rusco instigated what she called "The Tosawihi Quarry Project" (Rusco 1983). Rusco (1983; see also Rusco 1982:58-59) detailed the results of one mile transects in and around the Tosawihi region in order to define the first geographical boundaries of the "Tosawihi (White Knife) Quarry" (Figure 1). These surveys were not project-driven; Rusco essentially conducted these surveys on her own initiative. Rusco (1983) suggested that a discontinuous region, focusing on four key areas or loci measuring a total of 31 acres in size, be considered significant contributing loci to the eligibility of the District in the draft National Register of Historic Places Inventory – Nomination Form she completed. Rusco (1983) noted, however, that outcroppings of white chert were located in a vastly expanded region across nearly 28,500 acres. In a letter to the BLM dated August 10, 1983, however, Rusco (1983) included a map which suggested that the District should be at least 485 acres in size (Figure 1).

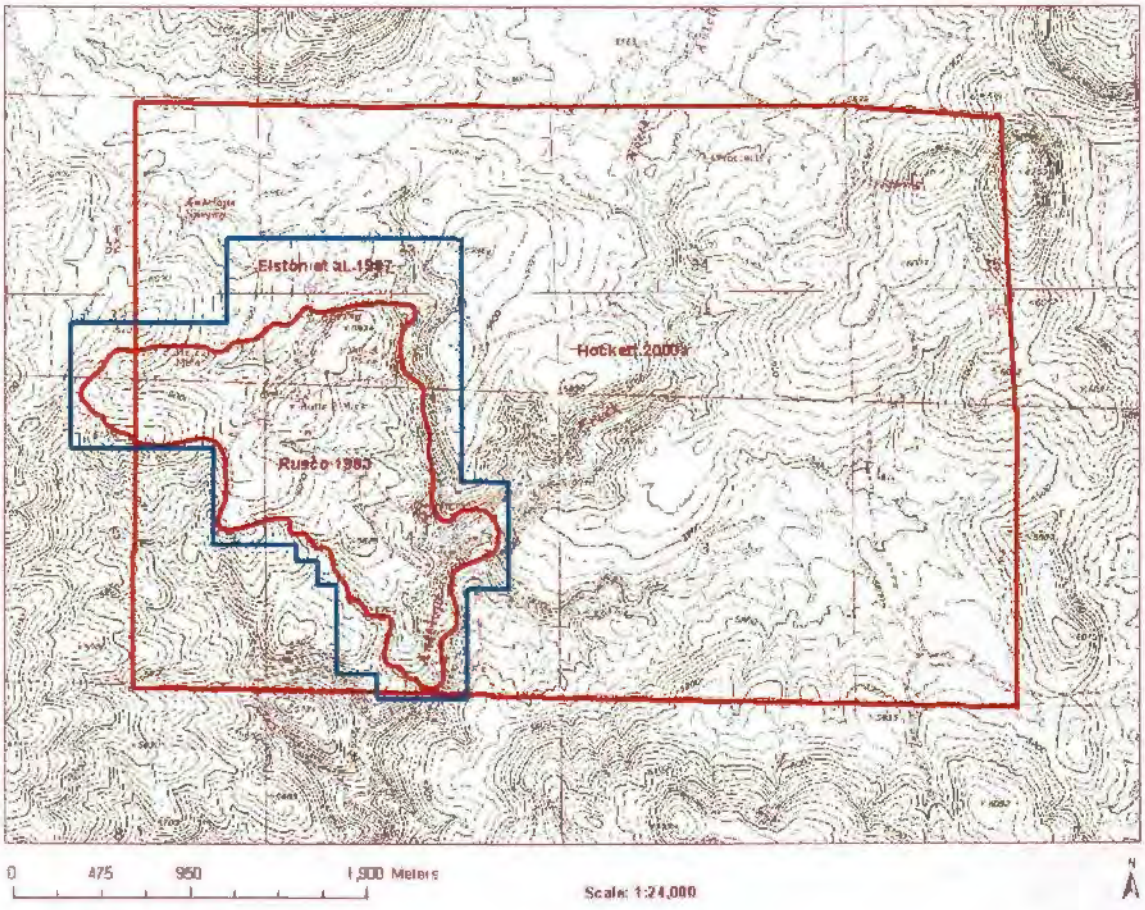


Figure 1. Changing boundaries of the Tosawihi Quarries Archaeological District between 1983 - 2000.

The first archaeological survey in conjunction with a proposed mining operation in the Tosawihi Quarries area was completed by Stanley Jaynes in 1981. This survey was small, measuring a little over two acres in size. The first large-scale survey of the Quarries, which initiated Intermountain Research's (IMR) long-standing work there, began in 1987 (Elston et al. 1987), and consisted of 823 acres. This survey resulted in the definition of the Tosawihi Quarries Archaeological District (26Ek3032) of like size (Figure 1). Between 1987 and 1995, IMR archaeologists completed numerous surveys and several excavation projects in the region (Appendix 1).

During IMR's investigations, important ethnographic research was also taking place, most notably by Clemmer (1990) and Rusco and Raven (1992). The early work by Clemmer (1990:3) helped establish the notion that the Tosawihi Quarries were a doomed resource:

> The Tosawihi Quarry has already been assessed as being eligible for listing on the National Register of Historic Places. But the area – about 800 acres – is under a mining lease from the BLM to Galactic Mining, a Canadian corporation based in Vancouver. If mining is undertaken, at least a third of the ancient Quarry will be destroyed in the first year of operation. If there is a lot of gold there, the whole site could be destroyed.

Clemmer was correct about one thing – there was a possibility for significant damage to occur to the Quarries as a result of gold mining operations. But, as I detail below, this situation did not materialize.

It has now been 10 years since IMR conducted its last surveys and excavations in the Tosawihi Quarries area (Appendix 1). Between 1995 and 2005, most of the surveys in and around the Quarries have been completed by BLM archaeologists. Before discussing some details of the results of these post-IMR inventories, however, it is necessary to provide a more general overview of the BLM's management strategy at the Tosawihi Quarries over the past decade. This overview will explain the BLM's decisions to: (1) redefine the boundaries of the Tosawihi Quarries Archaeological District from approximately 800 acres to nearly 4,000 acres (Figure 1); (2) provide new site and loci numbers for resources located within the District; and (3) define the Tosawihi Quarries Traditional Cultural Property (TCP).

Historic Overview of the Recordation Strategies at the Tosawihi Quarries

In the late 1980's, IMR redefined the boundaries of the Tosawihi Quarries Archaeological District (26EK3032) from that proposed by Rusco (1983) (Figure 1), and defined 219 loci within its boundaries (e.g., Elston et al. 1987; Elston and Raven 1991). The District boundaries encompassed about 825 acres. Definitions of site loci focused on artifact density and the

presence of features such as quarry pits, and are discussed in further detail elsewhere in this monograph. Subsequent to the District redefinition, IMR completed additional block surveys to the west and east of 26EK3032 (e.g., Budy 1987; Raven 1988). All of these surveys were project-driven by private industry seeking economic deposits of gold and silver.

These additional block surveys recorded numerous bedrock outcroppings of chert, quarry pits, and associated campsites. However, instead of assigning loci numbers, these sites were assigned individual site numbers (both Smithsonian and BLM numbers) because they fell outside of the boundary of 26EK3032. Put another way, instead of expanding the boundaries of 26EK3032 and assigning successive loci numbers, these locations were treated as new sites outside of the District itself. Many subsequent smaller surveys were conducted near the District boundaries as well (Appendix 1) -- some of which assigned loci numbers and some of which assigned site numbers to newly recorded resources.

IMR was well aware of the inconsistency of this strategy, but sometimes perfect protocol cannot match the real world deadlines set in CRM. In any case, these circumstances began a succession of events that the BLM would later find untenable to properly manage the District. By the end of 1995, the District and surrounding lands consisted of a confusing mixture of loci and site designations, including the fact that a number of sites were assigned a Smithsonian number, a BLM site number, and a District locus number!

Based on a review of the geological map of the region (Coats 1987), the BLM determined that the extent of the bedrock outcroppings of artifact-quality chert that make up the Tosawihi Quarries was likely to be concentrated over a region of about 4,000 acres in size. The unique layers of interbedded tuff and chert (opalite) are generally bounded to the north, south, east, and west by thick rhyolites and basalts, although ash flows and chert outcroppings are found outside of this zone, albeit more sparingly. This latter situation led Rusco (1983) to note that small chert-bearing outcrops can be found discontinuously spread across an area measuring nearly 28,000 acres in size. But the concentrated outcrops of opalite occurred within a 4,000-acre zone that included 26EK3032 and an additional 3,000-plus acres.

Some of the cherty deposits at Tosawihi contain mercury, and as Lapointe et al. (1991:131) put it:

> The ore deposits in the Ivanhoe district consist of several mercury deposits and the Hollister volcanic-hosted gold deposit. The mercury deposits occur in opalite derived from silicification of rhyolitic ash-flow tuff and tuffaceous sedimentary rocks of the upper tuff unit.... Several of the deposits exhibit features that suggest that the deposits were formed at quite shallow depths in a hot springs environment. Siliceous spring sinter has been reported from a locality near the Old Timer mine and probable subaqueous opalite and cinnabar deposition and hydrothermal brecciation have been reported at the Rimrock mine....

A BLM review of all of the surveys completed before 1999 revealed that there had been 226 loci and 91 individual site numbers assigned, for a total of 317 sites and loci, within this 4,000-acre geologically-defined zone (although not all of the 4,000 acres had yet been surveyed). In many cases, there were few qualitative or quantitative differences between loci and sites in terms of presence and density of artifacts and features. Many of them contained bedrock outcroppings of chert, quarry pits, and/or heavy concentrations of flakes, bifaces, and cores often numbering in the hundreds per square meter.

In addition, recent BLM pedestrian surveys revealed that there were no obvious boundaries between many of the loci originally defined by IMR. Individual quarry pits were easily distinguishable from one another on the ground, and IMR often assigned loci numbers based on the locations or clusters of these quarry pit features. However, the areas between the loci were often found to contain heavy concentrations of flaking debris, sometimes numbering in the hundreds or thousands of artifacts per square meter.

It therefore became clear to the BLM that (1) the Tosawihi Quarries Archaeological District should consist of an area measuring about 4,000 acres in size rather than the 825 original acres of 26EK3032; (2) within this 4,000 acres, two-thirds of the artifact concentrations were previously assigned loci numbers under the single 26EK3032 site designation, while one-third of the artifact concentrations were previously assigned unique site numbers; and (3) the BLM could not rely on the original loci designations to manage the resource because earth-disturbing activities that may have "missed" one of these loci may have resulted in the disturbance of nearby campsites or heavy lithic reduction debris.

Faced with this situation, as well as the fact that in the late 1990s Great Basin Gold Company (GBG) had recently purchased all of the mining claims previously held by Newmont Mining Company – and GBG had informed the BLM that they intended to begin new exploration activities within the Quarries – the BLM set out to "clean up" the loose ends created by the previous surveys. To this end, Janice Stadelman (BLM Minerals Compliance Specialist) and I walked the perimeter of most of the known sites, loci or concentrations of artifacts with a GPS Trimble unit set for sub-decimeter accuracy. We also walked the perimeter of the major mining disturbance that had occurred prior to 1999, including the two open pits and the large stockpile created during the open pit mining phase (Figures 2 and 3). At this time, Newmont had decided to end their mining operations at the Quarries, and were actively reclaiming the southwestern corner of the District that had been previously disturbed. For their part, GBG intended to open an underground operation, and they desired to avoid all surface loci and sites eligible for the National Register of Historic Places.

As Figures 2 and 3 illustrate, the previous large-scale mining disturbance is confined to the extreme southwestern corner of the Tosawihi Quarries Archaeological District. In fact, about one-half of that disturbance is located outside of the District itself. Approximately 90% (or more) of the District remains intact to this day. The rumors that the Tosawihi Quarries were destroyed by mining activity are in error.

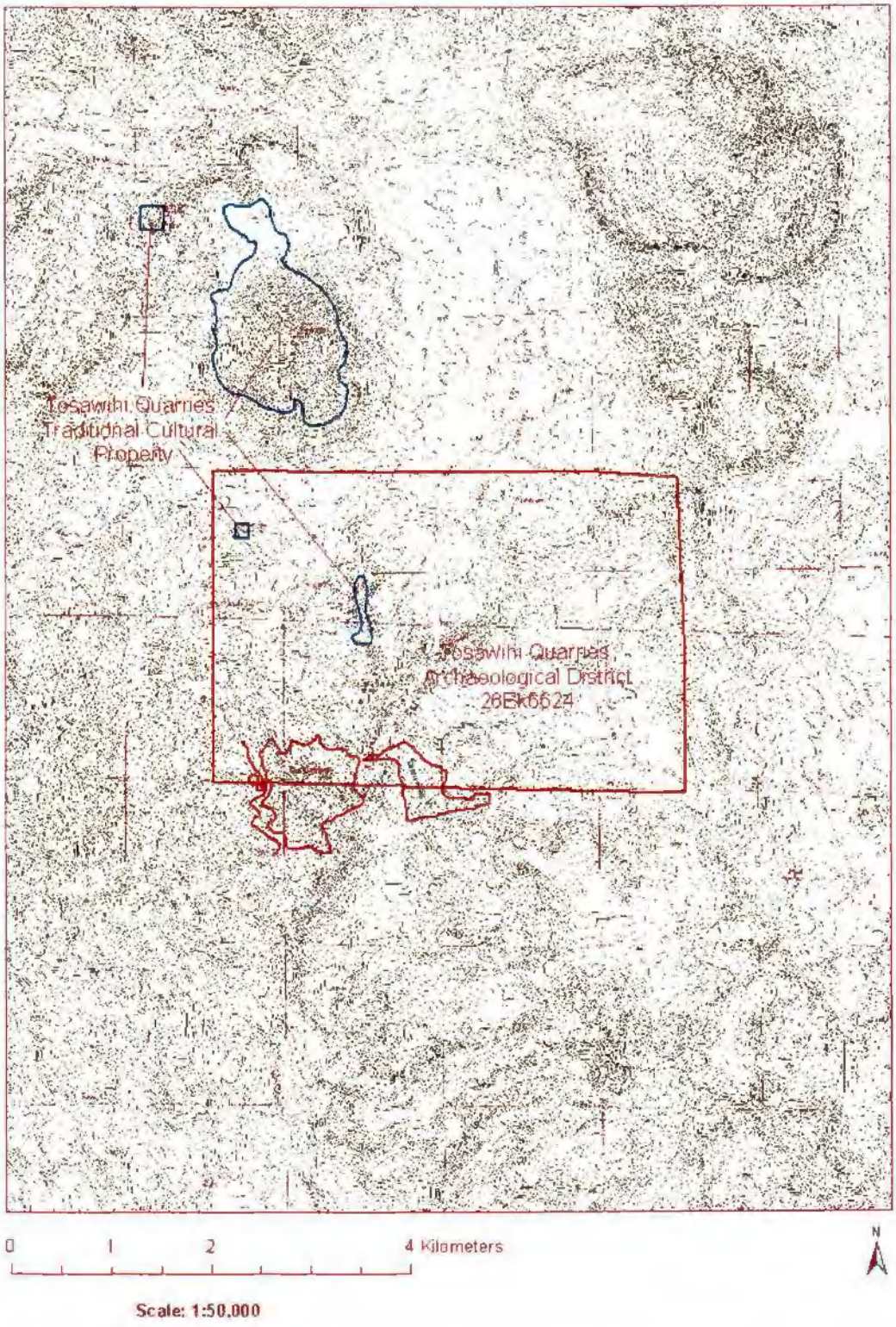


Figure 2. Size and geographic relationships between the Tosawihi Quarries Archaeological District, Tosawihi Quarries Traditional Cultural Property, and major mining disturbance.

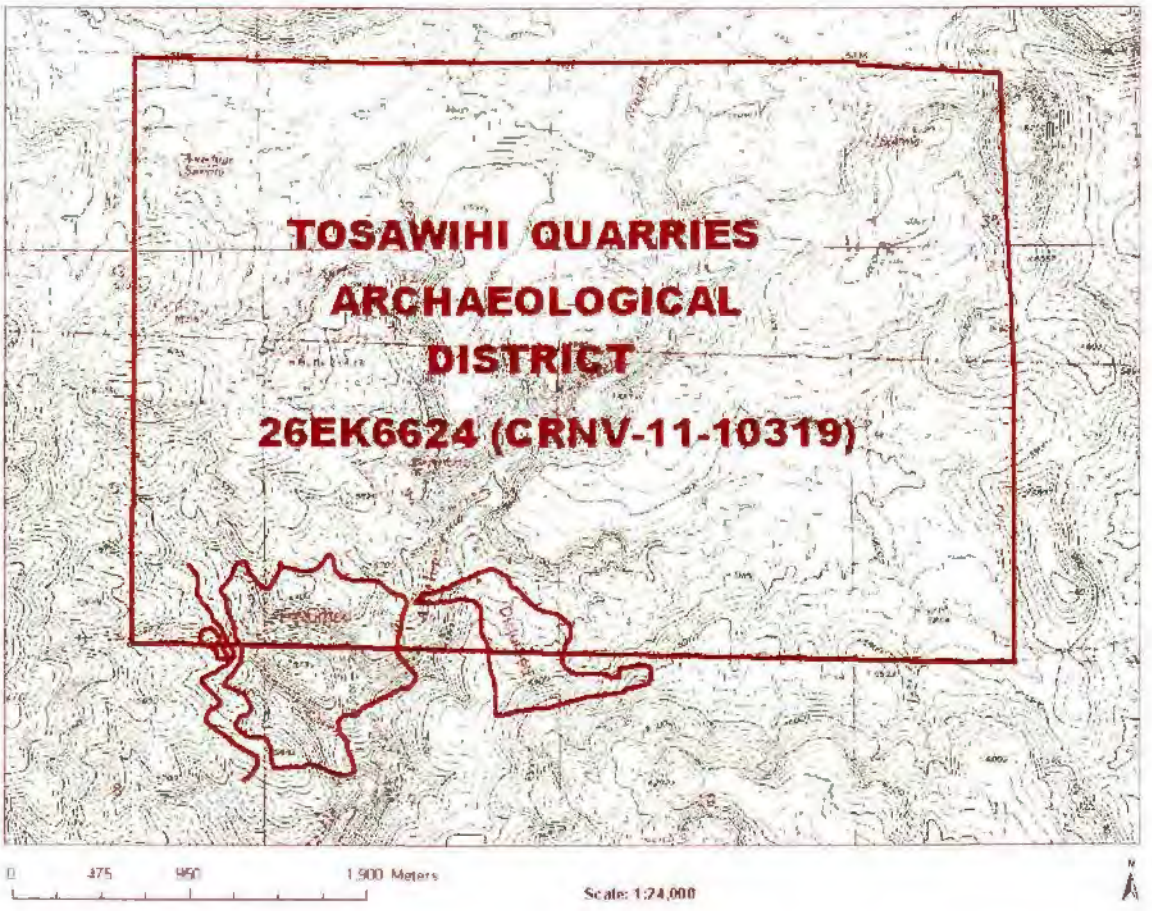


Figure 3. Size and geographic relationship of major mining disturbance and the Tosawihi Quarries Archaeological District.

The newly-designated artifact concentrations were defined by BLM utilizing IMR's original definition of a "locus" based on artifact density. These GPS-generated 'area features' were then overlain with IMR's original loci and site designations and locations. This process resulted in the BLM collapsing the original 317 sites and loci into 152 loci (Appendix 2). The loci were renumbered, 1 through 152, and then a table was created to cross-reference the new designations with their original numbers (Appendix 2). Additionally, because of the baggage associated with the 825-acre original District boundaries (26EK3032), in order to avoid confusion the newly expanded 4,000-acre District was assigned a new Smithsonian number – 26EK6624, as well as an associated BLM site number – CRNV-12-10319 (Figure 3) (Hockett 2000a). Tables were also created at this time that summarized the previously determined eligible site numbers, and sites and loci mitigated to date within and near the Quarries (Appendices 3-4). Eligible sites recorded and mitigated near the District boundaries are summarized in Appendices 5-6.

BLM's GPS work also determined the following: (1) IMR's original loci numbered 12, 13, 18, 19, 20, 21, 22, 23, 26, 93, and 98 have been destroyed by mining activity; (2) IMR's locus 223 was a very small lithic scatter that was not assigned one of the 152 loci defined by BLM; (3) IMR's loci 178 (also 26EK3223), 179 (also 26EK3224), and 180 (also 26EK3225) are lithic scatters that lie outside of the boundary of 26EK6624; and (4) Smithsonian number 26EK3034 was originally assigned to a region located to the southwest of the originally-defined 825-acre 26EK3032, and IMR's original plan was to assign 124 loci under the umbrella of that site number. However, this latter plan was never instigated, and according to BLM records, these 124 loci were assigned a much smaller number of individual Smithsonian site numbers, and 26EK3034 became a defunct number that was never used.

The BLM then consulted with the State Historic Preservation Office, determining that the Tosawihi Quarries Archaeological District (26EK6624) was eligible for the National Register under criteria "a" and "d."." As an archaeological resource, 26EK6624 was determined eligible under criterion "a" essentially for its uniqueness as one of the largest prehistoric chert quarries in the western United States (and the largest in the Great Basin), and under criterion "d" for its potential to provide significant additional information about the prehistory of the region (Hockett 2000a).

Since the BLM's redefinition of the District in January of 2000, an additional 11 loci have been recorded within its boundaries (Hockett 2000b; 2002). Thus, as of March, 2006, there are 163 loci eligible for the National Register within 26EK6624. And, as of this date much of the northwestern one-quarter of the District remains unsurveyed.

Also in the late 1990s, at the same time that fieldwork was underway to map and record the archaeological loci and previous mining disturbance at the Quarries, the BLM initiated new consultations with the Western Shoshone regarding the potential impacts of mine dewatering to seeps, springs, and streams that may hold special cultural importance to traditional life ways. As a result of these efforts, two Traditional Cultural Properties were finally defined, one at Rock Creek and one at Tosawihi. The Tosawihi Quarries TCP (CRNV-11-9932) encompasses several springs, a vision quest locale, and a chert collecting area (Figure 2) (Hockett 1999). The Tosawihi Quarries TCP was also determined eligible for the National Register under criteria "a" and "d".

Recent Surveys in the Tosawihi Quarries Area: Information Relevant to Understanding Large Game Hunting in the Region

Since 1995, there have been 14 cultural resources reports completed in the Tosawihi Quarries area. Two of these reports were located within the boundaries of 26EK6624, and 12 were completed near the Quarries. These surveys covered approximately 223 acres. The two surveys within the District recorded the 11 additional loci within the District boundaries (Hockett 2000b, 2002). The 12 surveys near the Quarries recorded 42 additional prehistoric sites. These loci and sites contained dozens of individual quarry pits and a host of bifaces, cores, and finished tools (Table 1).

Table 1. Tools and bifaces recorded within and near the Tosawihi Quarries Archaeological District since 1995.

	Projectile points	Bifaces	Ceramics	Grinding stones
Within Quarries	14	37	1	2
Near Quarries	25	102	0	9
Totals	39	139	1	11

Of the 39 projectile points recently recorded, 31 were typable. Of these, the vast majority are from the James Creek Phase and older, that is, pre-Late Archaic or pre-1,300 BP (see Table 2 below). A total of 25 of the 31 (81%) points were James Creek Phase or older styles. If these points are scaled to length of time each was produced, however, some interesting trends emerge.

Before discussing these trends at Tosawihi and other nearby regions, however, the assumptions guiding the following analyses are in order. First, overwhelming evidence suggests that Elko points were generally not manufactured before ca. 3,500 BP in northeastern Nevada (Hockett 1995; Hockett and Morgenstein 2003). Elko points were likely manufactured during the Maggie Creek Phase of the Late Archaic (ca. 1,300 – 550 BP), albeit much less frequently than during the James Creek Phase. Here, however, I assigned all Elko points to within the James Creek Phase (ca. 3,500 – 1,300 BP), and consider them generally representative although not always diagnostic of that time period. Second, current evidence suggests that Gatecliff points were manufactured during a relatively short period of time, lasting about a millennium-and-a-half, between about 5,000 – 3,500 BP (Hockett and Morgenstein 2003; McGuire et al. 2004). Humboldt points are poorly dated from the region, but definitely appear to overlap with Gatecliff points (Hockett 1995; McGuire et al. 2004). Humboldt points, and in particular the Humboldt Concave-Based variety, are known to have been manufactured earlier during the Middle Holocene as well (Holmer 1986). For example, Humboldt Concave-Based points are present in pre-5,000 BP, Middle Holocene-aged layers at sites such as Bonneville Estates Rockshelter. Nevertheless, C-14 and hydration data place the majority of Humboldt points within the South Fork Phase along with Gatecliff points. Thus, for this exercise, I placed Gatecliff and Humboldt points together into the South Fork Phase. Finally, I have assumed that projectile points were manufactured primarily for the hunting of large game, and that the numbers of projectile points previously recorded in the region, scaled to the number of years each style of point was manufactured, indicate diachronic patterns of intensity of large game hunting.

The projectile point data from the recent surveys completed after 1995 suggest that hunting near the Tosawihi Quarries was very infrequent between 11,500 and 7,500 BP (Table 2). Beginning sometime during the Middle Holocene (ca. 8,300 – 4,400 BP), however, hunting may

have increased in importance compared to Late Pleistocene and Early Holocene times (prior to 8,300 BP) with the advent of the Pie Creek Phase and the manufacture of Large Side-Notched projectile points. This trend continues through the South Fork and James Creek phases, with rather dramatic increases in projectile points between about 5,000 and 1,300 BP. The number of points decline to Middle Holocene levels during the early Late Archaic, or during the Maggie Creek phase, only to rise to their highest level during the Protohistoric Period. These latter data would seem to confirm the significance of the Quarries to the Western Shoshone of the region at historic contact.

Table 2. Projectile points recorded within and near the Tosawihi Quarries since 1995.

Type	Phase	Number Found	Points/Century
Desert Side-Notched/Cottonwood	Eagle Rock 550 BP – 50 BP	5	1.0
Rose Spring/Eastgate	Maggie Creek 1,300 – 550 BP	1	.13
Elko	James Creek 3,500 – 1,300 BP	13	.59
Gatecliff/Humboldt	South Fork 5,000 – 3,500 BP	6	.40
Large Side-Notched	Pie Creek 7,500 – 5,000 BP	4	.16
Great Basin Stemmed	Dry Gulch 10,800 – 7,500 BP	2	.06
Clovis	Izzenhood 11,500 – 10,800 BP	0	.00

How do these data match with the much larger sample of projectile points recorded by IMR before 1995? Table 3 shows the typological distribution of 239 projectile points listed by Ataman and Drews (1991) for the Tosawihi Quarries area. These data show how different samples and sample sizes can lead to different patterns of projectile point distribution. IMR's sample would indicate initial use of the Quarries during Clovis times, followed by a rather dramatic increase during the latest Pleistocene and Early Holocene (Great Basin Stemmed). A reduction in use is seen during the Middle Holocene (Pie Creek Phase), followed by a dramatic increase during the early Late Holocene (South Fork Phase). Large game hunting would appear to have been much less important during the middle portion of the Late Holocene (James Creek Phase), only to rise dramatically again during the early Late Archaic (Maggie Creek Phase). Use of the Quarries for hunting large game again rises to its greatest extent during the Protohistoric, as four times the number of points were deposited per century during the Eagle Rock phase compared to the Maggie Creek phase. Again, this may signal the importance of the area to the Western Shoshone over the past 550 years.

Table 3. Projectile points from the Tosawihi Quarries recorded prior to 1995, and reported by Ataman and Drews (1991).

Type	Phase	Number Found	Points/Century
Desert Side-Notched/Cottonwood	Eagle Rock 550 BP – 50 BP	99	20.0
Rose Spring/Eastgate	Maggie Creek 1,300 – 550 BP	35	4.7
Elko	James Creek 3,500 – 1,300 BP	35	1.6
Gatecliff/Humboldt	South Fork 5,000 – 3,500 BP	40	2.7
Large Side-Notched	Pie Creek 7, 500 – 5,000 BP	9	.36
Great Basin Stemmed	Dry Gulch 10,800 – 7,500 BP	20	.61
Clovis	Izzenhood 11,500 – 10,800 BP	1	.14

If we combine all of the projectile points recovered by IMR and BLM within the Quarries and nearby, we get the following pattern (Table 4):

Table 4. Total number of typable projectile points (270) recorded within and near the Tosawihi Quarries since 1987, based on Ataman and Drews (1991) and recent BLM surveys.

Type	Phase	Number Found	Points/Century
Desert Side-Notched/Cottonwood	Eagle Rock 550 BP – 50 BP	104	21.0
Rose Spring/Eastgate	Maggie Creek 1,300 – 550 BP	36	4.8
Elko	James Creek 3,500 – 1,300 BP	48	2.2
Gatecliff/Humboldt	South Fork 5,000 – 3,500 BP	46	3.1
Large Side-Notched	Pie Creek 7, 500 – 5,000 BP	13	.52
Great Basin Stemmed	Dry Gulch 10,800 – 7,500 BP	22	.67
Clovis	Izzenhood 11,500 – 10,800 BP	1	.14

These figures generally conform to the relative percentages obtained by IMR, but the greater numbers of pre-Late Archaic projectile points recently recorded by the BLM within and near the Quarries has smoothed out the transitions between phases to a certain extent, rendering variability between phases less dramatic in some cases compared to IMR's sample. Thus, after a very minimal use during Clovis times, Late Pleistocene and Early Holocene foragers manufacturing Great Basin Stemmed points appear to have utilized the Quarries with much greater intensity, although point numbers still fall below an average of one specimen per century. Use of the Quarries declines during the Middle Holocene when Large Side-Notched points were manufactured, but the region was not entirely abandoned, and overall use was not dramatically lower than during the preceding phase. Use of the Quarries for hunting large game increased dramatically during the early phases of the Late Holocene with the manufacture of Gatecliff and Humboldt points, then dropped during the middle portion of the Late Holocene when Elko points predominated. Hunting increased in importance during the earliest phase of the Late Archaic when Eastgate and Rose Spring points enter the record, and then increases four-fold during the subsequent Protohistoric Period of the last 550 years.

I have previously shown that the degree of large game hunting in the prehistoric Great Basin varies considerably from site to site based on setting and elevation (Hockett 2005). For example, during the Late Pleistocene and Early Holocene at mid-elevation settings (~ 5,200 feet), such as at Bonneville Estates Rockshelter, faunal remains suggest a quite eclectic diet that consisted of large and small terrestrial game, birds, and insects. While large game was present and these animals clearly were taken at this time, it was not the focal point of hunting activities. In contrast, at Bonneville Estates and other higher elevation sites such as Sudden Shelter, the taking of large game was the primary focus of hunting activities during the relatively warm and dry Middle Holocene. A caveat here is the fact that at Bonneville Estates, the four major pulses of human occupation during the Middle Holocene were of relatively short duration, and were further associated with wetter phases within this overall warm and dry climatic period. At some lower elevation sites such as Camels Back Cave, leporids predominated rather than large game in the Middle Holocene levels (Schmitt and Madsen 2005). These data overall suggest that large game hunting was the predominant activity that occurred at specific locales during the Middle Holocene, while at other sites smaller game predominated. Whether all large game hunting during the Middle Holocene can be correlated to wetter intra-phases such as those documented at Bonneville Estates Rockshelter is unknown at this time.

At Tosawihi, large game hunting apparently continued in this mid-elevation setting (sites there average about 5,600 feet in elevation) during the Middle Holocene, albeit at slightly reduced levels compared to the Dry Gulch phase. Whether these Large Side-Notched points were left behind during those same wetter intra-phases similar to those documented at Bonneville Estates Rockshelter, or during drier intra-phase periods, is unknown as none of these points are associated with single component occupations that have been radiocarbon dated.

During the Late Holocene, large game hunting appears to have waxed and waned at Tosawihi throughout the last 4,500 years, reaching its peak within the past 550 years. This is a most interesting situation, and adds to the growing body of evidence suggesting variability in

hunting patterns across the Late Holocene at specific locales as well. For example, I found that large game hunting remained consistent throughout the Late Holocene at sites such as Pie Creek Shelter in northeastern Nevada and Hogup Cave in northern Utah (Hockett 2005). The projectile point data from Tosawihi, however, suggest that large game hunting was relatively moderate between 5,000 – 3,500 BP and 1,300 – 550 BP (but of greater importance than during the Late Pleistocene, Early Holocene, or Middle Holocene), relatively low between 3,500 – 1,300 BP, and then relatively high during the past 550 years. Explanations based simply on changes in climate seem unlikely to account for this variability. The projectile point data from the Tosawihi Quarries hold value for addressing these issues in the future.

These data may be compared to the distribution of projectile points in other regions of northeastern Nevada that have had relatively extensive survey coverage. These areas include Little Boulder Basin south of Tosawihi, the Spruce Mountain area southeast of Tosawihi, and Pilot Creek Valley east of the Quarries (Table 5 and Figure 4). Schroedl (1996) reported on the distribution of 716 points recovered during pedestrian surveys in Little Boulder Basin through 1995 (Table 5). These results are intriguing. Some of the general patterns in projectile point frequency match those from Tosawihi; in other cases, notable differences are seen. The Little Boulder Basin point distribution data, like Tosawihi, show very limited use during the Late Pleistocene and Early Holocene. However, Tosawihi appears to have been a more significant draw during Western Stemmed times than was Little Boulder Basin (22 stemmed points at Tosawihi versus one at Little Boulder Basin). In contrast to Tosawihi, large game hunting increases during the Middle Holocene in Little Boulder Basin – by nearly 4,000%! A rather dramatic increase in large game hunting (a nearly 600% increase) is then seen at the earliest stages of the Late Holocene during the manufacture of Gatecliff and Humboldt points. This pattern matches that seen at Tosawihi. However, at Little Boulder Basin large game hunting may have increased slightly during the middle portion of the Late Holocene, between 3,500 – 1,300 BP, associated with Elko point manufacture. The other major differences between Little Boulder Basin and Tosawihi are seen in the use of the two areas during the Late Archaic. In Little Boulder Basin, there is a dramatic three-fold increase in projectile point frequency during the earliest stages of the Late Archaic, and then a rather dramatic reduction in large game hunting during the final 550 years of occupation. Tosawihi, of course, shows just the opposite pattern – a four-fold increase in hunting use from the early to late stages of the Late Archaic.

These data would seem to imply that similar strategies of land use were being employed during the hunting of large game during Clovis times, and again during the early-to-mid stages of the Late Holocene, or during the manufacture of Clovis, Gatecliff, and Humboldt projectile points. However, Western Stemmed groups appeared to favor Tosawihi over Little Boulder Basin, while Middle Holocene foragers favored Little Boulder Basin over Tosawihi. In addition, during the early Late Archaic (Eastgate and Rose Spring), Little Boulder Basin was preferred over the Tosawihi region to the north during large game hunting forays. This is also confirmed by the fact that gray ware ceramics of the Fremont tradition are also found in much greater frequency in Little Boulder Basin than at Tosawihi. Foraging during the Fremont period, then, was more focused in Little Boulder Basin than at Tosawihi. During the final phases of the Late Archaic, with the manufacture of Desert Side-Notched points indicative of Western Shoshone occupation, focus shifted northward into the Tosawihi region. Neither phase eschewed the other

region during the Late Archaic, but clearly differences in land use are seen. One implication of these data may be that the pre-550 BP foragers did not ascribe the same importance to the Tosawihi Quarries as did the Western Shoshone. If that is the case, then Tosawihi as a sacred locale may be restricted in time to the Protohistoric. This is, of course, highly speculative, but remains a possibility.

Table 5. Total number of projectile points recorded from surveys in Little Boulder Basin through 1995 (Schroedl 1996).

Type	Phase	Number Found	Points/Century
Desert Side-Notched/Cottonwood	Eagle Rock 550 BP – 50 BP	79	15.8
Rose Spring/Eastgate	Maggie Creek 1,300 – 550 BP	248	33.0
Elko	James Creek 3,500 – 1,300 BP	236	10.7
Gatecliff/Humboldt	South Fork 5,000 – 3,500 BP	123	8.2
Large Side-Notched	Pie Creek 7, 500 – 5,000 BP	29	1.2
Great Basin Stemmed	Dry Gulch 10,800 – 7,500 BP	1	.03
Clovis	Izzenhood 11,500 – 10,800 BP	0	0

Near Spruce Mountain, a sample of nearly 1,200 projectile points produced the patterns displayed in Table 6 (Hockett 2005:727, Table 9). The general patterns here are: (1) low numbers of points during the Late Pleistocene and Early Holocene; (2) increases in large game hunting intensity during the Middle Holocene; (3) a dramatic increase in points beginning about 5,000 BP; and (4) a drop in large game hunting during the James Creek Phase. At Spruce, there was a continued drop in the intensity of large game hunting during the earliest phase of the Late Archaic; in contrast, large game hunting increases at this time at both Tosawihi and Little Boulder Basin. Similar to Tosawihi, large game hunting increased again rather dramatically during the past 550 years near Spruce Mountain.

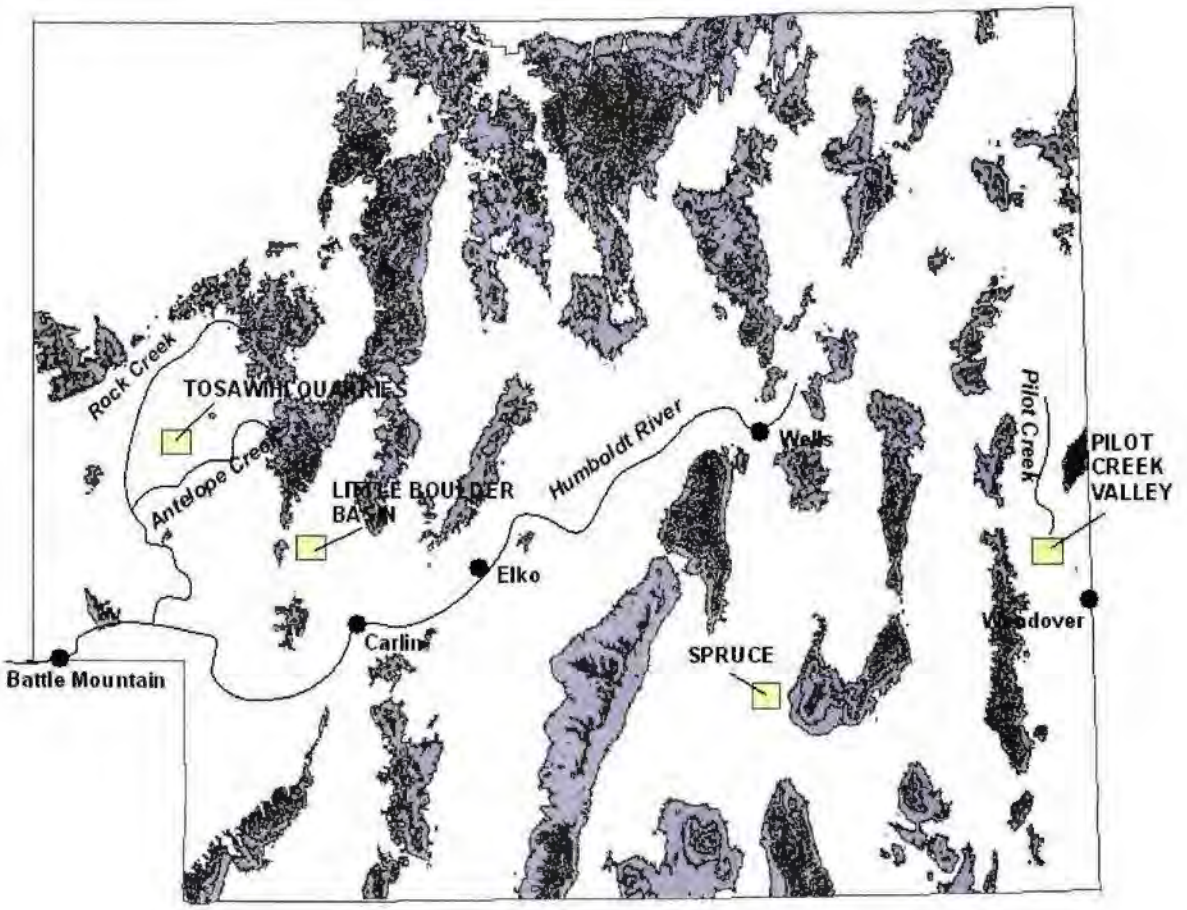


Figure 4. General location of the four study areas discussed in the text.

Table 6 Total number of projectile points recorded near Spruce Mountain through 2004 (Hockett 2005).

Type	Phase	Number Found	Points/Century
Desert Side-Notched/Cottonwood	Eagle Rock 550 BP – 50 BP	124	22.5
Rose Spring/Eastgate	Maggie Creek 1,300 – 550 BP	115	15.3
Elko	James Creek 3,500 – 1,300 BP	428	19.5
Gatecliff/Humboldt	South Fork 5,000 – 3,500 BP	437	29.1
Large Side-Notched	Pie Creek 7, 500 – 5,000 BP	34	1.4
Great Basin Stemmed	Dry Gulch 10,800 – 7,500 BP	29	.88
Clovis	Izzenhood 11,500 – 10,800 BP	0	0

In Pilot Creek Valley, Moore (1994) reported on the recordation of 265 typable points across a survey area encompassing 18,500 acres in both lowland and upland settings. The breakdown of the chronological distribution of these points is displayed in Table 7. These data show the same patterns of relatively low numbers of points during the Izzenhood and Dry Gulch phases, either suggesting low population densities, a lower reliance on large game hunting compared to later periods, or both. Again, the intensity of large game hunting increases during the Middle Holocene, and then rather sharply spikes at the beginning of the Late Holocene during the South Fork Phase, just as they do at Tosawihi, Little Boulder Basin, and Spruce. A difference in Pilot Creek Valley, however, is that the sharpest spike in large game hunting occurs during the James Creek Phase during the middle portion of the Late Holocene rather than earlier in the beginning of the Late Holocene. Large game hunting drops but remains relatively elevated during the earliest Late Archaic, and then spikes again to its highest level during the Protohistoric, the latter pattern of which was also seen at Tosawihi and to a lesser extent at Spruce.

Table 7. Total number of projectile points recorded in Pilot Creek Valley and the Toano Range (Moore 1994).

Type	Phase	Number Found	Points/Century
Desert Side-Notched/Cottonwood	Eagle Rock 550 BP – 50 BP	35	6.4
Rose Spring/Eastgate	Maggie Creek 1,300 – 550 BP	30	4.0
Elko	James Creek 3,500 – 1,300 BP	137	6.2
Gatecliff/Humboldt	South Fork 5,000 – 3,500 BP	50	3.3
Large Side-Notched	Pie Creek 7, 500 – 5,000 BP	7	.28
Great Basin Stemmed	Dry Gulch 10,800 – 7,500 BP	5	.15
Clovis	Izzenhood 11,500 – 10,800 BP	1	.14

Together, the projectile point data from Tosawihi, Little Boulder Basin, Spruce Mountain, and Pilot Creek Valley suggest low intensity large game hunting during the Late Pleistocene and Early Holocene. At this time, large game hunting may not have been as important as later time periods, a conclusion recently advanced by Hockett (2005) for the Middle Holocene and by Hildebrandt and McGuire (2002) and McGuire and Hildebrandt (2005) for the Late Holocene. The fact that these data may be reflecting intensity of large game hunting more than population size per se, however, may be more applicable to the Dry Gulch (Stemmed Series) phase rather than the Izzenhood (fluted) phase. There is a rather sharp increase in the number of Dry Gulch Phase sites compared to sites that contain fluted points in northeastern Nevada. In the four samples here, there were only two fluted artifacts recorded – a Clovis perform at Tosawihi and a probable broken fluted point from Pilot Creek Valley. This confirms the results of survey data from the rest of the region, where only 6-7 fluted points have been found in nearly 30 years of survey (Fawcett and Hockett 2006). If Haynes (2002) is correct that the earliest foragers in western North America chose a hunting strategy that focused on large megafauna, then the low numbers of fluted points recorded from the region may be a better reflection of low human population density coupled with high mobility rather than a reflection of the reliance on large mammal resources for sustenance. If this is the case, then it would further suggest that megafaunal populations were likely exceedingly sparse in the central Great Basin between 11,500 and 10,800 BP (see also Willig and Aikens 1988).

Although the intensity of large game hunting may not have been dramatic as measured by number of points per century during the subsequent Dry Gulch phase, the number of locales or sites containing Great Basin Stemmed points does jump considerably compared to the Izzenhood Phase (Fawcett and Hockett 2006). This suggests the first population pulse occurred in this part

of the Great Basin between 10,800 – 7,500 BP. As examples, while no fluted points were found at Spruce, several Stemmed sites were recorded there, no fluted points have been found in Little Boulder Basin but a Stemmed point was recovered, a single Clovis perform was found at Tosawihi but 22 Stemmed points were recovered from several different sites, and so forth. This general pattern of no fluted points present but one or more stemmed points present has been documented at over 100 localities across northeastern Nevada over the past 30 years (e.g., Frampton et al. 1985; Murphy and Frampton 1985; Hockett 1991; Malinky and Goebel 2003; Fawcett 2005; Baker and Goebel 2006; Fawcett and Hockett 2006). Additionally, recent data from Bonneville Estates Rockshelter (Goebel et al. 2003) confirm that the intensity of site occupation rose sharply during the Dry Gulch phase compared to earlier occupations -- and the subsistence pattern at this time was not focused on large game hunting but rather on a broad-based, eclectic diet. Thus, the relatively low numbers of points per century during the Dry Gulch phase is probably based on a number of factors, including (1) relatively low levels of population compared to Late Holocene levels, although populations grew considerably over that seen during the Izzenhood phase; and (2) a diverse diet that focused extensively on marsh resources in lowland habitats and a wide variety of resources in mid-slope and upland settings that included large mammals, small mammals, birds such as sage grouse, insects, and most likely plant resources such as fruits.

Recently, I suggested that Middle Holocene foragers relied on large game animals more so than did Early Holocene foragers, as seen at a number of cave and rockshelter sites across the Great Basin (Hockett 2005). Interestingly, the data from the four samples of projectile points described above generally corroborate this pattern. Ironically, populations appeared to have declined in many regions of the Basin at this time as well, or during the transition between the Dry Gulch and Pie Creek phases, including at Bonneville Estates Rockshelter. Nevertheless, the numbers of Large Side-Notched points per century actually increases compared to Late Pleistocene and Early Holocene levels. There is a possibility, then, that when Middle Holocene groups forayed into these regions they were seeking large mammal resources more intently than the Dry Gulch phase foragers.

The Late Holocene in the Great Basin seems to indicate that both human populations and large game hunting patterns differed considerably from those seen in earlier times. Sites that contain Gatecliff and Humboldt points are more numerous than sites that contain Large Side-Notched points, and large game hunting spikes considerably from the Dry Gulch phase based on numbers of points per century. Whether this pattern suggests greater reliance on large game and larger populations is difficult to assess. Faunal data from sites such as Bonneville Estates Rockshelter suggest that large game may have been as important to Middle Holocene foragers, and perhaps even more so, than Late Holocene foragers, despite the presence of fewer people. In any case, it seems clear that large game hunting was a significant subsistence component to early Late Holocene foragers throughout northeastern Nevada, including at the Tosawihi Quarries.

The middle portion of the Late Holocene shows interesting variability in the degree of large game hunting. This period, generally associated with the James Creek Phase, as well as the heart of the cool and moist Neoglacial, has been described as the "Good Times" by Elston (1982). That this period has been characterized as "good times" for Great Basin foragers seems

like a fair representation. These good times, however, did not necessarily mean that foragers were dining more frequently on steak covered with A-1 sauce. At Tosawihi and Spruce Mountain, there was a 30% drop in the number of points per century in each of these areas between the South Fork and James Creek phases, suggesting that the intensity of large game hunting relaxed there. However, in Little Boulder Basin south of Tosawihi, there is a 30% increase in points per century. This may suggest a shift in hunting grounds from further northward in the immediate vicinity of Tosawihi in the South Fork phase to a greater emphasis in Little Boulder Basin to the south during the James Creek phase. Thus, the Tosawihi-Little Boulder Basin region may document a shift in favored hunting grounds for large game between 5,000 and 1,300 BP rather than reductions in intensity through time per se. Spruce, however, displays a more complex pattern. There is a 33% reduction in points per century in the Spruce area during the James Creek phase. The vast majority of the points from this sample come from communal kill spots (Hockett 2005). This reduction in points could have been caused by a number of factors, including reduced frequencies of communal kills or changes in killing technique from an emphasis on shooting or stabbing to clubbing and strangling. It is impossible at this time to know which of these possibilities, or others, caused this reduction in the intensity of points during the 'Good Times' of the James Creek phase. One of these other possibilities, however, might be a shift in the location of hunting grounds similar to that seen between Tosawihi and Little Boulder Basin. In Pilot Creek Valley, located about 100 km (~50 miles) northeast of the Spruce area, points per century increased by 88% between the South Fork and James Creek phases. This suggests dramatic increases in large mammal hunting by foragers manufacturing Elko projectile points in this valley and nearby uplands such as the Toano Range. An interpretation of a shift in hunting grounds, of course, would assume that the foraging range of these peoples extended across both the Spruce Mountain and Pilot Creek Valley areas, which is certainly a possibility. In sum, then, there may or may not have been a fundamental change in the degree of large game hunting intensity between the early and middle phases of the Late Holocene; rather this period may have been characterized by shifts from one valley to another without entirely ignoring the previous preferred hunting grounds of the South Fork Phase. Alternatively, if foraging radii were being reduced because of increases in population during the James Creek phase, then the data from Spruce and Pilot Creek Valley, for example, may well indicate that some populations were able to rely on large game resources to greater degrees than other forager groups – in other words, we may not have a one-size-fits-all scenario, and perhaps, just perhaps, we need to not look at all of the Great Basin foraging societies during the James Creek phase under a single, normative umbrella, with all foraging groups behaving precisely the same way.

The introduction of the bow-and-arrow and the beginning of the archaeologically-defined Late Archaic in the central Great Basin witnessed the influence of Fremont material culture in northeastern Nevada, including all four areas of projectile point distributions considered here. This period, represented by the Maggie Creek phase, is generally associated with a warm and wet climatic pattern and the concomitant expansion of grassland habitat along with relatively small herds of bison (Currey and James 1982; Grayson 1993). Compared to the preceding James Creek Phase, the earliest Late Archaic foragers reduced their intensity of large game hunting at both Spruce and Pilot Creek Valley, while large game hunting expanded considerably in the Little Boulder Basin-Tosawihi Quarries area. In the case of Spruce Mountain and Pilot Creek Valley,

points per century dropped by 22% and 35%, respectively. However, at Little Boulder Basin and Tosawihi, points per century increased by 200% and 120%, respectively. This variability between the two general regions of northeastern Nevada is most intriguing, and once again suggests that caution must be exercised in making sweeping generalizations about large game hunting across the Basin during specific time periods; it also suggests that micro scale patterns do not always mirror larger, macro-scale patterns.

There is probably enough accumulated evidence now to suggest that previous interpretations of Protohistoric Great Basin foragers as relying primarily on small game and seed resources is simply in error. Three of the four regions analyzed here show relatively substantial increases in points per century during the Eagle Rock phase compared to Maggie Creek phase levels. At Pilot Creek Valley and Spruce points per century rise by 60% and 47%, respectively. It is unlikely that these data are simply the result of sample bias due to the recent accumulation of these sites. Northeastern Nevada also contains one of the highest concentrations of aboriginal pronghorn corrals known from western North America (e.g., Hockett 2005), so large game hunting was clearly important to some Protohistoric groups. In the Little Boulder Basin-Tosawihi Quarries area, as noted previously, points per century from the Maggie Creek to the Eagle Rock phases dropped by 53% in Little Boulder Basin at the same time that they increased by 340% at Tosawihi. Again, sweeping generalizations are not likely to be very useful in describing land use patterns at the micro-scale level, the latter of which more closely matches the social and environmental circumstances in which individual foraging societies were engaged during decision-making about subsistence.

CONCLUSION

In summary, the Tosawihi Quarries remain largely intact. Although mining continues within the Quarries, all of the current facilities have been placed within the two existing open pits that were excavated in the extreme southwestern corner of the District in the 1980s. The current mining operation is underground, where deep veins of gold and silver are sought. The Tosawihi Quarries Archaeological District (26EK6624) is about 4,000 acres in size. It contains over 160 loci eligible for the National Register of Historic Places. These loci include quarry pits where the mining of toolstone took place, rockshelters, campsites, lithic reduction stations, and sacred spots. While the Quarries have obvious significance as a source of raw material for making stone tools, it is equally apparent that the area served a variety of other purposes over the past 13,000 years. Large game hunting was one of these purposes. Others include plant processing (milling stones are not uncommon in and surrounding the District) and as a place for sacred ceremonies. The District boundaries contain two perennial springs, two additional perennial springs are located at the base of Big Butte just to the north of the Quarries, and, during above-average water years, water perennially flows down Little Antelope Creek within the heart of the District. In short, water was not a limiting factor, nor were plant and animal resources. The region continues to support populations of mountain sheep, pronghorn, deer, marmots, squirrels, hares, and rabbits. Important plant resources including Great Basin wild rye, Indian ricegrass, and wild onion are all abundant throughout the District and surrounding area. In short, the Tosawihi Quarries had it all – plant and animal resources, perennial water sources, and abundant toolstone.

Few loci have been investigated at the Tosawihi Quarries. The survey and excavation work completed by IMR in the 1980s and early 1990s established a baseline for future studies of the prehistoric use of this important region of northeastern Nevada.

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Appendix 1.

List of the major surveys in and near the Tosawihi Quarries Archaeological District since 1977. The list is in order, from earliest to latest, based on the BLM report number. Report numbers preceded by an asterisk (*) are included in this BLM compilation of reports.

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BLM1-2409(P). (2004). "Ken and Stone Mining Notices. BLM. Bryan Hockett.

BLM1-2439(P). (2004). "Geologix Mining Notice in the Silver Cloud Area." BLM. Bryan Hockett.

BLM1-2440(P). (2004). "Newmont's Gov-Fox Mining Notice." BLM. Bryan Hockett.

BLM1-2481(P). (2004). "Reliance Geological Services Mining Notice – Ivanhoe Creek Area." BLM. Bryan Hockett.

Appendix 2.

Newly designated loci in the Tosawihi Quarries Archaeological District (26EK6624) cross-referenced with their previously designated site/locus numbers. A * designates a newly defined boundary for a locus by the BLM using GPS technology. All other boundaries were taken from site reports.

New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #
1	26EK3509	2	26EK3249/3250	3	26EK3263
4	26EK3226; 26EK3032 - locus 181	5	26EK4663	6	26EK3052
7	26EK3055	8	26EK3068	9	26EK3053
10	26EK3076	11	26EK3127	12	26EK3140
13	26EK3078	14	26EK3073	15	26EK3062
16	26EK3070	17	26EK3069	18	26EK3071
19	26EK3060	20	26EK3057	21	26EK3050
22	26EK3058	23	26EK3049	24	26EK3045
25	26EK3032 - loci 156, 157	26	26EK3032 - loci 148, 149	27*	26EK3032 - loci 158, 159
28*	26EK3032 - locus 161	29*	26EK3032 - loci 162, 163, 165, 166, 169, 188	30	26EK3032 - locus 194
31*	26EK3032 - loci 42, 43, 44, 46, 47, 64, 91, 102, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205	32	26EK3103; 26EK3032 - locus 45	33*	26EK3032 - loci 151, 152, 153, 154, 155, 177, 219

New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #
34*	26EK3032 - loci 63, 65, 67, 68, 69, 78, 79, 86, 87, 104, 107, 108	35*	26EK3032 - loci 77, 81, 103, 105, 106	36*	26EK3032 - loci 82, 83, 84, 85, 124, 209, 214, 215, 224
37*	newly defined locus	38*	26EK3032 - loci 127, 128, 211, 212	39*	newly defined locus
40	26EK3222; 26EK3032 - locus 125	41	26EK3218; 26EK3032 - locus 120	42	26EK3220; 26EK3032 - locus 122
43	26EK3221; 26EK3032 - locus 123	44	26EK3217; 26EK3032 - locus 119	45	26EK5080
46	26EK3216; 26EK3032 - locus 118	47	26EK3215; 26EK3032 - locus 117	48	26EK3227; 26EK3032 - locus 210
49	26EK3214; 26EK3032 - locus 116	50	26EK3212; 26EK3032 - locus 114	51*	26EK3032 - loci 70, 92, 109, 110, 111, 112, 113, 213
52*	26EK3032 - loci 71, 72, 73, 74, 75, 76	53*	26EK3032 - loci 62, 100, 222	54*	26EK3032 - loci 60, 61
55	26EK3213; 26EK3032 - locus 115	56	26EK3032 - loci 59, 66	57*	26EK3032 - loci 57, 58, 80

New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #
58*	26EK3032 - locus 56	59	26EK3211; 26EK3032 - locus 55	60	26EK3210
61*	26EK3032 - loci 52, 54	62	26EK3209; 26EK3032 - loci 53, 95	63*	newly defined locus
64*	26EK3032 - locus 51	65*	26EK3032 - loci 33, 49, 50, 88, 89, 99	66*	26EK3032 - loci 30, 96, 97
67*	26EK3032 - locus 30	68*	newly defined locus	69*	newly defined locus
70*	newly defined locus	71*	26EK3032 - loci 32, 90	72	newly defined locus
73*	26EK3032 - loci 37, 39, 40, 41, 48	74*	26EK3032 - locus 101	75*	26EK3032 - locus 226
76*	26EK3032 - loci 34, 206	77*	26EK3032 - loci 25, 35, 36, 225	78	26EK3032 - loci 24, 164, 208
79*	26EK3032 - loci 27, 28, 29	80*	26EK3032 - locus 10	81	26EK3032 - locus 220
82	26EK3032 - locus 221	83*	26EK3032 - loci 16, 17	84*	newly defined locus
85	26EK3205	86	26EK3206	87*	newly defined locus

New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #
88*	newly defined locus	89*	newly defined locus	90*	newly defined locus
91	26EK5044	92*	newly defined locus	93	26EK3199
94	26EK3176	95	26EK5046	96	26EK5077
97	26EK5048	98	26EK5047	99	26EK5049
100	26EK5051	101	26EK5072	102	26EK5073
103	26EK5076	104	26EK5071	105	26EK5065
106	26EK5052	107	26EK5067	108	26EK5050
109	26EK5054	110	26EK5053	111	26EK5058
112	26EK5068	113	26EK5069	114	26EK5059
115	26EK5066	116	26EK5060	117	26EK5062
118	CRNV-12-11402	119	CRNV-12-10505	120	CRNV-12-11527
121	CRNV-12-11404	122	CRNV-12-11405	123	CRNV-12-11789
124*	newly defined locus	125	CRNV-12-11403	126	26EK3032 - loci 1, 2, 3, 4, 5, 6, 7, 8, 9
127	26EK3032 - loci 11, 14, 15, 126	128	26EK3032 - locus 31	129	26EK3032 - locus 38
130	26EK3032 - locus 94	131	26EK3032 - locus 121	132	26EK3032 - loci 129, 131

New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #	New Locus #	Previous Site/ Locus #
133	26EK3032 - locus 130	134	26EK3032 - loci 132, 133	135	26EK3032 - locus 134
136	26EK3032 - locus 135	137	26EK3032 - loci 136, 137, 138	138	26EK3032 - loci 139, 140, 141
139	26EK3032 - loci 142, 143	140	26EK3032 - loci 144, 146, 147	141	26EK3032 - locus 145
142	26EK3032 - locus 150	143	26EK3032 - loci 160, 167, 168	144	26EK3032 - locus 170
145	26EK3032 - loci 171, 172, 173, 174, 175	146	26EK3032 - locus 176	147	26EK3032 - loci 182, 183
148	26EK3032 - loci 184, 185, 186, 187, 189	149	26EK3032 - loci 190, 191, 192, 193, 207	150	26EK3032 - locus 216
151	26EK3032 - loci 217, 218	152	CRNV-12-8968	153	newly defined locus
154	newly defined locus	155	newly defined locus	156	newly defined locus
157	newly defined locus	158	newly defined locus	159	newly defined locus
160	newly defined locus	161	newly defined locus	162	newly defined locus
163	newly defined locus				

Appendix 3.

Sites eligible or unevaluated within the newly defined boundaries of the Tosawihi Quarries Archaeological District (26EK6624 and CRNV-11-10319).

Site #	BLM Report #
26EK3032	BLM1-489(P); BLM1-1101(P); BLM1-1327(P); BLM1-1878(P)
CRNV-12-10505	BLM1-1506(P)
26EK5044, 26EK5046, 26EK5047, 26EK5048, 26EK5049, 26EK5050, 26EK5051, 26EK5052, 26EK5053, 2KEK5054, 26EK5058, 26EK5059, 26EK5060, 26EK5062, 26EK5065, 26EK5066, 26EK5067, 26EK5068, 26EK5069, 26EK5071, 26EK5072, 26EK5073, 26EK5076, 26EK5077, 26EK5080	BLM1-1461(P)
CRNV-12-11402, CRNV-12-11403, CRNV-12-11404, CRNV-12-11405	BLM1-1720(P)
CRNV-12-11527	BLM1-1747(P)
CRNV-12-11789	BLM1-1883(P)
26EK3209, 26EK3210, 26EK3211, 26EK3212, 26EK3213, 26EK3214, 26EK3215, 26EK3216, 26EK3217, 26EK3218, 26EK3220, 26EK3221, 26EK3222, 26EL3226, 26EK3227	BLM1-1101(P), VOLUME 1
26EK3045, 26EK3049, 26EK3050, 26EK3052, 26EK3053, 26EK3055, 26EK3057, 26EK3058, 26EK3060, 26EK3062, 26EK3068, 26EK3069, 26EK3070, 26EK3071, 26EK3073, 26EK3076, 26EK3078, 26EK3103, 26EK3127, 26EK3140	BLM1-1124(P)
26EK3176, 26EK3199, 26EK3205, 26EK3206	BLM1-1161(P)
26EK3249, 26EK3250, 26EK3263, 26EK3509, 26EK4663	BLM1-1181(P), VOLUME 1

Appendix 4.

Sites mitigated within the newly defined boundaries of the Tosawihi Quarries Archaeological District (26EK6624).

Site #	BLM Report #
26EK3208/3085	BLM1-1101(P); BLM1-1124(P); BLM1-1207(P); BLM1-1668(P)
26EK3084; 26EK3092; 26EK3095	BLM1-1124(P); BLM1-1207(P); BLM1-1668(P)
26EK3170; 26EK3171; 26EK3184; 26EK3192; 26EK3195; 26EK3198; 26EK3200; 26EK3204	BLM1-1161(P); BLM1-1207(P); BLM1-1668(P)
26EK3032, LOCALITY 36; Note: Mitigated for criterion "d" only; BLM considers the site still eligible under criterion "a"	BLM1-1362(P)

Appendix 5.

Sites mitigated near the boundaries of the Tosawihi Quarries Archaeological District (26EK6624) and the Tosawihi Quarries Traditional Cultural Property (CRNV-11-9932).

Site #	Report #
26EK3160, 26EK3165	BLM1-1124(P), BLM1-1207(P), BLM1-1668(P)
26EK3237, 26EK3251	BLM1-1181(P), BLM1-1668(P)
26EK5040	BLM1-1449(P), BLM1-1641(P), BLM11845(P)

Appendix 6.

Sites eligible or unevaluated within 2 miles of the newly defined Tosawihi Quarries Archaeological District (26EK6624)and Tosawihi Quarries Traditional Cultural Property (CRNV-11-9932).

Site #	BLM Report #
26EK3223, 26EK3224, 26EK3225	BLM1-1101(P), VOLUME 1
26EK3051, 26EK3065, 26EK3067, 26EK3131, 26EK3132, 26EK3133, 26EK3134, 26EK3135, 26EK3141, 26EK3145, 26EK3151, 26EK3153, 26EK3154, 26EK3156, 26EK3157, 26EK3158, 26EK3159, 26EK3164	BLM1-1124(P)
26EK3246, 26EK3247, 26EK3252, 26EK3253, 26EK3254, 26EK3255, 26EK3262, 26EK3267, 26EK3269, 26EK3510, 26EK3511, 26EK3512, 26EK3513, 26EK3514, 26EK3515	BLM1-1181(P), VOLUME 1
26EK5043	BLM1-1448(P)
CRNV-01-128; CRNV-12-8229, CRNV-12-8242, CRNV-128243, CRNV-12-8244	BLM1-102(P); BLM1-1328(P)
CRNV-12-11927	BLM1-1907(P)
CRNV-12-11928, CRNV-12-11929, CRNV-12-11940	BLM1-1909(P)
CRNV-01-190, CRNV-01-192	BLM1-185(P); BLM1-561(P)
CRNV-01-187	BLM1-162(P)
CRNV-11-9675	BLM1-1770(P) Note: Approximately 3 miles from Quarries
CRNV-12-11983	BLM1-1927(P) Note: Approximately 3 miles from Quarries

TOSAWIHI QUARRY

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WHO ARE THE WHITE KNIFES (TOSAWIHI)?

The White Knife Shoshone are known from anthropological literature (Harris 1938, 1940), but their existence as an actual socio-political entity was denied by Julian Steward (1938:162, 238; 1939) who is widely accepted as the ethnographic authority on the Great Basin. Named "Tosawihi" ("white" + "knife" or "sharp-thing-for-shooting") because of their use of white chert from a quarry near present-day Battle Mountain, Shoshones in that vicinity were designated as "White Knives" by Indian agents, other Shoshones, and various contemporary observers (Holeman 1852; Hurt 1857; Forney 1858, 1859; Wasson 1862; Powell and Ingalls 1874.)

The question of White Knife (Tosawihi) ethnic identity is one of the most intriguing problems in recent Great Basin culture history. Steward (1938: 248, 162) tossed off the question of Tosawihi identity with this assessment:

> Among Shoshoni from the Snake River, Idaho, to Death Valley, California, the largest permanent organization was the village. There is not a single feature which warrants calling any of them a "band." There are no sharp dialectic, cultural, or political boundaries, nor well-defined named groups larger than the village.....The much publicized Tosawi or White Knife people of the Battle Mountain region are so called because an excellent grade of white flint occurs in that country....They had no organization and were not a band. People who wintered on the Humboldt River above Battle Mountain were called Tosawi (tosa, white and wi, knife) because they procured...white flint for knives in the mountains to the north. This name, unfortunately, became prominent and led to the fiction that all the Shoshoni in a large area around Battle Mountain had comprised a band by this name. Because, like other Shoshoni group names, Tosawi did not designate a definitely bounded linguistic, political, cultural or even geographical division, no two writers have agreed on its use.

The Tosawihi chert quarry locality is the source of a knappable lithic material about 30 miles east of the Osgood Mountains, a generally agreed upon boundary between historic Northern Paiute and western Shoshone groups. There is ethnographic record of its use as far north as the Snake River plain. The archaeological distribution of this material has been interpreted as reflecting one of three sets of conditioning factors:

1. band territory, direct contact zone or trade networks;

2. variation in the physical characteristics related to knappability of available raw materials;

3. variation in the intended use of the manufactured tools (Rusco 1976: 2).

In 1974, Mary Rusco obtained a sample collection from the quarry and compared it, on the basis of macroscopic similarity, to Tosawihi chert in flake stone artifact collections from a series of sites up to as far north or east of the quarry as 150 miles, but all within historic western Shoshone territory. The chert was not found in collections west of the Osgood Mountains

although many of these sites are closer to the quarry than others where the chert has been found. A few sites in Northern Paiute territory have turned up some Tosawihi chert, but the apparent distribution of the Tosawihi chert in relation to the location of the quarry and to the historic boundary between Northern Paiute and Western Shoshone raises a number of questions (Rusco 1976.)

Does the distribution of the chert mark, in fact, the boundaries of a use area? Or does it mark the boundaries of an actual band territory? Could the availability of good quality obsidian from localities just west of the Osgood Mountains have simply made importation of the Tosawihi chert – however near – simply unnecessary? Or could it be that similar materials – that is, quartzite-type materials from other localities, two of which have been identified approximately 80 miles northwest and 150 miles southwest, respectively of the Tosawihi locality, have been mistaken for the Tosawihi chert (Rusco 1976: 3)?

In a monograph entitled "The White Knife Shoshoni of Nevada," Jack Harris (1940: 39) says:

> Before the advent of the Whites, the TOSAWIHI Shoshone ranged over that portion of the Great Basin now included in the northeastern section of the state of Nevada....In the summer, the camps foraged for food as far north as the Snake River and some few went south to Austin and Eureka....It appears, however, that this term was restricted at one time to those camps in the immediate vicinity of Tuscarora and Battle Mountain where white flint for knives and other artifacts is found. The White Knives are not to be considered as having a band organization with the traditional ethnological connotations of restriction and cohesiveness. The term was primarily geographical, designating a shifting membership of Indians who were also known by a number of other names depending upon their temporary location or their principal food supply.

Indian agents' reports give a very different picture. They talk of White Knives being a distinct band, migrating between the Humboldt and Snake Rivers, and sometimes going south and interfering with groups in Ruby Valley. It is unclear whether these bands were mounted or not. Most Western Shoshone bands were not mounted prior to 1860, if at all; but the White Knives seem to have been mounted earlier than 1860, and being mounted permitted them greater mobility earlier than other Shoshones south of the Snake River.

One of the fuller accounts of "White Knives" in Indian agents' reports is in a letter by Jacob Forney, Superintendent of Indian Affairs in Salt Lake City, to the Commissioner of Indian Affairs in 1858. Forney mentioned meeting a group that he called "White Knives" numbering 200 or 300 people at Stony Point, near Battle Mountain. He said these people planned to winter on the Snake River where the fishing was very good. According to Forney, the group had a chief with "complete control."

It seems that the White Knives, whoever they were, moved around quite a bit and did so en masse, as a group. In 1862, they were in Ruby Valley. Nye (1862) was "informed that about one-half of the Indians belonging in Ruby Valley had left for the 'White Knife' country in the Upper Humboldt on account of the late difficulties consequent upon the death of their chief

'Sho-kub.'" The difficulty probably centered on whether Buck or Temoke would be the acknowledged leader, with Buck leading the Tosawihi back to the White Knife country and Temoke remaining in Ruby Valley (See Clemmer 1988 for a fuller account.)

Warren Wasson (1862), an Indian agent under Nye, also indicated the mobility and distinct identity of the "White Knives" in warning Nye that "the danger of interruption by Indians to the mail and telegraph lines apprehended during the coming Spring is from a band of the Sho sho nees called "White knives' occupying the country between the Upper Humboldt and the present mail road...." If there were White Knives on the Snake River, the Humboldt River, near Battle Mountain, and in Ruby Valley, they certainly must have had horses, and there must have been some mechanisms for White Knife people themselves as well as for others to keep track of the identity. If so, what were they?

In 1970, a Shoshone consultant living in Elko gave me the impression that White Knives had been a group with very definite "connotations of restriction and cohesiveness." I was told that descendents of White Knifes lived only at Wells, Nevada, and on the Duck Valley Reservation, and that they had been "sent" to Duck Valley as punishment for stealing cattle from Ruby Valley Shoshones, and that Duck Valley was their "concentration camp."

The enigma of White Knife group-definition is part of a larger question concerning the nature of social organization in the Great Basin. Omer Stewart (1942, 1964, 1978) and Elman Service (1962: 98-99) argued directly against Steward's (1938) assertion that band formation in the Great Basin was a post-contact process. Stewart (1964) argued on the basis of his own empirical data on Northern Paiutes and on the basis of an analogy between territoriality in humans and territoriality in primates. Service relied heavily on Powell's and Ingall's (1874) data reporting that the Shoshone of central Nevada had been divided into 31 "tribes," each with a distinct, named territory, before being reduced to the "demoralized state" in which Powell and Ingalls found them as a result of White intrusion. (See Fowler and Fowler 1971: 38-107. The table on page 105 actually lists 33 "tribes," not 31.) Steward countered the arguments and assertions in 1955, 1965, and 1970.

Could "Tosawihi" have been an identity without being a "tribe" or "band?" If so, how would that identity be maintained over generations and how would it be expressed? No work had ever been done on how the "White Knifes" perceived themselves; who they really were; and whether or not they would have survived the reservation era, either as an ethnic entity or as a memory. If Steward were correct, their total disappearance would be a logical prediction, since the quarrying of white flint must have ceased shortly after construction of Camp Ruby in 1862.

The only research done on the "White Knifes" was by Jack and Martha Harris on the Duck Valley Reservation in summer of 1937. Harris used the term merely to designate the Shoshone-speaking population of Duck Valley, and to distinguish it from the Northern Paiute-speaking population. In his short monograph, Harris (1940) did not address the question of White Knife ethnicity, its definition, or its parameters. He uses "White Knife" to describe people that Indian agents referred to sometimes as White Knifes and sometimes merely as Shoshones. He does not say what the people he spoke with at Duck Valley called themselves, nor did he seem to consider the possibility that the White Knives were a distinct group who were moved

onto Duck Valley after intermarrying with other Western Shoshones south of Battle Mountain and in Ruby Valley for several previous generations.

RESEARCH DESIGN

The theoretical problem is, in terms of the controversy over "bandness" which led Steward and Stewart to publish a series of parries and thrusts over a 36-year period, actually threefold with regard to the Tosawihi *ethnie*: (1) Did the label designate an actual group of people who alone, and exclusively, used the white chert to make knives, scrapers, and other items? and thus identify a way of life that had, as a substantial component, the quarrying of this white chert and the shaping of it into tools and the use of the area around the quarry?

(2) A derivation from the above question is: would quarrying of the flint have led to exclusive rights, ownership, trading monopoly and political hegemony such that one could recognize the existence of a distinct "band" defying Steward's insistence to the contrary? At one level, the distinction of "White Knifes" historically must have proceeded from a "we/they" dichotomy fundamental to ethnicity (Barth 1969: 14; Vincent 1974: 375-379.) Was the Tosawihi identity confirmed by cultural norms that can be recognized as exclusive rights, that is ownership? And further: can the archaeological distribution of the white chert tools be taken as an indication of a pivotal position of this group as traders with exclusive trading rights? Or does the distribution reflect an area of use and occupation?

(3) The third problem is contemporary: Was there ever, and is there still, a "White Knife" ethnicity at Duck Valley? Or was Jack Harris merely using a convenient label? Barth (1969: 12) notes the problem in this way with regard to studies of culture change and acculturation in general:

> What is the unit whose continuity in time is depicted in such studies? Paradoxically, it must include cultures in the past which would clearly be excluded in the present because of differences in form – differences of precisely the kind that are diagnostic in synchronic differentiation of ethnic units.

In other words, if White Knifes were distinguishable historically by their use of white flint and their area of residence, as opposed to other Western Shoshone groups, would they as an ethnic group, be distinguishable from Indians living on the Duck Valley Reservation, or elsewhere, today? If so, how? If it does survive, why and how does it survive in the face of competing ethnicities?

The first two problems can be tackled only indirectly through ethnographic method. Only traditions and oral histories would be left from which to derive any inferences, and thus evidence would be very indirect. However, the third problem can be tackled directly through ethnographic method. It is possible to construct a set of hypotheses and alternate hypotheses that combine several different theories. For example, once a "tribe" such as the "Sho-Pai Tribe" has been "constructed" through a rational-contractual process such as referenda, the drawing up of a tribal constitution that regularizes relationships between the group in question and the U.S.

Government and establishes the rights and obligations of the members of the tribe, regardless of ethnic identity, might well put into place certain political, economic, and social processes that would create a certain uniformity of attitude, behavior, and social life that would result in a configuration of culture that would have many more specific characteristics of the particular reservation in question, and of reservations in general, than of the ways of life that had previously characterized the ancestors of the population on the reservation.

Thus, any previously existing ethnicity would be submerged under the new "tribal" ethnicity. If the "old ethnicities" had ever existed, they would survive as myths and memories marking a way for individuals to maintain ethnic identity – that is, as a set of stories and symbols expressing claims about the group's origins and lines of descent. Anthony Smith (1986: 57-58) calls this myth-symbol complex a "MYTHOMOTEUR," and assumes its existence only within a political context. Individuals would manipulate their identities by manipulating the symbolic pattern language associated with them. But without the political context, why should an identity such as "White Knife," so closely tied to use of a specific resource (white chert) from a specific place, persist, with no advantage to convey and no daily activity to reinforce it?

However, if ethnic identity is closely tied to kinship and social structure, and is reinforced by territorial association and language, then persistence of a Tosawihi ethnicity could be inferred to indicate the prior existence of an actual *ethnie*, that is, a group of people with some shared behavioral traits that did, in fact, distinguish them from other Western Shoshones. The question, of course, is just what those behavioral traits would be, and how they would be reflected in social structure, if at all. If Tosawihi ethnicity has not been submerged completely under new tribal ethnicities, then kinship, marriage patterns, and social structure would most likely provide the clues to its persistence.

THE HYPOTHESES:

Here, then, are the operating hypotheses: (1) With the creation of Indian reservations, distinct bands and identifiable groups were brought together and subjected to a uniform set of ecological, economic, and political conditions. These conditions derive from the nature of the reservations as geographically bounded areas and also as administrative units first of the U.S. Government and then of legal tribal entities. The social and political effects of non-Indian and Tribal jurisdiction over any particular Indian group would cause certain uniform cultural processes to operate on reservations that would result in the submergence of "old" ethnicities and identities under new Tribal ones.

Not only culture but also *ethnie* and ethnic identity in this model are dependent variables of political and legal administration, and their political and economic effects. Ethnicity is conceptualized as a social fact, but a social fact that is historical in nature, that is, one that changes with political and economic conditions. *Ethnie* and ethnic identity are derivative of culture and way of life, but culture and way of life can, in turn, be quickly and radically changed by political and economic forces of the kinds that Carneiro (1970) proposed in his theory of state formation.

(2) The ALTERNATIVE HYPOTHESIS predicts that no White Knife *ethnie* exists, and that efforts to discuss the Tosawihi or the Tosawihi Quarry would either elicit a "blank" – that is, non-comprehension and no knowledge – or would elicit identification with it as a "monument" important in what Anthony Smith (1986: 51-52, 161-165, 186-190) would call a "movement for territorial restoration" – that is, a social movement seeking restoration of jurisdiction over territory that is perceived as being necessary for the economic well-being of a group, ethnically defined, that is associated with it. In that case, it could be expected that the Tosawihi quarry and the area around it would be spoken of as a historic resource or a monument tied to a specific reservation-tribal designation such as "Sho-Pai" or to a more general designation such as "Western Shoshone." In other words, people would say, "That belongs to us because descendents of the people who used to use it are on this reservation" and would identify it as a Tribal resource belonging to the legal, corporate entity having jurisdiction on the particular reservation. Or, people would identify it as a general Western Shoshone resource and would perceive its significance in terms of its inclusion within Western Shoshone territory as circumscribed by boundaries established in bureaucratic, administrative, or contractual documents produced under United States jurisdiction, such as treaties or other legal contexts.

METHODS

The literature indicates Battle Mountain, Ruby Valley, Elko, and Duck Valley as locations where White Knifes used to live. My previous research indicated Wells as an additional location. Thus, research concentrated on these f five areas. Interviewing was done at South Fork as a kind of control measure and also to investigate relationships between Wadaduka – a possible "old" ethnicity similar to "Tosawihi" – and the Tosawihi themselves. The "key consultant" interviewing technique was used, both to acquire depth and detail for ethnographic data, and also to identify other key consultants.

Open-ended interviews were used to obtain kinship charts for all individuals asserting White Knife ethnicity; to push descent lines back into the past as far as possible; and to obtain qualitative information on the determinants of key informants' interactions with others whom they identify as "White Knifes." If kin ties were primary determinants, it could be inferred that the behavioral coordinates of White Knife ethnicity would have been subsumed under conditions of reservation or community life that favor maintenance of kin ties rather than ties that formerly bound White Knives together or ones that would bind them to larger ethnic tribal entities.

Oral traditions concerning behavior relating to the solidarity of the White Knife *ethnie* were elicited. Specifically, oral history concerning the significance of the white chert and the quarry, as well as activities associated with the chert and the area around the quarry were elicited. One visit to the quarry site and a nearby area was arranged. Opinions concerning the Tosawihi quarry and its significance were also elicited. The genealogical, oral traditional, attitudinal, and kinship factors were each treated as independent variables.

THE CONSULTANTS

I interviewed 51 individuals: 21 females and 30 males. The 40-50 age cohort yield the larges number of interviewees (10) but the 50-60, 60-70, and 70-80 age cohorts had nearly equal representation. The largest number of interviewees were at Owyhee (17), with Battle Mountain (10) and Lee (8) running close seconds (The greater frequency of interviewees over 40 reflects the fact that generally they knew more than those under 40 and referred me to others who tended to be in the same age cohort or older.

Number of interviews totaled 77. Thirteen consultants were especially helpful. They were sufficiently interested in various aspects of the project, and had flexible enough time schedules, to be able to assist me with multiple interviews each. These individuals and several others constituted "key informants." They were especially knowledgeable and supplied depth and detail on various topics.

I approached a total of 54 individuals. Three people, all from one extended family and all over 80, declined to be interviewed. I was told that one of these individuals had declined specifically because he felt I might "capture" (*suuwaya*) his story. I would write it down and then it would no longer belong to him.

Interviews were loosely structured and open-ended. I told people what I was interested in knowing, and they responded accordingly. The topics I approached first were "Tosawihi;" "Tosawihi Quarry;" and the Tosawihi Homeland and specific uses of places and resources in the area, including use of the white chert. Sometimes I drew complete blanks on these topics. At other times, opening those topics yielded multi-faceted discussions with much ethnographic detail and personal reminiscence.

Following the thread of the alternative hypothesis also yielded fruitful results. Many consultants gave valuable information about what they considered to be the markers of the "old ethnicities" from which their personal heritage derived, and what they considered to be the essential characteristics of contemporary Western Shoshone identity. Invariably, opening this topic led to discussion of the land claim, the Treaty, and Treaty rights, because the ideology through which these topics are interpreted was regarded as an essential component of Western Shoshone-ness. It quickly became evident that Western Shoshone identity was something that had slowly developed over many years, but within the last three of four generations – that is, since about 1920 – and was coalescing as a nationalist movement growing out of an earlier Traditionalist movement (Clemmer 1972: 463-552; 1973; Clemmer and Stewart 1986: 554-555; Johnson 1986: 592-593. See Crum 1988, Rusco 1989 for similar views.) Therefore, some interviews opened specifically with the topic of Treaty rights.

PROCEDURE

In locating consultants, I followed several procedures: (1) Prior to initiating field work, I wrote letters to seven individuals and asked their assistance. Six I had known from previous field work. The seventh was unknown to me but was a tribal official. Three of these individuals

turned out to be basically unacquainted with the Tosawihi, but all but one proved helpful in some way. (2) Because the hypothesis predicted that Tosawihi would be found, if at all, in only four places – Duck Valley, Battle Mountain, Wells, and Elko – I decided to test this aspect of the hypothesis by first contacting two of the individuals to whom I had written whom I knew to be living on reservations where the hypothesis predicted there would be no Tosawihi, and another on a reservation where the hypothesis predicted there should be Tosawihi. All three were Tribal officials.

All three individuals assured me there were no Tosawihi on any of the three reservations. Later, however, through the procedure described under (4) below, I did locate a Tosawihi individual on the predicted reservation. The two Tribal officials on each of the negative-case reservations independently referred me to an individual on a fourth reservation where my hypothesis predicted there would be Tosawihi. Both officials told me that this individual knew all about the Tosawihi.

(3) This turned out to be true. The individual turned out to be Tosawihi. This consultant provided kinship data from which other Tosawihi individuals were identifiable. I followed my consultant's recommendations in locating and contacting other Tosawihi consultants.

(4) At Duck Valley I was assisted by a Tribal official who identified an individual who would know about the Tosawihi. I also had been referred to other individuals there through procedure (3) above. The individual turned out actually to be Tosawihi and provided me with kinship data and introductions to more Tosawihi. In turn, one of those individuals provided me with kinship data and introduction to additional Tosawihi relatives. In this way, I was able to consult the largest number of Tosawihi – 14 – concentrated on any single reservation.

(5) Contacting the other individuals to whom I had written and also obtaining permission to attend three council meetings provided me with additional consultants. These consultants were extremely valuable in helping me to:

(a) Investigate the components and markers of another "old" ethnicity (Wadaduka); and

(b) Achieve a better understanding of the nature of Western Shoshone nationalism and its ethnic character.

In accordance with standard ethnographic practice, consultants in this report are accorded complete anonymity.

In the first few days of initiating the project in the field, some information regarding the Tosawihi Homeland became available to me which both necessitated and facilitated some alteration of the original research design and the parameters of the project. Casual discussion with a BLM official in Elko within the first week of the project revealed that two projects were planned for areas that were either near the Tosawihi Quarry or actually included it. One was a gold mine. The other was a dam and reservoir. BLM assertion of jurisdiction over various parcels within the two areas made the BLM a stakeholder. Provisions of the National Environmental Policy Act and more than 30 associated federal Acts and Executive Orders,

including the (1978) American Indian Religious Freedom Act, required the BLM to assume a role as coordinating agency in assuring compliance with these laws and orders by the would-be developers. Thus, each of the developers had commissioned preparation of an Environmental Assessment. Both EAs were deposited in BLM files and thus were public information. I reviewed them.

For the Tosawihi Quarry area, no present use of the area other than hunting, off-the-road vehicles use, and livestock grazing were mentioned. Thirty-seven prehistoric sites were identified, of which two-thirds were either recommended for National Historic Register eligibility or were assessed as potentially eligible (ERT 1988: 3-14-3-18.) No consultation was done with Indians or Indian Tribes. Possible outstanding Western Shoshone claims to the area (Clemmer 1974; Rusco 1982, Clemmer and Stewart 1986: 554-555) were not mentioned.

For the area near the Quarry, known as Rock Creek, the EA mentioned cattle grazing and deer and bird-hunting, and stated that "the dam site is reportedly still utilized in annual ceremonies by northern Shoshone" (SEA 1988: 149.) No assessment of this latter identified use was done in the section on socio-economic impacts (SEA 1988: 162.) Only the inundation of the ceremonial grounds by the proposed reservoir water was noted. The EA identified 63 sites on the basis of an archaeological reconnaissance including four rock shelters, one with "a rock wall and a nearby stone alignment used for a hunting blind" (SEA 1988: 148.) No Indian individuals or Tribes were consulted.

However, the BLM did contact one Indian Tribe and several Indian individuals on its own. Additionally, one Indian individual contacted the BLM on his own initiative after reading about the proposed dam and reservoir in the newspaper. The BLM arranged tours of both areas for Indian individuals. Eventually, separate letters protesting both proposed projects, signed by several Indian individuals, were received and filed by the BLM.

These facts raised several possibilities in terms of the Tosawihi project. One was that in addition to being included by Western Shoshones in their land claim, both of these areas might be used extensively and intensively. If the users turned out to be Tosawihi, an exciting new dimension to the research would be introduced. In addition, such use would greatly strengthen the basic assumption of the primary hypothesis: that ethnicity is derivative of culture as defined in the project: that is, a way of life, daily activities, production and use of material items and food, as well as shared values, attitudes and knowledge. The facts from the BLM introduced yet another interesting possibility: that both of these areas were still actually used for a variety of activities, and furthermore, that there might be a historical continuity of use stretching back to prehistoric times. Such use would not clearly reflect development of a reservation-based Tribal ethnicity, but rather, would reflect either development of some larger identity, such as "Western Shoshone," or would have served to maintain a pre-existing "old" ethnicity, possibly that of Tosawihi.

Furthermore, reported ceremonial use of the Rock Creek Dam site raised several questions about the role of religion in identity. The hypothesis would predict that because ethnicity has strong political, economic, and social conditioning factors, the political and economic conditions of reservation life would promote development of religions that would

supplant older ones. Such processes are well documented for the Utes, the Fort Hall and Wind River Shoshones, and the Navajo, among whom either the Sun Dance or Peyotism have eclipsed traditional animism or shamanism (Jorgensen 1972, 1986: Aberle 1966.) But if ceremonies were "STILL" being held OFF reservations, what kinds of ceremonies were they? And who participated in them? Were they really "Northern Shoshones?" Or might they be Tosawihi? Why were they held at the Rock Creek Dam site? Were they alternatives to pan-Shoshone religions such as the Sun Dance?

Clearly, this new information and the questions it raised, required development of a couple of corollary-hypotheses and some additional interviewing priorities. One corollary was that use of the Tosawihi Homeland would be confined to identifiable Tosawihi. Another was that use of the area for religious purposes would also be confined to identifiable Tosawihi, and that religious use of the area would serve as a point of contrast between Tosawihi and other Shoshone. A third was that, in line with the alternate hypothesis, those who did not use the area and its resources, whether Tosawihi or not, would not have any perceptions of the area as having any religious significance and further, would not be able to supply any specific information documenting historical or contemporary behavior associated with the Tosawihi Quarry itself. Rather, non-users would either not know of the Quarry; or would know about it but be indifferent to its fate; or would speak of it as a historic resource or a monument tied to a much more general territorial ethnic identification.

Additional data-gathering goals were required to operationalize these corollaries. First, data on actual use of the area had to be sought. Second, consultants identifying themselves as Tosawihi had to be pressed concerning their knowledge and use of the Quarry and surrounding area. Third, some behavioral texture had to be given to whatever religious use was asserted for the area. This would be hard to do from interviews unless they were lengthy and extended. Finally, some systematic means of ascertaining non-Tosawihis' perceptions and uses of the area had to be developed.

Procedurally, attaining these goals required building sufficient flexibility into the interview schedule so that I could return to knowledgeable and helpful consultants to follow up leads obtained from others or to check up on uncertain or perplexing items. Doing this demanded the ability to work seven days a week and 12 hours a day if necessary, and to shuttle a hundred miles or more between one reservation community and another.

By agreement with the Elko BLM Office, I acquired the temporary status of "BLM volunteer." Status as a BLM volunteer enable me to finance a more ambitious work schedule and also facilitated one field trip to the Tosawihi Quarry and the Rock Creek Dam Site with 3 male Shoshone consultants, 2 of which are Tosawihi. All are between the ages of 55 and 65. Three additional "likely participants" in the field trip could not accompany us due to health reasons and other commitments. A fourth likely participant had, unfortunately, died recently.

The new information obtained from the BLM also required building in the interview schedule a substantial number of people who were definitely not Tosawihi, and doing so in some systematic way with regard to a topic and issue that derived from the research design. I did this

by using the concept of the World Heritage Site and applying it to the Quarry as a hypothetical suggestion and interview question.

The Tosawihi Quarry had already been assessed as being eligible for listing on the National Register of Historic Places. Thus it made sense for it to be proposed as a World Heritage Site. World Heritage Sites range from the Great Temple of Abu Simbel in Egypt to panels of rock art in arctic Norway. World Heritage Sites are designated and listed by UNESCO, a branch of the United Nations. They may be aesthetic landscapes of unique beauty; refuges of unique or endangered wildlife; actual monuments of unique human artistry; artifacts created by human beings and unique to a specific spot; or places where documented events important in human history occurred (UNESCO 1970; 1985; 1988.)

If the suggestion were made to Western Shoshones to designate the Tosawihi Quarry as a World Heritage Site, what would their reactions be? Clearly, general approval of the idea would not constitute documentation of the Site's significance. On the other hand, making the suggestions would likely elicit information from those to whom the Site was personally significant. Furthermore, it would be to no one's disadvantage to come forth with such information, and they would likely do so. Thus, the idea of the Tosawihi Quarry World Heritage Site was built into the research strategy.

I presented this idea at meetings of the Western Shoshone National Council and the Council of Elders. I found that the responses I obtained provided a controlled context for not only addressing the research problems uncovered by the BLM, but also for uncovering data that had important ramifications for the more general study of ethnicity and ethnic identity among Western Shoshones. Designation as a volunteer for the BLM enabled me to maintain my complete independence as a researcher for the Nevada State Museum and the Trumann-Orr Foundation, which had provided the major funding, but provided a little bit of additional financial support that enabled me to travel long distances, conduct more interviews, accomplish the field trip to the Tosawihi Quarry and Rock Creek Dam Site, and attend the Council meetings. Thus I was able to properly and systematically address the research problems in light of the new information provided by the BLM.

CAVEAT

The research results in this report should not, and cannot, be interpreted independently of the conclusions to which they lead and of the procedures that were followed in generating them. The conclusions are the results of research undertaken at a particular historical moment and by some one who is known personally or by reputation to a substantial number of the Western Shoshone people and has a prior record of research in the area. Because I used the "key informant" and "networking" approaches, the research results should not be interpreted in the same way as those that might have been obtained from either a random or a stratified sample often used in survey research. The results cannot be tested *statistically* for significance.

Rather, the conclusions drawn from the research are based on the assumption that interviewees represent a continuum of knowledge, values, attitudes, experiences, and behavioral

patterning that are identifiable as "Tosawihi," "Wadaduka," "Guwudaga," "Western Shoshone," "Indian," etc., who are either participants in the western Shoshone nationalist movement or who live at Wells, Battle Mountain, South Fork, Ruby Valley, Elko, or Duck valley. This continuum is a reflection of contemporary Shoshone culture, society, and identity, but it obviously does not constitute any sort of system or totality, because I did not systematically interview Western Shoshones on other reservations or even try to obtain any kind of "representative sample" of Tosawihi.

In other words, the NUMBERS and PERCENTAGES of persons in any particular category ("Tosawihi users of white chert" or "Wadaduka who identify primarily as Western Shoshones") neither indicate nor reflect anything statistically significant. They are simply presented as part of the reportage style. They cannot be interpreted either as the total universe of persons in that category or as any sort of percentages of responses that might be obtained for that category if all 6,000 estimated Western Shoshones had been contacted. Likewise, other inquiries by other investigators with different backgrounds, who use different techniques or who approach different people on different reservations might derive different results and reach different conclusions.

USE OF PLACE IN THE TOSAWIHI HOMELAND: TOSAWIHI QUARRY

Nine consultants knew about the Tosawihi Quarry area and knew where it was, of whom five were White Knife Shoshone. Of the White Knife Shoshone consultants, then 22% knew about the Tosawihi Quarry. All except one Tosawihi individual were favorable to the Quarry being a World Heritage Site. One was indifferent. Only one non-Tosawihi had knowledge of the area. With this exception, all the non-Tosawihi either expressed ignorance of the area or were not able to provide specific documentation of its significance. They approved the idea of it being a World Heritage Site because it constituted a monument tied to the much more general territorial ethnic identification of "Western Shoshone." Thus, for non-Tosawihi, the significance of the Quarry became apparent as one of several monuments symbolic of the shared territory claimed by the Western Shoshone Nationalist Movement.

For self-identified Tosawihi, however, the associations with the Quarry were quite different. They were much more specific. They were not, however, in conflict or contradiction with non-Tosawihis' appreciation and valuation of the Quarry. One man identifying himself as Tosawihi was sufficiently knowledgeable about the area to be able to tell me exactly how to get there. He described virtually every landmark. Three consultants from one family have used the Quarry area on a regular basis. It is their family's traditional use area. One man recalled specific oral traditions referring to the area that involved his named lineal ancestors to the fourth ascending generation. Two more consultants recalled their own former use of the area and residency in it but did not know about the Quarry specifically.

Use of the area falls into four categories: (1) Seasonal hunting; (2) Seasonal haying and buckarooing for nearby ranches; (3) Long-term residency and buckarooing; (4) occasional and regular gathering of chert. The latest date secured for seasonal hunting was 1988. Deer, rock chucks (groundhogs or marmots, YA'HAA in Shoshone), squirrels, and rabbit were hunted.

Deer used to be hunted with poisoned arrows. One consultant said that the poison was a paste made from smashed greasewood root. The paste was applied to the tip of the arrow. The poison took two to three hours to work into the animal's wound. At that point, the animal would drop. When they found the animal, the hunters would finish it off. An Indian doctor or prayer person would pray over the animal. That would make the meat edible. The poison would not have an effect – it would go away. That is the way the "old Indians" hunted. They never killed the animal with their arrows. They just hit it once or twice, then tracked it.

Hunting is done with the help of little men. These little men cannot be seen but they are always there. They whistle like a bird. That's how you know they're there. This is still the way Shoshones hunt. They will guide you right to the animal if you pray to them. It's important not to do anything to change the land because if the land is changed, those little men will go away and there will be no more deer to hunt.

Squirrels are also hunted, but the technique used in the mid-twentieth century in the Tosawihi Quarry area was more akin to gathering than to hunting. There are two types of squirrel. Gray squirrels ("kangaroo rats") are called *davva?aih* ("sun-one") because they like to sun themselves. Red squirrels ("prairie dogs") are called *engatsippih*. To catch them in the summer, plug up their holes and/or station people around them. Hunting squirrels this way was done by men and women together. Take a 5-gallon can of water and pour it into their holes. They'll come right out. Then you wring their necks and throw them on the fire to singe the hair off. They are good to eat in the summer, but they are inedible in spring. In spring they eat greasewood roots and that makes them inedible. They don't taste good.

To keep a squirrel or rock chuck fresh while on the way back to camp, the "old Indians" used to wrap the game in rye grass (probably Elymus condensatus – cf. Steward 1938: 24.) Squirrels and rock chucks are prepared in the same way. The best time to hunt rock chucks is July. When you get one, singe the hair off the rock chuck in an open fire – the same way you do it with a squirrel. Then, roast them. Dig out a big hole and put hot ashes into it with a shovel. Then put the squirrels in, or the rock chuck. Cover them up with more ashes and dirt. Build a fire on top. When the meat (*yaa 'han-dook* = rock chuck meat; *tsippiahndook* = squirrel meat) is done, the grease will shoot up out of the top. Dig them out and take a green willow twig and beat the ashes off them. They are delicious.

Anything can be cooked that way. One consultant averred that cooking with ashes was the secret to the success of "Indian cooking." Ashes go into everything. That is why trash should never be thrown into a camp fire; it spoils the ashes.

This consultant recalled his uncle roasting a cow's head that way. The uncle also used to roast beaver heads in the same way. When the head was taken out, the meat would just fall away from the bones. "You never tasted anything so good," he said. His uncle taught him to make bread in the same way. The dough was made from flour, water, and baking soda. A female consultant also recalled making bread that way. The bread became a favorite of cowboys and called "moccasin bread." It can also be made in a cast-iron dutch oven.

Jackrabbits were hunted with rifles. They would use a spotlight at night. Sometimes they had jackrabbit every night. One consultant said she used the ranch kitchen where she worked to can the jackrabbit meat for use in winter. Another recalled his grandmother making rabbitskin blankets. A lot of skins were necessary for one blanket – 15 or 20. Usually two women worked on a blanket together. A skin would be cut into smaller strips and the strips would be sewn together. The cutting and sewing was done at the same time. The cutting was done with a chert knife. The woman drew the rabbitskin along the cutting edge of the knife which she held between her teeth. Knives of either chert of basalt could be used.

Three consultants recalled buckarooing in the Tosawihi area. One was a buckaroo. Another was a camp cook. A third had a husband who was a buckaroo. Among the ranches they worked for were Betty O'Neill, Eisenhood, Hadley, 25 Ranch, and Spanish Ranch. Two said they hunted during their buckaroo days. The earliest date I obtained for Indian buckarooing in this area was 1927; the latest was 1965. I was told that a lot of Indians used to come down to that area from Duck Valley and Fort Hall during the summer and fall to do seasoning work cutting, baling, and stacking hay for the white-owned ranches. They also used to come from Deeth and Starr Valley.

Ten consultants reported use of the area for gathering purposes. One consultant said that the women used to collect a red mineral called *avvee* or *pisa-pihh* ("BISHOP") (ochre – Miller 1972: 131.) It was powdered. She said the women used it for rouge. Ten consultants said they gathered white chert, although only three of them knew about the Tosawihi Quarry as a specific location. Three reported it as an on-going activity by them and other members of their families. One consultant keeps a collection of large knives, points, and scrapers in a "Velvet" can.

Two consultants gather unworked chert to make arrowheads and scrapers. One man said he mostly makes notched arrowheads because they are the Shoshone ones. The Paiute ones were unnotched. I was shown one white chert point that was hafted to a cane arrow with sinew. Sinew was taken from the deer's spinal column. Cane arrows would be effective for birds and small game. For increased strength and velocity, a cane arrow could be fitted with a willow splint.

Two Tosawihi consultants reported religious associations for worked chert. One man reported that he and his family search for the white chert because it is religiously important for them as White Knife Shoshones. They pick it up and use it for religious purposes. It is important in doctoring as well as for general protection. They must keep some of the white chert on their persons at all times. For them, the white chert has to be the specific kind that comes from the Tosawihi Quarry area because that is the kind that is necessary for them to use in terms of their religious practices.

One man demonstrated flint-knapping. He learned it from his father. His father used white chert from the Tosawihi Quarry area almost exclusively. But he said he found the white chert very hard to work. It breaks easily. He has never been able to work it all the way over – that is, to knap it on both surfaces – without it breaking. He tried heating it once, thinking that heating it might make it easier to work. He heated it for some hours in a camp fire. But that did

not help. Therefore, he uses obsidian. He got his obsidian from a spot near Golconda, about 50 miles east of the Tosawihi Quarry.

He demonstrated flint-knapping with some obsidian, starting with a nodule and breaking it into flakes A thin flake is crucial to success. To work a flake, he used deer antlers, alternating among three that he had, depending on whether he wanted to do fine work or gross. He tried five flakes before being able to work one all the way to completion without it breaking. He worked for 15 minutes on one, but in the process of putting notches on it, he broke it. It took him about ten minutes, start to finish, to make the one that was finally a success, with notches.

A different consultant said that in earlier times, it was always the women who made the arrowheads, not the men. The men just used them.

A story was told about a contest held once between "a man from Oregon" and a Shoshone. This was more than 30 years ago. The man from Oregon made his arrowhead out of obsidian that he had brought with him. The Shoshone man made his arrowheads out of Tosawihi chert. When they were done, each hafted their points to arrows and shot the arrows at a railroad tie. The Oregon man shot first. His point stuck, but it broke. The Shoshone man got a couple of feet farther away and shot. His arrow went into the railroad tie farther, and it did not break. The contest demonstrated that the Shoshone flint was harder and thus better material for arrowhead than obsidian.

RELIGION

Western Shoshone religion revolves around the acquisition and legitimate use of *buha*, or *poha* ("*boha*") – power – and the maintenance of proper relationships between human beings and the spirits of plants; animals life-giving forces such as sun, earth, and water; and guardian spirits generally called "Little Men" or "younger relatives" (*nu:nummi* or *nenewe.*) Steward (1941) did not mention these for Nevada Shoshone but he did mention them for the Northern Shoshone at Fort Hall (Steward 1943: 271.) Non-legitimate use of *boha* is witchcraft, and to some extent, the counteracting of illegitimate use of *boha* as well as the "putting to right" of relationships between human beings and spirits that have been neglected or abused are also part of Western Shoshone religion.

There does not seem ever to have been a concept of a supreme being among the Western Shoshone aboriginally (Harris1940: 56), although Hultkrantz (1986: 632) finds some evidence for its aboriginality among the Northern and Eastern Shoshone. Julian Steward (1938, 1941: 267) did little inquiry about the concept in his salvage ethnographic work and therefore it is impossible to confirm or deny the existence of the concept outside the contexts in which field work has been conducted since Steward's time (Harris 1940; Malouf 1942; Clemmer 1972; Stewart 1978, 1987: 265-272.) Harris (1940: 55-56) discovered the concept of "Father-Spirit" (*Apo* or *Appeh*) which his Tosawihi consultants at Duck valley equated with the power of the sun in 1937. But they did not say the *Appeh* was the same thing as "sun" (*dave.*)

I found *Appeh* to be a concept with which Western Shoshones were acquainted, but not to the exclusion of other sources of power. One man regarded *Appeh* as the source of laws by which Shoshones should live. In some cases, "Father-*appeh*" was equated with "Father Peyote," but only among those who are Peyotists. Peyotists are a tiny minority among the Western Shoshone (cf. Lieber 1972; Jorgensen 1986: 667-671; Stewart 1987: 265-272.) In other cases, the terms "God" or "Great Spirit" are used (cf. Jorgensen 1972: 206) synonymously with *Appeh*. I found *Appeh* to be connected with the sun and sun-power to be most prominent among followers of the Sun Dance religion.

The Sun Dance has been part of Shoshone religion since about 1800. But until about1900, only the Eastern Shoshone put them up (Jorgensen 1986: 665-666.) The first one at Fort Hall was in 1907. The four Pabawena brothers, who were from the Ruby Valley-Starr Valley area but had close ties to Fort Hall, brought the Sun Dance down from there and put up the first one at Deeth. This was probably about 1920. There were at least two more in Deeth and Elko in the 1920s. Some Western Shoshone became initiated into the Sun Dance at that time.

Some of those initiates also put up Bear Dances. These were held in the 1930s and possibly in the 1940s at Elko and Battle Mountain.

In the late 1970s some Western Shoshones became initiated into a Sioux-style Sun Dance which was brought first to Fort McDermitt (Jorgensen 1986: 667-671) and later to Duck Valley. However, it was only done at Duck Valley one or two times. Some Western Shoshones who had been initiated into the Sun Dance in the 1920s also became involved in this "new" Sun Dance, but Sun Dancers, like Peyotists, remain a small minority, although they are larger in numbers than the Peyotists. The Sun Dance is a source of *boha*.

However, the most frequent forms of religious expression are individual prayers. These prayers may be done at any time, but they should always be done prior to eating because food is ultimately owned by the spirits of the plants and animals from which the food was obtained. Prayers are especially important in connection with places and the spirits that live there. Prayers are made to the spirits of plants and animals; to the "Little Men"; and to the spirits of places that are regarded as power spots. Some of these power spots are seen to embody anthropomorphic figures that represent the spirits that dwell there. Sometimes they can be brought out by prayer and song.

Some specific power spots mentioned to me were in the Rock Creek drainage; the Lamoille Creek drainage; the Ruby Mountains' crest; the Shifting Sands near Fallon; the Wildhorse Creek drainage; and the Skull Creek drainage. Springs were also mentioned as power spots where spirits dwell. The general association of spirits with lakes, springs, and water holes among all Great Basin peoples is well known (Hultkrantz 1986: 633.)

Hultkrantz (1986: 633) distinguishes "little dwarf spirits with poisonous arrows" from the guardian spirits that "own" plant and animal species, and distinguishes both of those from an individual guardian spirit that may assist a hunter in securing game. He also follows Steward (1941: 230) in conceptualizing the "owner of game" as a "coyotelike spirit."

In contrast, I found no distinction between Little Men who could potentially do harm and Little Men who could be beneficial. I was told that the Little Men, who live everywhere in Western Shoshone country, were the very ones who could be either beneficial or malevolent, depending upon how they were treated. For example, when going into an area you've never traversed before, you should pray and ask permission to be there. If you do that, then the Little Men there won't do anything to you. If you pray to them, they will guide you right to game. You also have to pray to the spirit of the game, who is different from the Little Men. If an area is disturbed or torn up, the Little Men will leave and so will the game spirits. There is no single spirit for all the game, except perhaps *Appeh*. After the game has been obtained, or, in the case of plant food, after the food has been gathered, a thanksgiving prayer is appropriate. If a lot of people have been participating, then they should sing a prayer while doing a round dance.

An individual's guardian spirit is different from game spirits, *Appeh*, and the Little Men. But not everyone has a guardian spirit. You get a guardian spirit by being put on the mountain. You have to be put on the mountain by a doctor (shaman.) Once you are there, you get instructions from the guardian spirit. You might be given a song there if that's the spot where songs can be acquired. Otherwise, you might be instructed to go to another spot to get a song. Or you might be instructed to pledge yourself in the Sun Dance.

Sweats are important for purification. They are important in curing and in doctoring. Sweat houses can be built anywhere. It is not the placement of a sweat house in a particular spot that makes that spot sacred or powerful. However, sometimes a sweat house is built at a power spot because purification is necessary in connection with a vision quest undertaken at that power spot, or because a *bohakanten* (shaman or doctor) gets his power from there and uses it to doctor.

Doctoring is distinguished from curing by the participation of a *bohakanten*. Curing can be done by any one who has special knowledge of where natural substances such as herbs or hot mineral waters occur; how to use them; and how to pray to the spirits – Little Men or Water Spirits or plant and animal spirits – that own those things. Thus, any individual can in theory, become a curing specialist.

Such an individual is not necessarily a *bohakanten*. A *bohakanten* is a man or woman who has special *boha*, that is, spiritual power. A *bohakanten* is able to channel spiritual power to change physical circumstances. There are lots of things a *bohakanten* can do with power. One of them is doctoring. Power can be inherited but inherited power is not as strong or as likely to be used as power that is acquired. Power can be acquired or strengthened either through dreams at the Sun Dance, or in a vision quest. A person who inherits power and then strengthens it in these ways is very powerful.

To be acquired through a vision quest, power must be sought at known power spots. Power spots are always on mountains or on the tops of prominent, isolated rock formations or in springs. In doctoring, the *bohakanten* uses *boha* to bring the person who is being doctored back into a state of wellness. The *bohakanten* may do this in the person's home or in a sweathouse or in an outdoor place. If the *bohakanten* has acquired power in a particular power spot, he or she may want to do the doctoring close to that spot.

Thus, today, Western Shoshone religion has three primary expressions: Sun-Dancing; individual prayer to the spirits of plants, animals, power spots, and to Little Men; and use of power spots for vision questing; curing; or doctoring. In addition, of course, a few are Peyotists, and some are Catholic, Episcopalian, or Presbyterian. Mormonism seems to have waned, but it seems that only those who are Mormon, Baptist, or Assembly-of-God adherents shun the constellation of religious activities that are strictly Indian.

Tosawihi individuals did not exhibit any particular constellation of religious activities that would distinguish them from other Western Shoshones except for some Tosawihis' use of white chert as a source of *boha*. However, among those who knew of the power spots in the Rock Creek drainage and used them, the majority were Tosawihi. Also, there was a tendency for Tosawihi to be strong adherents and advocates of the Sun Dance religion, moreso than non-Tosawihi Shoshone that I interviewed. This tendency may well derive from the fact that not only the Pabawenas, who were identified to me as Tosawihi, but also several other Tosawihi who are no longer alive, were among those who put up and participated in the first Sun Dances at Deeth and Elko in the 1920s. It cannot be said, then, that there is anything like a distinct Tosawihi religion. But certain features of religion as practiced by certain Shoshones, such as religious use of white chert, are directly attributable to their Tosawihi heritage, and knowledge and use of certain power spots in the Tosawihi area, although not limited to those of Tosawihi descent, have certainly been maintained as a result of continuity between the generations among those with Tosawihi kindreds.

Shoshone religion, then, depends to some extent on maintaining the Sun Dance, but more on maintaining the pristine nature of power spots and on maintaining the presence of Little Men and the owner-spirits of plants and animals where Shoshones gather herbs, medicines and wild foods and where they hunt. Four consultants volunteered strong opinions on "California hunters" who, they said, not only failed to pray to the spirit of the deer, but also wasted the game. In contrast, they said, Shoshone hunters could not get away with doing things that way and if too many "modern" Shoshones hunted like that, then soon, the Little Men and the animals' spirits would go away and there would be no more game. Destroying the habitats of the Little Men by activities such as mining could also cause them to go away.

USE OF PLACE IN THE TOSAWIHI HOMELAND: ROCK CREEK AND VICINITY

The Tosawihi Quarry area was not used for settlements or permanent seasonal camps after the first decade of the twentieth century. Steward's (1938) map also shows no villages in this area for the protohistoric era. However, in areas to the west, south, and north, in Squaw Valley and in the Antelope, Rock, Boulder, and Willow Creek drainages, Shoshones did maintain settlements and camps until about 1927. These areas are part of the area that I have called the "Tosawihi Homeland." One large farm was on Antelope Creek. Another settlement with several families was located up on Rock creek. Steward's (1938) map shows two villages in approximately these two locations for the protohistoric period.

In addition to having settlements and camps there, Shoshones maintained the following kinds of relationships with the area: (1) Use as a burial ground. Recent archaeological survey

work (M. Rusco 1989 personal communication) indicates that this use represents a continuity with prehistoric use patterns, since the existence of prehistoric burials is well substantiated. Prehistorically, caves, crevices and rock shelters were used. However, one Tosawihi consultant reported hearing of a burial on a rock ledge when he was a young man, although he had never seen it. Another Tosawihi reported burials under rock piles and cairns.

(2) Historical use of several hot springs and one cold spring for curing was reported for the period prior to 1960, as was (3) historical and contemporary use of particular power spots for religious purposes including doctoring. Two of these power spots are located in the Rock creek Drainage. They are quite close to one another. One is a *bohapaa*, a "power spring." Therefore, these power spots have been the site of many doctorings by at least two different *bohakanti* over the last 80-100 years. One of the power spots is also a vision quest site.

Other uses of the area include: (4) historical use for permanent residence and farming; (5) historical and contemporary use for hunting and gathering and for maintaining associated camps; and (6) historical occupancy as a result of buckarooing. These last two uses are variables of the same factors conditioning hunting and buckarooing in the Tosawihi Quarry area. They will be discussed below. (7) In addition, four consultants mentioned six specific geographical features or formations that mnemonically commemorate either specific events from Shoshone history and tradition or supply crucial components in the practice of Shoshone religion.

I could not ascertain a date for the most recent burial but it probably occurred between 1920 and 1925. One of the last Tosawihi to live in the area continued to "look after" some of the graves until he left in 1927. Three consultants, all in their 60s, said that all the individuals buried there are Tosawihi. Two individuals who are buried above the Rock Creek drainage were mentioned by name. A third was mentioned by one consultant, but other consultants said he had died elsewhere and was buried elsewhere and still others disagreed concerning the individual's identity, thus making it even more difficult to ascertain his burial spot. However, one consultant in his 60s who is part-Tosawihi identified two living Tosawihi individuals in the next ascending generation as having known ancestors buried in the Rock Creek area. One of these individuals was said to be able to name many of her ancestors and relatives who are buried there.

One consultant mentioned use of hot springs in the area for curing ailments. She said the "old Indians" used it and she did too, when she was living in the area as a young woman. Seven consultants identified one or both of the power spots mentioned above. An eighth knew the pots, but did not identify any religious associations with them, saying, rather, that the area nearby had been a frequent and familiar camping site in her youth. One consultant affirmed personal use of the spot for religious purposes. Five other specific individuals were known and mentioned by two consultants as maintaining on-going religious practices at these spots. Altogether, three users are Tosawihi.

Two different consultants each mentioned a different *bohagant* who used the spot for doctoring because they are power spots. One was also known to have used one of them to receive instructions ("visions".) One is recently deceased. He had used it between about 1925 and about 1980, while the other had died sometime earlier and had used the spot in the early 1900s, maybe until the 1930s. Other *bohagants* were said to have left some of their

paraphernalia in the cracks and crevices around the area. Some consultants said the spot also could be used for obtaining songs but others said that songs could not be obtained in that way. It is the special characteristics of the spots themselves that give them *boha*. Tosawihi consultants mentioned additional power spots at Hilltop near Golconda Butte, at Lamoille Creek, and at Sheep Creek, in the Wildhorse Canyon/Owyhee River drainage system. Each power spot has different specific characteristics, however, and is used for different purposes on different occasions. For example, to have a vision that will give you songs, you might go to one power spot rather than another.

Five consultants stated emphatically that full appreciation of the power of the white chert – physical and spiritual – and of the cultural significance of the Tosawihi Homeland in general, could only be obtained through familiarity with the land, its power spots, its subsistence resources, and the traditions associated with it. This familiarity is a key component of the Tosawihi heritage. Some non-Tosawihi Shoshone share this familiarity and appreciation, but unless introduced to the area by a Tosawihi, it was felt, non-Tosawihi are unlikely to acquire it.

This viewpoint was illustrated to me with two anecdotes, each given by a different consultant. One concerned a non-Indian who, outfitted as a "mountain man," was credited with several erroneous statements and factual errors in newspaper reportage of a talk given to some school-age children in Battle Mountain. These were pointed out to me with some pique. The second example concerned a member of the Te-Moak Bands who had publicly supported a recreation facility that, if constructed, would inundate important parts of the Rock creek drainage. This man's approval of the project as attributed to the fact that his ancestry was not Tosawihi, which was demonstrated to me in a detailed description of just what his ancestry was.

Other uses of Rock Creek and associated drainages by Shoshones include hunting, gathering, farming, ranching, buckarooing, and quarrying. One consultant said that gold used to be quarried and beaten into jewelry with hand-made, hand-held tools from exposed veins. He had heard about this from his aunt.

Parts of Willow Creek are used for obtaining willow material. Men and women do this together. The sallow material is used to make cradleboards. Only women make the cradleboards.

Cradleboards seem to be in widespread use among Shoshones in Battle Mountain, Lee, Ruby Valley, and Owyhee. Three out of the four households that had small children either reported recent use of cradleboards or had them in use. Cradleboard bonnets are always decorated with either dyed willow or colored yarn. Straight, diagonally-slanting line designs are for a boy baby. A girl baby may have zig-zag line designs, diamonds, or any other design. One Tosawihi consultant said that very child should have its own bonnet, at least at first. As the child outgrows its first cradleboard, it can be put into ones made for older siblings that still have the old bonnets on them. A child's cradleboard bonnet should, at some point, be taken by a parent and hung in a tree. A Tosawihi's bonnet should be hung in the Tosawihi Homeland. Having it hung there maintains the person's ties to that area.

When a child is born, the father should bathe in the cold water of a creek or the Humboldt River. One consultant reported doing that. But a younger man said that he used an outside bathtub full of cold water. The father's cold-water bath insures that the child will be protected from disease and ill health, and will grow up tough, strong, and robust, physically as well as spiritually.

All Tosawihi consultants identifying themselves as Tosawihi said that the Tosawihi used to come through the area seasonally, on their way to the Snake River and back from it. They quarried chert and hunted, but they did not stay in the Quarry area long. However, they made their winter camp at Rock Creek.

There are five springs within a seven-mile stretch of Rock Creek and these were places where the "old Indians" camped. One of these springs is associated with otters. I was told that no one had seen otters there for a long time, however – 80 years or so. There used to be permanent settlements in the area then, where the Indians tried to farm. Indian settlements and homesteads were mentioned for Rattlesnake Creek, Antelope Creek, and Rock Creek. Four specific individuals were remembered to have had places there along with their families. Three had left by 1927, one moving to Battle Mountain and the other two to Duck Valley. One had already died.

Definite dates for these farming settlements could not be established. However, there seems to have been a direct association between non-Indians' establishment of cattle and sheep ranches in the general vicinity with Indians' efforts in the same direction. One consultant described what seemed to be a similar process in the Starr Valley-Deeth-Wells area, with Indians and non-Indians competing for arable land and water sources. Still other consultants recounted something similar for the Maggie Creek area and for an area close to the confluence of Antelope Creek and the Humboldt River, near present-day Battle Mountain. One woman in her 80s recalled that her grandfather had had a farm there along with other Indians. When the Battle Mountain Colony was established in 1918, they were told that they had to leave their farms and move to the colony because, they were told, that was "where they belonged." Non-Indians then took that land, she said.

Familiarity with these areas must have initially made these adaptations successful. Tosawihi already knew the locations of springs and potentially good land. Hunting and gathering continued to play an important part in food supply. As noted above, rabbit, prairie dog, and kangaroo rat were especially sought. Seasonal work such as bucking hay, irrigating, running horses and cattle, and cooking for ranch crews either out of a chuck wagon or in the ranch kitchen provided some cash as well as "on-the-job training" in some aspects of ranching. Cash would have been useful in purchasing capital equipment and horses. Consultants mentioned a rusting horse-drawn plow and parts of other equipment near the sites of former farms that were thought to have been used by Shoshones.

Traditional utilization of burial sites, *bohapa*, power spots, hunting and gathering areas, and the white chert – whether for religious or practical purposes – continued in the Tosawihi Homeland in the contact and post-contact eras alongside new adaptations which, if successful, would have enabled at least some Tosawihi to continue to stay. However, ecological and

economic conditions were against them. Irrigation over more than a few seasons results in alkali deposits that kill most domesticated plants except potatoes, grains, and grasses. An undependable growing season results in killing frosts in either June or September once every few years. Cattle and sheep are easily subject to disease, death, and rustling.

Legal interpretations of the times were also against them. Although Indians continued to hold title by right of use and occupancy, neither Nevada nor U.S. land tenure law gave them advantage or even equality with better-capitalized, non-Indian ranchers. One consultant said, also that White ranchers kept stealing water. When asked why the Indian ranches and farms had been abandoned, consultants responded that they could just "not make a go of it." Only one case of an Indian being forced out by gunpoint, on Maggie creek, 50 miles to the east, was recounted, although creation of the Battle Mountain Colony and non-Indians' assertion of fee-patent title over Indians' aboriginal title might also fall into that category. Tosawihi who continued to use the area after the mid-1920s were those who were employed in buckarooing or who lived at the Battle Mountain Colony and could reach the area easily.

CONCLUSIONS

The Tosawihi clearly, at one time, constituted an *ethnie*: a self-identified group of people with shared cultural characteristics distinguishing them from others and sharing ties to a well-defined, but not exclusively owned, territory. The distinguishing characteristics derived from use of the white flint from the Tosawihi Quarry area; trading of the flint and tools made from it to other groups; seasonal transhumance across three distinct ecological zones (the pine-nut territory of the central Nevada mountains and foothills; the Tosawihi Homeland; and the salmon and beaver areas of the Snake/Owyhee drainage); a dialect that tied them to other groups to the north and south but also set them apart, especially with regard to use of certain kin terms; kinship relationships, terminology, and marriage patterns forming a behavioral complex with pseudo-cross-cousin marriage, fraternal polyandry and sororal polygyny, and adoption as important components; and a greater tendency than other Nevada Shoshones to adopt and maintain customs and traditions practiced by Northern Shoshones. Their territory encompassed more than half of the area circumscribed in the descriptions in the Treaty of Ruby Valley as drawn on the Doty map, but was not held to the exclusion of other Shoshones.

Religion appears to have always been an independent variable in the continuum of identities under discussion – i.e., the "old ethnicities" such as Tosawihi as well as the newer "Tribal" ones and "Western Shoshone," "Shoshone," and "Indian." Only the systematic use of power spots within the Tosawihi Homeland by Tosawihi seems to distinguish Tosawihi religious behavior from that of other Shoshones. But Tosawihi also use power spots outside the Tosawihi Homeland, and the importance of religious concepts and behaviors tied to territorially-based spirits and power within the Tosawihi Homeland and without, is a general characteristic of Shoshone religion and thus of generalized Shoshone identity.

Ecological factors were quite significant in Tosawihi identity in the pre-reservation era. Historically and perhaps prehistorically, Tosawihi ranged over three ecological zones, but clearly their identity comes from the white chert deriving from the Quarry area. It is possible that the

working and trading of Tosawihi flint was the factor enabling the White Knifes to travel as far as the Snake River and farther, and permitted them to further enhance their ecological niche by acquiring horses.

In the historic period, the Tosawihi became distinguished by two more characteristics: they became mounted and distinguished themselves as fighters, primarily, according to Indian agents, against U.S. troops and mail carriers, but possibly against Paiutes as well; and the identity became important as a component of a larger identity, "Shoshone-ness," as oppose to "Paiute-ness." It is possible that the reputation as fighters precedes acquisition of the horse, but it is unlikely that conflict with Paiutes was very frequent or intense.

Their distinction as mounted fighters raises the question, once again, of whether they were a true band and if so, whether they had been one before acquiring horses, or *became* one *as a result* of acquiring horses. Bands are defined as having a distinct territory, well-defined membership criteria and customs defining political leadership, authority, and succession. The Tosawihi come very close to fitting this definition. But they do not appear to have had a well-defined political leadership. Indian agents' reports clearly place Sho-kub as "Chief" of the White Knives in the 1850s. But when Sho-kub died, there was reportedly dissatisfaction with Sho-kub's choice of successor, Buck, and apparent fragmentation of the Tosawihi into several groups with different leaders. This fragmentation did not destroy them as an *ethnie*, but it certainly argues against their being a band. The fact that Temoke, who, contrary to Steward's (1938: 149-150) implication, did NOT rise to ascendancy due to his military leadership but rather rose to prominence as a good talker, was able to assert leadership in Ruby Valley against Buck, also argues against the Tosawihi having any sort of tight band-type organization.

Did the Tosawihi maintain themselves as an *ethnie* during the reservation period? No. But they did maintain themselves as an ethnic group and the ethnic identity, "Tosawihi" was maintained as an operable social fact through kin ties that united overlapping kindreds. Frequent daily contact among Tosawihi at Duck Valley as well as continued use of the Tosawihi Homeland reinforced these ties. Some Tosawihi who had moved away from Duck Valley after initially relocating there, returned to the Tosawihi Homeland for hunting, gathering, doctoring, curing, collecting and working the white chert, religious activities, wage work, and long-term and seasonal residence. Some attempted to homestead. Their relatives at Duck Valley maintained association with the Tosawihi territory through association within kindreds, despite intermarriages with individuals of other "old" ethnic identities.

When the old leaders died off, Shoshones formed their own council at Duck Valley and selected their own representatives to a reservation-wide council on which Paddy Cap Paiutes also had representation. Shoshone identity at Duck Valley forged itself from the "old" Shoshone identities such as Tosawihi, Bruneau, Agaiduka, Tubaduka, etc., constructing and maintaining the component ethnicities which gave it its form and character. Outside Duck Valley, the Traditionalist Movement started forming in the 1920s, and reinforced the components of Shoshone identity.

When the Sho-Pai Tribe was created in 1937 under the Indian Reorganization Act, it failed to submerge either their "old" identities or the emerging Shoshone identities under it. The

"old" identities, including Tosawihi, came to be maintained as components of "Shoshone-ness." This process was aided by the growth in importance of descent from apical ancestors connected either with settling of the Reservation or with signing of the Treaty of Ruby Valley or both.

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BACKGROUND STUDY FOR CONSULTATION WITH NATIVE AMERICANS ON PROPOSED MINING DEVELOPMENT WITHIN THE TRADITIONAL *TOSAWIHI* ('WHITE KNIFE') QUARRY NORTH OF BATTLE MOUNTAIN, NEVADA, IN THE TRADITIONAL LAND OF THE *TOSAWIHI* PEOPLE, WESTERN SHOSHONE NATION

by

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and
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August 13, 1991 (Revised February 12, 1992)

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INTRODUCTION

This report was prepared as background information for an Environmental Impact Statement for proposed mining activities by the Ivanhoe Gold Mining Company within the Ivanhoe Mining District, the location of the traditional *Tosawihi* or 'White Knife' Quarry. The quarry, which is on land managed by the Bureau of Land Management (BLM), was the source of a predominantly white opalite used prehistorically and by the historically-known *Tosawihi* Indians to make various flaked stone tools, including knives and projectile points. The authors were instructed to conduct a Native American study program to provide the background for consultation with tribal groups and individuals who retain traditional religious and other cultural ties to the quarry. This consultation was undertaken to provide adequate compliance with the American Indian Religious Freedom Act (AIRFA) and related legislation.

REASONS FOR CONSULTATION WITH NATIVE AMERICANS

Although there are several reasons for a Federal agency to consult with local Native Americans during the planning and environmental review of a project, such as the proposed mining development, the primary objective is for the agency to comply with AIRFA and related legislation and regulations. In addition to this statutory obligation, the government may learn from such consultation a great deal of historically and scientifically important information about cultural and archaeological resources of value to its general land-management interests.

AIRFA was passed by the U. S. Congress as an attempt to bring an end to a long history of federal restrictions on the free religious practices of Native Americans. Although the early federal policy was directed toward the discouragement or even prohibition of traditional religions, this has not been the case since the passage of the Indian Reorganization Act in 1934. Since that time, most of the federal actions that have been objectionable to Native Americans are probably the result of administrators' insensitivity and ignorance about traditional religions.

This act required Federal agencies, in consultation with Native Americans, to evaluate any administrative policies or actions that may adversely affect the constitutionally guaranteed free exercise of a Native American traditional religion, and to change policies or recommend legislation needed to avoid infringement on this right. Most agencies, including the BLM, adopted policies that provided for consultation on any specific actions that might impinge on a place, object or practice sacred to Native Americans.

Traditional religious practices vary a great deal from one North American Indian group to another, but all share a general world view. The earth with all of its biophysical components is believed to be a living being to whom people, and especially Native Americans, have an obligation of stewardship (Suagee 1982:10-12). Native religious beliefs and practices are grounded in this obligation, and are especially tied to traditional tribal lands. These fundamental qualities shared by all of the traditional Native American religions differ greatly from the Judaeo-Christian tradition that currently dominates the religious beliefs of most United States citizens.

The initial phase of the consultation for compliance with AIRFA and related legislation is the preparation of a background study based on a review of the relevant literature. This document addresses the following topics: 1) legislative issues, that mandate Native American consultation and study; 2) the identification of ethnic and tribal groups that would be potentially affected by the mining if it is

undertaken; 3) a summary of ethnographic and ethnohistoric information about these groups; and 4) the identification of known cultural and natural resources that are likely to be regarded by affected tribal people as especially sacred or otherwise sensitive. The last topic is also addressed as a result of consultation, and the final phase of the consultation concludes with a set of recommendations for the protection of significant cultural and religious properties and/or for the mitigation of unavoidable adverse effects by the proposed project on these significant cultural resources.

LEGISLATIVE ISSUES

The first Congressional action to require consultation with American Indians and other Native American groups on government policy affecting their religious freedom was AIRFA. Since the enactment of AIRFA, amendments to and/or revised regulations for several earlier pieces of legislation have explicitly included clauses that amplify AIRFA concerns. This relevant legislation includes the National Environmental Policy Act (NEPA) of 1969 and the National Historic Preservation Act (NHPA) of 1966. The Archaeological Resources Protection Act (ARPA) of 1979 (93 Stat. 721), passed after the enactment of AIRFA, explicitly references that act.

AMERICAN INDIAN RELIGIOUS FREEDOM ACT

AIRFA (P.L. 95-341) was a joint resolution of Congress passed in 1978 to affirm "the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise" their traditional religions. Its preamble acknowledges the First Amendment guarantee of this inherent right for all people, and that the lack of a clear Federal policy has often resulted in violations. The resolution recognizes that some laws designed to protect endangered species and some land management policies have unintentionally prohibited the use and possession of sacred objects and free access to sacred sites. The intent of Congress is clear: Native American religions are entitled to full First Amendment protection, recognizing that they differ in significant ways from dominant religious traditions in the United States. In spite of this, the resolution required no specific administrative action beyond an initial study in consultation with traditional Native American leaders to evaluate administrative procedures and report feasible remedies to Congress. Pending further Congressional action, compliance with the resolution has been determined at the agency level by provisions spelled out in the original report to Congress (Federal Agency Task Force 1979) and subsequent regulations and internal policy directives adopted directly in compliance with AIRFA, as well as the related legislation discussed below.

The Federal agency task force, appointed by the President shortly after passage of the act, undertook the mandated study and a report was filed approximately a year later. For its part in the report, the BLM reported that its land-use plans, guided by principles of multiple-use management, and its planning process provide

> ...the overall policy and direction to incorporate socio-cultural values, such as Native American religious concerns, into its land-use planning and management systems. Many of the potential impacts upon Native American religious freedom can be avoided through use of these existing systems.

One consequence of the assignment of AIRFA considerations to the BLM's "land-use planning and management systems" was raised by one BLM cultural resource specialist (Laidlaw 1990). There has been a tendency to confuse AIRFA with cultural resource management concerns. The latter, as specified in a set of laws and regulations, are primarily involved with the identification, evaluation and preservation of historic structures or archaeological sites. When government needs require actions that may adversely affect these structures or sites, procedures to mitigate the effects are designed and implemented. This is quite different from AIRFA, which invokes First Amendment protection of Native American religious practice and expression. The United States Supreme Court has traditionally required the government to demonstrate that a "compelling governmental interest" is involved when an action infringes on a plaintiff's First Amendment rights.

The BLM concluded its report to the task force by affirming that it

> ...will continue to evaluate its policies and procedures relevant to Native American religious concerns and will work toward providing full consideration of socio-cultural values in its land-use planning and management systems (Federal Agency Task Force 1979:33).

NATIONAL ENVIRONMENTAL POLICY ACT (1969)

Regulations adopted by the Council on Environmental Quality in 1978, after passage of AIRFA to update NEPA, clarify the role of Indian tribes in the NEPA assessment process (Federal Register Vol. 43, No. 230:44978-56007). Whenever a project can have an impact on Indian people "living on a reservation," they shall be notified in an early stage of the project and be invited to participate in the planning and research and to comment on report drafts before the public comment period. These regulations also include social and economic as well as religious impacts in the assessment.

NATIONAL HISTORIC PRESERVATION ACT (1966)

NHPA (80 Stat.915) established the National Register of Historic Places (NRHP) and the Advisory Council on Historic Preservation (ACHP). Amendments in 1976 (P.L. 94-422) and 1980 (P.L.96-515) expanded the NRHP and modified the role of the Advisory Council.

The National Register is a record of districts, sites, buildings, structures and objects significant in American history, architecture, archaeology and culture. The Advisory Council, an independent federal agency, is the major policy advisor to the government on historic preservation. Section 106 provides for Advisory Council consultation on federal projects that would have an effect on a property on or eligible for the National Register, and provides a process for determining eligibility for the National Register. Amendments to NHPA specify that Indian tribes and other Native American groups are provided full opportunity to participate in the review of federal undertakings under Section 106 on non-Indian as well as tribally owned lands.

ARCHAEOLOGICAL RESOURCES PROTECTION ACT (1979)

ARPA, which expanded earlier penalty provisions for the disturbance of archaeological sites on Federal lands and specifies enforcement responsibilities of Federal land-management agencies, specified notification of Indian tribes prior to the issuance of archaeological excavation permits on their traditional lands. Supplemental regulations (43CFR Subtitle A, 1989 Edition) specify consultation with tribal officials or representatives when the issuance of an archaeological excavation or collection permit has an effect on a site of cultural or religious importance to an Indian tribe.

EFFECTIVE CONSULTATION: ENABLING NATIVE AMERICAN PARTICIPATION IN THE LAND MANAGEMENT PROCESS

Environmental and cultural resource protection legislation requires land managers to undertake a systematic review of the potential impacts of any land-altering projects before they can be started. AIRFA compliance, with its requirement for Native American consultation, is a part of this larger environmental/cultural resource review process. Other related legislation and regulations delineate the need for Native American participation in the land management process where traditional and/or tribal lands are involved.

The letter of these laws and regulations, but arguably not the spirit, is met by the simple notification by mail of a proposed project. These letters may be addressed to the nearest tribal council office. The notification, in this case, may not reach the most interested tribal members. Instead, an overworked and often unpaid tribal chair may respond with a form letter or ignore the notification altogether.

Recent AIRFA compliance efforts in Nevada and California (Bean and Vane 1982; Fowler, Rusco and Hamby 1988; Woods and Raven 1985; Stoffle et al., 1988) provide models for effective Native American consultation. In these projects, the following set of procedures was generally undertaken:

1. Consultation was initiated by mail, followed by telephone communication and in-person interviews with tribal officials and/or representatives.

2. An opportunity was provided for official representatives of relevant tribal governments and other tribal members who have expert knowledge about sacred and culturally important sites to view the project area.

3. Tribal members, including tribal council representatives and traditional religious leaders, were then given the opportunity to comment on the proposed project, and to make recommendations for the preservation of sacred, culturally important sites or traditionally, religiously important natural resources. They were also asked to recommend suitable action to mitigate any unavoidable adverse effects on these cultural, historic and/or religious resources caused by federal land management actions or policy.

The Native American consultations cited and described above were thus able to give involved tribal groups their mandated opportunity to participate in the environmental review process prior to the initiation of government programs that might adversely affect their lives.

The effect of Native American comments on a project in its planning stage depends upon several factors, including whether an alternate location for the proposed project is available and how compelling the

government's need for the project is. Another variable is the nature of the Native American comments. A frequent comment takes the form that the project will violate traditional religious teachings about the sacredness of Mother Earth and should not be undertaken at all. This recommendation would equate to the "no action alternative" considered in all Environmental Impact Statements. When such a comment is the only one received, even land managers who are sensitive to Native American religious concerns may see no way to avoid or mitigate impacts of the project.

A recent paper (Stoffle and Evans 1990) deals with this problem. The authors discuss the dilemma created by the Native American tendency to take the position that all of the land and its natural and cultural resources should be protected. They term this position "holistic conservation" and point out its religious basis in concepts about the sanctity of the earth. They then point out that when an agency's need for a proposed action is likely to override religious concerns, the Indian people must move to a consideration of how to save at least some of the threatened resources or at least mitigate impacts on them; otherwise they may forfeit their opportunity to take an effective role in land-use planning. For this, the authors propose a process of "cultural triage." By embarking on an attempt to rank resources on the basis of relative importance, scarcity, vulnerability or other reasonable quality, the Native American consultants can increase the possibility that some high-ranked resources can be saved, although others may be sacrificed.

There are ethical conflicts faced by tribal people in the course of attempting to save some resources at the expense of others. It is important that all tribal positions on the proposed construction project, both the no action alternative and mitigation recommendations, be included. A variation on this process was followed for the Native American consultation undertaken for the planned mining development in the traditional *Tosawihi* Quarry.

NATIVE AMERICAN GROUPS POTENTIALLY AFFECTED BY THE PROPOSED PROJECT

For millennia, what is now north central Nevada has been the homeland of the descendants and/or predecessors of a large ethnic group, the Western Shoshone (Figure 1). The particular project area was a core part of the traditional homeland of the White Knife sub-group of the Western Shoshone (Steward 1938; Thomas, Pendleton and Cappannari 1986). Kinship ties and the joint participation in various cultural and economic events linked this group with its neighbors, so that a much larger Western Shoshone population may have known of the quarry area or have used stone tools made from the *Tosawihi* opalite obtained through direct use of the quarry or by trade.

Northeast and north central Nevada is the location of numerous colonies and reservations where descendants of the White Knife people live (Figure 2). Besides those on reservations, some descendants live elsewhere in Nevada and surrounding states.

INVOLVED TRIBAL GROUPS

The Western Shoshone reservations and colonies where the majority of *Tosawihi* descendants are known to reside are located at Battle Mountain, Elko, Lee (South Fork), and Owyhee (Duck Valley), and Wells, Nevada; and Fort Hall, Idaho.

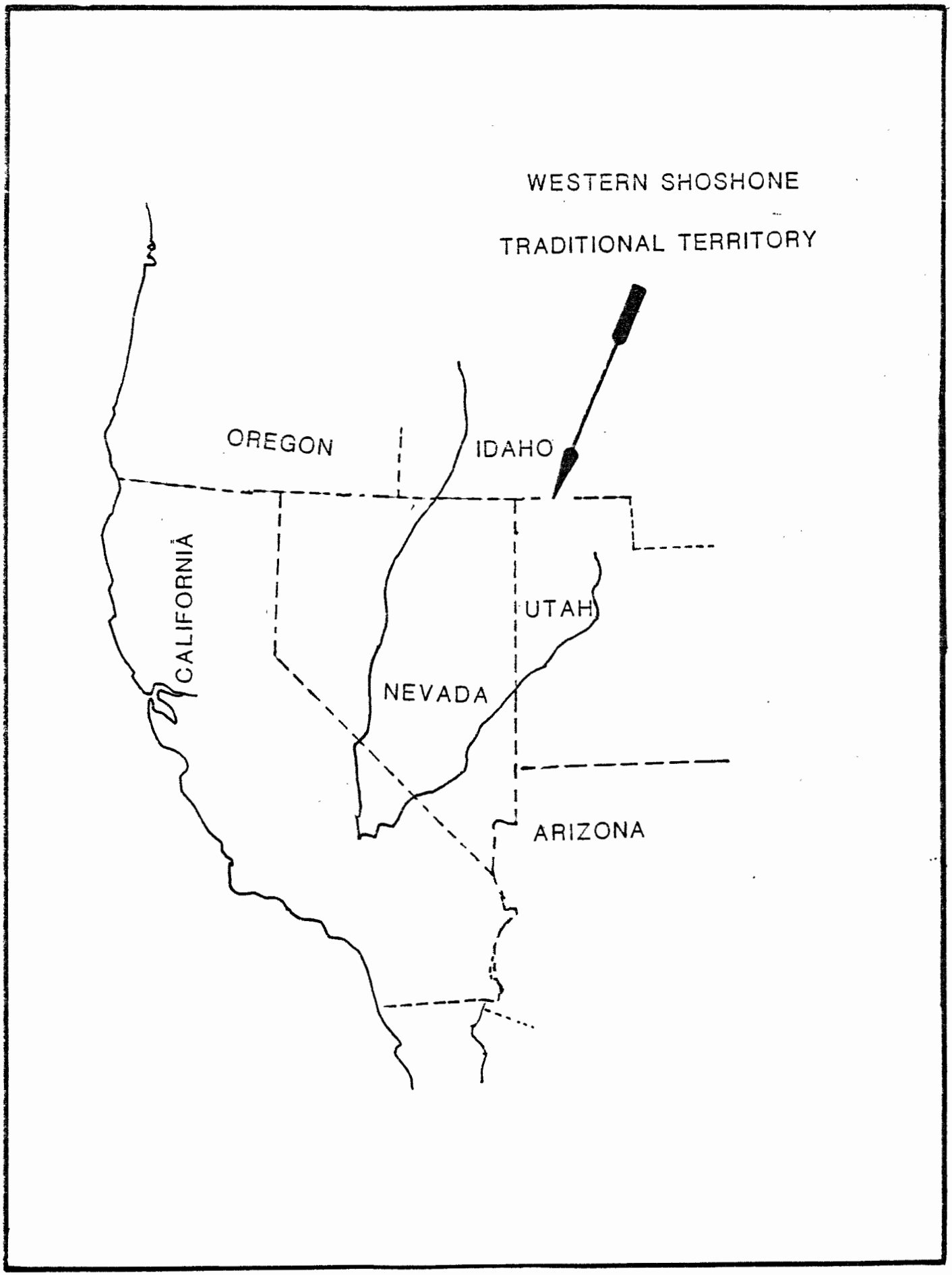


Figure 1. Map showing Western Shoshone traditional territory.

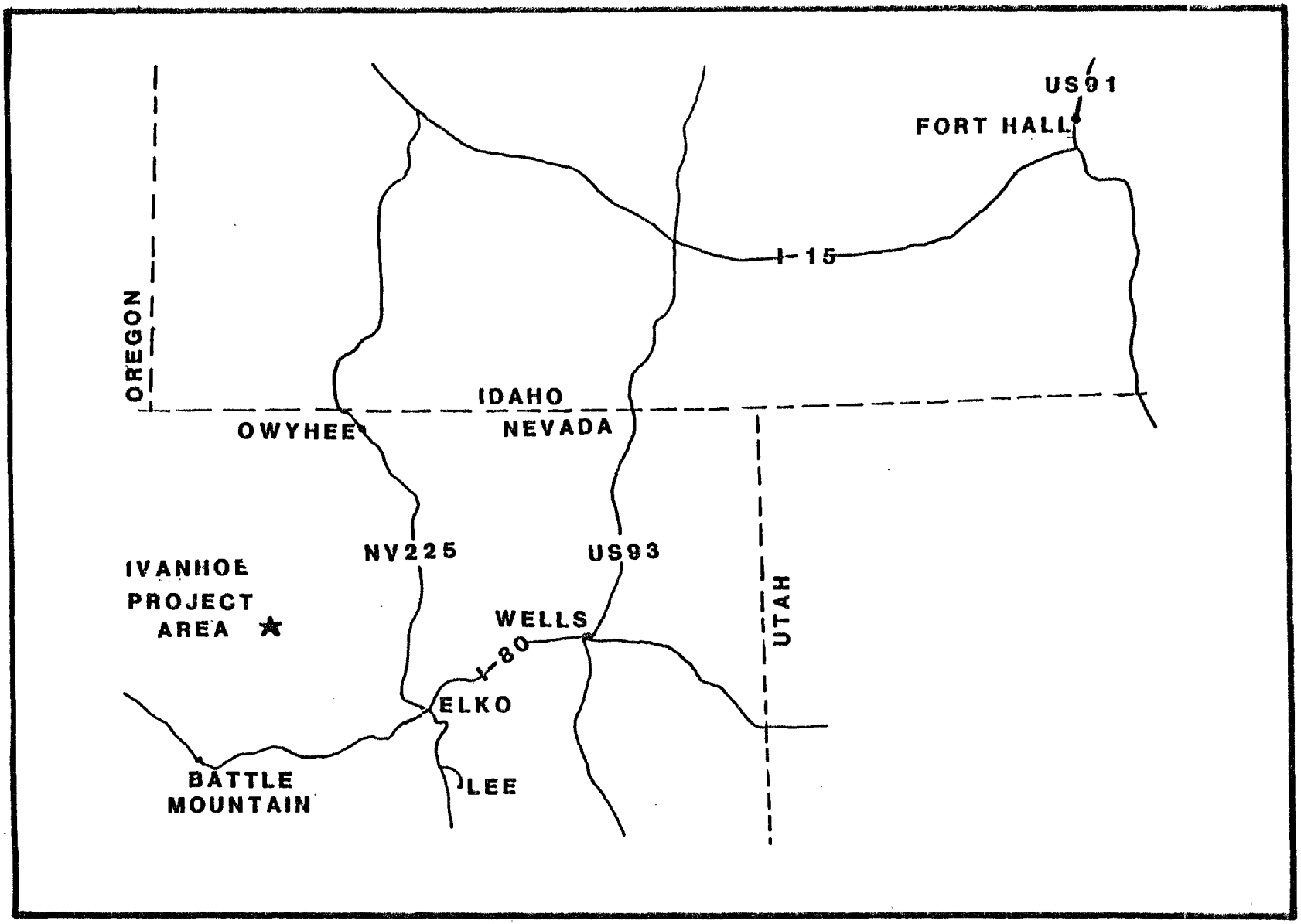


Figure 2. Map of the project area, showing location of tribal groups and individuals consulted.

Three of the reservations contacted as a part of this project, the Wells Colony and Duckwater Reservation in Nevada, and the Gosute Reservation in Ibapah, Utah, were added to the original list because *Tosawihi* descendants currently residing there were particularly interested in the potential impact on the *Tosawihi* Quarry area.

ETHNOGRAPHIC AND ETHNOHISTORICAL INFORMATION ABOUT THE AFFECTED TRIBAL GROUPS

The Western Shoshone peoples have lived in the Great Basin at least for many centuries. They speak Central Numic dialects and are included in the Uto-Aztecan language family. Linguistic (specifically, glottochronological) data have been used to estimate when the Numic languages diverged from a proto-Numic language. The Comanche people in Oklahoma, who occupied the Green River basin in Wyoming prior to the eighteenth century, speak a Central Numic language that now differs significantly from the language of the Western Shoshone in Nevada.

In view of the relative uniformity of the Numic languages over a large area in Nevada and southeastern California, many linguists postulate (after Lamb 1958) a population movement that began in the southwest Great Basin approximately two thousand years ago and fanned out until the present homeland was fully occupied a few hundred (ca. 600 or so) years ago (Miller 1986). Attempts to confirm this movement from the archaeological record have met with mixed success, and some archaeologists have argued for a northern-based spread into the Great Basin (cf. Swanson 1968).

The introduction of the bow and arrow into the Great Basin, the intensification of seed procurement and processing, the manufacture and use of plain grey brown utilitarian ceramics, and changes in rock art have been argued to mark the Numic movement throughout the Great Basin (Bettinger and Baumhoff 1982, 1983), but most of the evidence for a recent peopling of the Great Basin by Numic speakers has come from linguistic studies (Miller 1986:102-103). An alternate explanation of the linguistic data was offered by Goss (1977), who attributes the relative uniformity to frequent contact among the various dialect groups rather than their recent arrival.

The oral tradition of the Numic-speaking ethnic groups traces their occupation of the Great Basin back to when the earth was young--when "animals were people." Coyote and Wolf figure in the creation stories, with prominent mountain peaks in traditional Western Shoshone territory honored as sacred places connected with their creation.

The economic base of proto-historic Western Shoshone people was hunting and gathering food and other essential resources. They lived in small kin-based highly mobile groups, forming inter-group kin ties that provided access and familiarity within a large territory. Neighboring groups were granted hunting and gathering privileges within each other's territory, and the maintenance of boundaries between the Western Shoshone and neighboring ethnic groups was sufficiently flexible to permit both frequent intergroup marriages and large joint-use areas to exist. This social-political organization permitted a relatively large population to be sustained in the semi-arid Great Basin, because when food resources failed in one area, it was possible for groups to move to another where food might be more plentiful. Today, descendants of the proto-historic Western Shoshone belong to organized tribal groups that hold reservation lands or live in other communities, most of which are within their traditional homeland.

The Western Shoshone clustered in winter camp sites, dividing into smaller family groups for an extensive round of hunting and gathering from spring through early fall. Thomas (1981; cf., Fowler 1982) has pointed out that although the Western Shoshone shared this general settlement-subsistence pattern, there is a great deal of diversity in the ways individual groups actualized this pattern. In well-watered valleys, such as in major tributaries of the Humboldt River, large, more-or-less regularly occupied winter camp sites were present. In the drier central Nevada valleys, such as Kawich Valley, where resources were less predictable, "families had to travel to distant resource patches, and group composition in any given year was dependent on who chose which patch" (Thomas, Pendleton and Cappannari 1986:276).

All winter camp sites or villages were located near permanent springs. In the dry valleys it is unlikely that each camp site was occupied every year. Camp populations moved winter locations from one year to another in order to position themselves nearest the best pine-nut harvesting areas. One or more kin-based households would camp together for the winter, leaving for brief periods to hunt as needed. In the early spring they would divide into smaller groups, which moved about the territory hunting and following the harvest seasons of wild plants.

The nuclear family was the basic socioeconomic unit for the Western Shoshone. Winter village or camp group composition seems to have varied somewhat. Extensive kinship networks facilitated cooperation in communal game drives, and festivals provided the opportunity for marriages to be made. Respected senior men headed each winter camp group or even each major family.

THE *TOSAWIHI* SHOSHONE

The *Tosawihi* Shoshone traditionally occupied the Humboldt River Valley around Battle Mountain, the lands drained by Rock Creek and other northern tributaries of the Humboldt from as far west as Golconda or Winnemucca and east to the Independence Mountains. In the summer they foraged as far north as the upper reaches of the Owyhee and the Snake rivers with some groups going south to Austin and Eureka (Harris 1940:39; Steward 1938:163). According to Harris (1940:39), the term "White Knife" was apparently "restricted at one time to those camps in the immediate vicinity of Tuscarora and Battle Mountain where white flint for knives and other articles is found." Information about the White Knife people comes from three general sources: ethnographic, ethnohistoric and archaeological.

Ethnographic Information

Two ethnographic sources account for most of the early information about the White Knife people (Steward 1938; Harris 1940). Julian Steward (1938:ix-xi) spent six months in 1935 and four months in 1936 collecting data on the Western Shoshone in Nevada, Idaho and Utah. This included a relatively brief time in Battle Mountain in 1935, probably no longer than a few days with a primary informant, JP, identified as having "ranged the [Humboldt] river between Ellison and Iron Point," wintering two miles upstream from Herrin. Another family, which wintered there, was that of Captain Sam, who was not related to JP (Steward 1938:162). Captain Sam was the White Knife leader who is credited with first asking for a reservation in Duck Valley (Inter-Tribal Council 1976:72-74; McKinney 1983:42). Of the four months in 1936, Steward (1937) seems to have spent the longest time (six weeks) at Fort Hall and with Shoshone people in Utah. It is not certain whether there were *Tosawihi* descendants living at Fort

Hall in Idaho at that time; there are apparently few if any living on this reservation at the present time (Fort Hall tribal administrator, personal communication 1991).

Jack and Martha Harris spent three and one-half months at Owyhee in 1937 (Harris 1940:39), where they collected more detailed information about the proto-historic or early post-contact White Knife people in connection with a comparative study of acculturation. Harris did not specify whether he was writing only about the proto-historic White Knife and their descendants, or whether some of his information was from or about other Western Shoshone subgroups represented in the 1937 Duck Valley population. Clemmer (1990a:21) speculates that Harris used the term "White Knife" for all Western Shoshone people at Duck Valley Reservation, distinguishing them from the Northern Paiute people on the reservation. Harris's (1940:39) description of White Knife proto-historic or very early post-contact territory (see above) is essentially the same as Steward's (1938:163, 248). For other information Harris (1940:40) specifically distinguished between the White Knife and the Snake River Indians.

Harris (1940:44) estimated the size of the White Knife summer range at approximately 25,000 square miles. The extended range was so large because the winter settlements were dispersed over a relatively large area. Each camp would usually move over an area from 25 to 100 miles from its winter base. A winter settlement would consist of from two to ten camps spaced from 1/8 to 1/4 mile apart; houses were dome-shaped, made of willow and/or tule grass.

In complete agreement with Steward (1938, 1970), who found the "village" or "family clusters" to be the largest permanent organization of the Western Shoshone, Harris (1940:39-40) denied that the White Knife people had a band organization "with the traditional ethnological connotations of restriction and cohesiveness." He expressed doubts that the concept of land ownership "ever occurred to these people" (Harris 1940:45), and said that there was no period during the year when all White Knife people came together (Harris 1940:53).

Richard Clemmer (1990a, b) recently undertook a study of the persistence of *Tosawihi* Shoshone culture and identity on several reservations in northeastern Nevada. Reviewing both the ethnohistoric and early ethnographic information, he concluded that the *Tosawihi* were not a true band as usually defined: i.e., maintaining a distinct territory, with well-defined criteria for group membership, political leadership and authority, including an accepted process for determining succession. Instead, he offers the concept of the "ethnie" (after Smith 1986:22-31) at least for the early post-contact White Knife people: "a collectivity of people possessing symbolic, cognitive and normative elements as well as behavioral practices that bind them together as a population over generations and distinguish them from other populations" (Clemmer 1990a:22).

Ethnohistoric Information

The *Tosawihi* Shoshone attracted public attention for nearly three decades after 1850. They figured in the correspondence of various Indian Agents sent to the Utah-Nevada Territory to estimate the number of Indians present (Forney 1858, 1859; Holeman 1852; Hurt 1857; Wasson 1862). They were also discussed in the report to the Commission on Indian Affairs by John Wesley Powell and George W. Ingalls (1874; Fowler and Fowler 1971). At least one contemporary travel book (Burton 1862) mentioned the group, as did reports of government exploration parties (Fremont 1845; Inter-Tribal Council 1976; Simpson 1869).

Some of these references placed the White Knife people far outside the generally-accepted limits of their traditional homeland, as far east as the upper Humboldt River (Wasson 1862) and Ruby Valley (Nye 1862), and as far north as the Snake River (Forney 1858). They are described by Hurt (1857) as well-equipped with guns and horses, and acquired a reputation as fighters and raiders. Raids on emigrant trains along the middle and upper reaches of the Humboldt River were attributed to White Knife parties (Holeman 1852; Inter- Tribal Council 1976:43). In a recent review of ethnohistoric information, Clemmer (1990a:19-20) concludes that the White Knife people, unlike other Western Shoshone subgroups, were mounted (prior to 1860), "[they] moved around quite a bit and did so en masse, as a group." Harris dated their taking of horses (except for food) as between 1850 and 1860. It was only then that the Shoshone "welded" into a band-like organization (Harris 1940:75-77).

Two treaties were negotiated with the White Knife and other Western Shoshone people (Clemmer and Stewart 1986:534-536). The first of these was a treaty of friendship between the Western Shoshone people and the United States. The U. S. government (1855) agreed to a payment of "provisions, clothing and farming implements." It was never ratified. In 1859, Jacob Forney, Indian Agent assigned to Western Shoshone country, initiated plans to establish a six square mile reservation in Ruby Valley. A farm was actually begun (Inter-Tribal Council 1976:39), but the reservation was never officially established. The second treaty, the Ruby Valley Treaty of 1863, was ratified. This was also a peace and friendship treaty negotiated by the United States and various Western Shoshone leaders. No land was ceded by the Western Shoshone, who were, however, to "abandon the roaming life" and move on to reservations when made available to them (The Treaty of 1863: Article 6, Inter-Tribal Council 1976: Appendix B). Signatures of Western Shoshone leaders were affixed to the treaty, including Buck, Po-on-ga-sah, and Tosa-weent-so-op, *Tosawihi* leaders (Clemmer 1990b:88).

Two Western Shoshone reservations were actually set aside in 1877. One of these was both small and short-lived:

> In 1873 some Western Shoshones, probably White Knives, under Captain Sam, established a small settlement north of Palisades and began to farm. A farmer was appointed specially for them, and 52 acres were set aside by executive order in 1877 as the Carlin Farms Reserve. Almost as soon as the reserve was set aside, two settlers claimed they had filed on the land prior to its withdrawal. In spite of considerable opposition to their claim by Shoshones, their agent, the state's governor, and other settlers who thought Indians should be encouraged in the "civilized" pursuits of farming, Shoshones were evicted from Carlin Farms when the land was restored to the public domain in 1879 (Clemmer and Stewart 1986:534).

The Duck Valley Reservation, originally 289,667 acres, was intended for "all Western Shoshone outside of Carlin Farms," and when the latter was closed in 1879 Captain Sam and his followers moved there. By April 1879 approximately one-fourth of the enumerated Western Shoshone had moved to Duck Valley (McKinney 1983:55; Clemmer and Stewart 1986:535). Leaders of the *Tosawihi* families at Duck Valley were Captain George, Captain Sam, Henry, and Buck (Clemmer 1990a:64).

The first years of the reservation were marked by

> ...low selling prices for reservation crops and high purchase prices for supplies, nondelivery of government-promised rations, lack of support and expertise from the BIA [Bureau of Indian Affairs], and a corrupt agent" (Clemmer and Stewart 1986:535).

Residents began to leave in great numbers by 1882, and in 1884 only 250 Western Shoshone remained at Duck Valley. The remaining residents refused to move to Fort Hall. In 1886, the reservation was enlarged to accommodate a group of Northern Paiute Indians led by Paddy Cap and "such other Indians as the Secretary of the Interior may see fit to settle thereon." The mixed Western Shoshone and Northern Paiute population then stabilized at around 600 individuals (Clemmer and Stewart 1986:535-536; Inter-Tribal Council 1976:75-76; McKinney 1983:79-86).

After the settlement of the Nevada towns of Tuscarora and Elko, another ethnohistoric record was accumulated--newspaper accounts and an oral tradition of Indians farming, buckarooing on ranches, having fandangos, and other Indian activity in the traditional White Knife homeland (Clemmer 1990a:78-84, 1990b:18-20; Crum, personal communication). Many, if not all of the individuals mentioned in these accounts can now be identified as *Tosawihi* descendants.

THE *TOSAWIHI* ETHNIC GROUP: THE EARLY RESERVATION PERIOD TO THE PRESENT

Because of the early scattering of the *Tosawihi* people and subsequent intermarriage with other Indian groups, descendants of the *Tosawihi* Shoshone live on many of the Shoshone as well as other reservations in Nevada and surrounding states. Some live in urban, non-reservation settings. Many of these maintain some ties to the *Tosawihi* homeland between Battle Mountain and the upper Owyhee River, close to the *Tosawihi* Quarry area. Writing about Western Shoshone in general, Clemmer (1978:70) observed that

> Although Western Shoshones are now incorporated into Euro-American economic pursuits, most still participate in traditional food-gathering behavior to some extent, primarily to enforce their cultural and psychological ties to the land....

Use of the White Knife homeland, specifically the *Tosawihi* Quarry area, was found by Clemmer (1990a:72-73) to involve hunting, seasonal buckarooing for White-owned ranches, long-term residency and buckarooing, gathering plants and other resources, and gathering the *Tosawihi* chert.

Data collected for hunting in the area up to and including 1988 revealed that "deer, rock chucks [marmots]...squirrels, and rabbit were hunted." One of Clemmer's (1990a:75) consultants reported "using the ranch kitchen where she worked to can the jackrabbit meat for use in the winter." One consultant recalled seeing his grandmother making a rabbitskin blanket.

Three of Clemmer's (1990a:75) consultants reported that they had buckarooed in the *Tosawihi* area; another was a camp cook, and a fifth had been married to a buckaroo. Ranches worked included: Betty O'Neill, Izzenhood, Hadly, 25 Ranch, and Spanish Ranch, from 1927 to as late as 1965. Consultants

also reported that others would come to the area from Duck Valley, Fort Hall, Deeth and Starr Valley during the summer and fall for seasonal work, such as cutting, baling and stacking hay for the ranches.

Several consultants told Clemmer (1990a:75-76, 81) about the use of the area to collect red ochre and various plants, including willow material for making cradle boards. At least three of his consultants discussed making trips to the area to gather the white chert.

Finally, a number of burials were reported to Clemmer (1990a:79) from the quarry area and along Rock Creek to the south. The most recent, for which a date was given, was between 1920 and 1925, and one consultant told him that one of the last *Tosawihi* Shoshone to live in the area had continued to care for the graves until he left in 1927. Other individuals were reported to have known ancestors buried in the region, but these were not interviewed by Clemmer.

RELIGION AND WORLD VIEW

Although all North American religions are tied to the earth, nowhere is this more important than in the Great Basin, where the balance between subsistence and an unpredictable environment was most delicate (Hultkrantz 1986; Miller 1983a, 1983b, Clemmer 1981). Hultkrantz (1986:631) sees Basin religion as "the result of a unique fusion of ecological and traditional factors." He sees it as adjusted to the biophysical constraints on a small hunting and gathering population, with religious goals oriented toward the "needs and patterns of subsistence and the small nomadic social units that prevailed." The belief that supernatural power (*Puha*) has permeated the earth since its creation in the myth age "when animals were people" (Miller 1983a:70) is a central feature in Basin religion.

A major religious goal is the acquisition and use or control of power. According to Harris (1940:56-57) the

> ...richest religious expression for Shoshonean life is to be found in the concept of *Buha*--supernatural power--and its embodiment in shamanistic practice... [E]very person must possess *Buha*, the life principle...to live. [Note: *Puha* and *Buha* are different spellings of the same word.]

Special power is given to humans who have the discipline and strength to use it. It can come solicited or unsolicited in dreams and visions. In the Great Basin, the shaman obtains power to heal illnesses, injuries and wounds. Such power can also act as a preventative measure. Special powers aid the hunting of large game. Once obtained power can be used for the good of the individual or the community; it can also be used against individual or public interest.

Relatively few people were shamans or had special powers (cf. Harris 1940:57), just as in many organized religions, few are in the priesthood or other religious orders. Most people participated in a wide range of rituals associated with hunting, gathering, obtaining water from a dangerous spring, attending a birth, or burying and mourning the dead. These rituals, as well as the control and use of power were directed towards the balancing of the potentially dangerous spiritual powers which pervade nature.

Prominent mountain peaks are major sources of power. Mountains collect the most precipitation in the Great Basin and encampments were often clustered in relation to mountain ranges rather than valleys

(Steward 1938:232). In view of the importance of water in this semi-desert region, it is not surprising that water "is the keystone of Basin religion because power, with its affinity for life, was strongly attracted to water" (Miller 1983a:78). Power is also present in caves, particularly deep caves with tunnels and separate chambers, and where water collects. Animals, and to a lesser extent plants, have power and this power can be given to people by the supernatural spirits who control these species. Because power is attracted to all life, it remains present in places where people have lived, and particularly around graves.

Ceremonies involving dancing and other rituals are a part of Native American religious life. Two of these have been important to *Tosawihi*. One is the *Gwinii* ceremony, which clearly has deep roots; the other is the Sun Dance, which is a much more recent practice.

The *Gwinii* ceremony was described by Harris (1940:53-54) as a six-day celebration held four times a year, in which round dancing, gambling games and feasting took place. He described how the ceremony, which he said was focused on health and fertility, was changed over the years under the influence of government agents. Well before 1936, three of the traditional occasions had been eliminated and the dances were held on the Fourth of July weekend. Although other dances introduced from elsewhere had been added, as well as many introduced games such as baseball, it remained an important enough event that Harris (1938:409) concluded it was the "most cohesive force" the White Knife people experienced. Steward (1939:265) objected to that conclusion, holding that the *Gwinii* was a "mere social dance" that exerted no cohesive force.

The Sun Dance is a "postreservation phenomenon" for the Western Shoshone (Jorgensen 1986:665). Invented on the High Plains by 1700, the dance was widely practiced by all Plains tribes. It was usually held after an individual made a vow to avenge the death of a friend or relative or to lead a war party, or was held to insure a good supply of buffaloes for a hunt. Jorgensen (1986:666; cf. Shimkin 1986:314-315) describes the original form briefly as follows:

> ...men danced for three or four days and nights to the accompaniment of drumming and singing. The dancers often underwent various tortures such as ritual fasting, thirsting, and mutilations, in a quest for power, good health, success in wars and on hunts, and the general welfare of the group.

By the time it reached the Northern Shoshone and Bannock reservation at Fort Hall, Idaho, in 1901, the Sun Dance had died out on the Great Plains, where it had been effectively suppressed by various actions of the federal government. With warfare and buffalo hunting no longer relevant, the purpose of the ceremony shifted to promoting the general health and unity of the tribe. Elements related to warfare and buffalo were dropped from the ceremony and some apparently Christian elements were added (Jorgensen 1986:666).

It is not clear when the Western Shoshone first became involved in the Sun Dance. Harris (1940:108), writing of the Duck Valley reservation in the mid-1930s, reported "the sun dance never reached the reservation, although a few of the natives go to Fort Hall each summer to participate in it." Western Shoshone apparently participated regularly in Sun Dances at Fort Hall. Jorgensen (1986:667) acknowledges that one was held at Elko in 1935 and possibly as early as 1918. More recently, Clemmer (1990a: 67, 70) reported that Sun Dances were held at Deeth, Nevada and later at Elko in the 1920s, at which time "some Western Shoshone became initiated."

Traditional Religion Today

It is probably the case that there are fewer traditional religious practitioners on Nevada reservations today than ever before. In 1936, Harris (1940:102-103) found eight shamans among the 670 Indians he visited on the Duck Valley Reservation. Few of the reservation population doubted the power of the shamans to cure illnesses, but some attributed this to the effect of their faith in their traditional ways. In contrast to curing-shamanism, Harris (1940:104) concluded that "other forms could not persist when the need for them had disappeared." In 1989, however, Clemmer (1990a:73) found a persistence of traditional rituals to enlist the assistance of spiritual beings, or "Little Men", in the hunt:

> Hunting is done with the help of the Little Men. These Little Men cannot be seen but they are always there. They whistle like a bird. That's how you know they're there. This is still the way Shoshone hunt. They will guide you right to the animal if you pray to them. It's important not to do anything to change the land because if the land is changed, those Little Men will go away and there will be no more deer to hunt.

Four of Clemmer's (1990a:71) consultants

> ...volunteered strong opinions on "California hunters" who, they said, not only failed to pray to the spirit of the deer, but also wasted the game. In contrast, they said, Shoshone hunters could not get away with doing things that way and if too many "modern" Shoshones hunted like that, then soon, the Little Men and the animal spirits would go away and there would be no more game. Destroying the habitats of the Little Men by activities such as mining could also cause them to go away.

It is also true that the traditional religions have changed over the past hundred years. This is not, as many outsiders seem to think, because conversion to Christianity or Mormonism replaced the traditional religion. Many traditional religious practitioners have had an eclectic view that permitted them to add new religious practices to the old (Hultkrantz 1986:631; Stewart 1956). For example, the Native American Church, which uses peyote as a sacrament, combines Christian and traditional Native American elements in its rituals (Stewart 1986).

Changes have taken place to adapt to the changing circumstances in which Native Americans have found themselves over the past 100 years or so. Today, few have sought or been offered instruction in the traditional ways. Most Great Basin Indians speak their native language as a second language if at all, and in most families traditional teachings are no longer emphasized. Altered as it has been, the traditional religion is still practiced, if in a somewhat attenuated form (Bean and Vane 1982; Clemmer 1981; Hamby 1986-1988; Stoffle, et al., 1988; Rusco 1986-1988).

Some *Tosawihi* and other Shoshone people heed the call of supernatural power and/or go to special power spots to receive power in visions (Clemmer 1990a:67- 70). Of the people he interviewed in 1989, only *Tosawihi* descendants seemed to be aware of power spots in the White Knife homeland. Four spots have been identified--two within the quarry area and two along Rock Creek downstream from its confluence with Antelope Creek, south of the quarry (Clemmer 1990a:68).

The persistence of shamanistic practices, now sometimes associated with the Sun Dance, actually may represent a resurgence of traditional religious practice by young people after the 1930s (Clemmer 1990a).

According to Clemmer (1990a:69):

> ...today, Western Shoshone religion has three primary expressions: Sun-Dancing; individual prayer to the spirits of plants, animals, power spots, and to Little Men; and use of power spots for vision questing, curing, or doctoring.

Other, largely social dances (local pow wows) continue to be held by Great Basin reservation groups. Usually confined to long weekends, in spring through early fall, they are often connected with a rodeo or other event. They may or may not have religious import, but they apparently serve to reinforce ethnic identity, and may well be termed a "strong cohesive force," thus continuing to fill the function Harris once attributed to the *Gwinii* ceremony.

At least two of the *Tosawihi* descendants interviewed by Clemmer (1990a:76) in 1989 reported a religious association for the *Tosawihi* chert, particularly in modified or worked form. Individuals collect artifacts made of the white chert, as well as unworked chert from the quarry. It is used for doctoring, and the adept keep some on their persons at all times. Later, one reported that a white chert knife was used to bleed the patient, and that a person with the power can cure a variety of diseases. In the light of this information, Harris's (1940:95) observation that "the Indians collect and prize the arrowheads and knives they find in the hills" is interesting, even though he did not specify whether the White Knife chert was particularly sought.

Tosawihi were found by Clemmer (1990a:70) to follow no particular set of religious practices, except for the use of the white chert as a source of power for healing and the use of power spots in the Rock Creek drainage. He did note that he found "a tendency for *Tosawihi* to be strong adherents and advocates of the Sun Dance religion, more so than non-*Tosawihi* Shoshone."

Projects like the major mining developments underway in the *Tosawihi* Quarry area would threaten power sources currently used by Western Shoshone people, including the white chert present only there. Such activities represent an intrusion on the sacred, regarded as dangerous by the practitioners of traditional native religions.

METHODS

The field work portion of the study had five components: initial contacts by telephone and mail; initial meetings at the various reservations and colonies enumerated above; interviews with individual consultants about the past and present religious and cultural significance of the project area, the *Tosawihi* Quarry; a trip to the project area; and a final meeting with all consultants to discuss the draft report and recommendations for management of the project area.

INITIAL CONTACTS AND MEETINGS

In late April and early May, 1991 letters and phone calls were made to tribal groups that were considered potentially affected, beginning with the list provided by the BLM. This list was expanded to include additional groups on the basis of information provided by tribal councils and individuals initially contacted.

A schedule of four meetings was planned:

Trip 1:	M. Rusco, S. Raven, C. Carroll
	May 7: Battle Mountain
Trip 2:	E. Rusco, S. Raven
	May 18: Wells, Lee
	May 20: Owyhee (canceled on recommendation of consultants interviewed).

Members of the Elko Tribal Council attended meetings at Battle Mountain and Lee.

The project staff made a brief presentation illustrated by maps and 35 mm color slides of the project area. A period for questions, answers and comments followed the presentation at each meeting. This discussion was tape-recorded and subsequently partially transcribed. The project staff also kept notes during and following the discussion.

INTERVIEWS

Interviews were conducted on May 8, and May 19 through 22, at Battle Mountain, Ruby Valley, Owyhee and Elko. Twelve individuals were interviewed. These interviews were also taped and subsequently transcribed, and the interviewers kept notes as well.

TRIP TO QUARRY

Between June 1-3, three meetings and a trip to the *Tosawihi* Quarry area took place. Shelly Raven and Elmer Rusco lead this activity as project ethnographers, with archaeologist Mark Moore and photographer Bill Germino assisting. Karen Caddis-Burrell of ENSR was present.

A total of 12 individuals, representing the Sho-Pai Tribe (Owyhee), the Sho-Ban Tribe (Fort Hall, Idaho), Duckwater Reservation, the Western Shoshone Business Council (Owyhee), and the Elko Colony, participated. We had initially requested that two representatives from each place attend. The

representatives from Wells and Battle Mountain did not participate and alternates from the other groups were able, then, to attend. No responses to the invitation to the field trip were received from the South Fork Reservation at Lee, the Gosute Reservation in Utah, and Ruby Valley. Fort Hall, which did not arrange for an initial meeting, however, did participate in the field trip.

An initial orientation meeting was held with all participants following dinner, on Saturday, June 1. On June 2, the field trip began with a tour of the currently operating mine. An Ivanhoe Mining Company safety officer conducted the tour, which included the open pits and the leach pad, and an orientation. The purpose of the orientation was to make participants aware of where the proposed mining effort would take place. Participants then proceeded to the Intermountain Research (IMR) archaeological camp, located in Velvet Canyon.

During a walk down this canyon, Robert Elston and Melinda Leach of IMR discussed the procedures that archaeologists follow to test sites and conduct data recovery for mitigation of unavoidable effects, including arrangements for curation. They summarized results of their work to date. Following their presentation, time was allowed for questions and discussion.

Quarry sites and overhangs were visited in the canyon, then a trip was taken to quarry pits at an open site where an undisturbed cache of bifaces was present, and to one area where evidence of dense prehistoric activity, including prehistoric adits, had been exposed by trenches.

Meetings were held in the evening after the trip and again the following morning. Participants were given the opportunity to discuss the management procedures that they felt were appropriate, both among themselves and with project staff.

FINAL MEETINGS FOR REVIEW AND CONSENSUS

Following the field trip project staff prepared a report of findings made during the interviews, meetings and field trip. Copies of this report, illustrated by a series of photographs made during the field trip, were sent to all participants for their review and comments. Two meetings were scheduled, one on July 25 at the Elko Colony Arts and Crafts building and one on July 26 at the Tribal Building at Owyhee.

These meetings were conducted by Elmer Rusco and Mary Rusco. The Elko meeting was attended by nine individuals including the representatives of the Tribal Council of the Elko Band of the TeMoak Tribe of Western Shoshone Indians and the Western Shoshone National Council, as well as one individual from Battle Mountain, and one from Owyhee. Nineteen individuals, including two visitors from Mountain City, attended the meeting at Owyhee. Representatives of the Western Shoshone Business Council and the Shoshone-Paiute Tribes of the Duck Valley Reservation were present. Following these meetings, project staff conferred with the chairman of the Battle Mountain Band of the TeMoak Tribe of Western Shoshone Indians about their concerns.

Each meeting was begun with a brief summary of the results of the previous consultations and participants were asked for corrections and comments, as well as recommendations. Participants were then asked to see if there was one or more recommendations on which they could reach consensus. Responses were recorded on tape and transcribed. Staff members also took notes on responses.

RESULTS OF CONSULTATION

INTRODUCTION

The level of interest in the fate of the prehistoric quarries at *Tosawihi* was unexpectedly high. Several groups and individuals contacted ARS to request more information and the opportunity to participate. The trip to the quarry itself could have involved four times the number of people taken if logistics had not been a problem. Tribal organizations were very cooperative in setting up meetings, which were usually well-attended, and information on the whereabouts of informed individuals was readily given.

The post-contact dispersal of *Tosawihi* people found many of the band living on various reservations and colonies, some quite distant from the quarry area. During early decades of reservation life, Indians were not permitted to travel freely in their former homelands. It is not surprising that knowledge of and concern about the *Tosawihi* Quarry varies. In Battle Mountain and Owyhee, interest and information were both high, while most other groups knew less about the quarry prior to our visit. It became clear to us that *Tosawihi* descendants are present in all of the tribal groups we consulted. Although meetings were best attended and most concern for the quarry area was expressed by people in Owyhee and Battle Mountain, there was great concern expressed by *Tosawihi* descendants and other Western Shoshone people we met elsewhere.

The amount of inter-consultant agreement about *Tosawihi* Quarry and related issues likewise varied. Some topics, particularly those pertaining to medicine and power, evoked wide agreement, but the reports of historic period and current use varied, mostly because post-contact experiences were different. Familiarity with the locale apparently varies partly with the distance of their residence from it. Moreover, the revival of interest in *Tosawihi* lifeways appears to differ in each area.

Interests and concerns about the quarry centered around three topics, encompassing both past and present use: medicine and power, economic pursuits, and *Tosawihi* as a focal point for ethnic identity.

PAST USES OF THE QUARRY

Medicine and Power

The traditional religious importance of the quarry was: 1) as a source of several medicinal substances; 2) as a place with special spiritual (power) spots; and 3) as the only source of the *Tosawihi* chert or opalite, a material with special spiritual powers of its own. Healing is a religious practice among the Western Shoshone people. The ability to heal injuries and illnesses is a power which must be granted supernaturally and medicinal substances, whether plant, animal or mineral, are gifts of the spirit world.

Medicine: White Opalite and Red and White Tuff

Three minerals found at the *Tosawihi* Quarry were traditionally used in healing. These are the white opalite or chert, used to make tools sometimes used in healing rituals, and two rhyolitic tuffs, red and white, used as both paint and medicine. The toolstone was not viewed as intrinsically sacred, but seen

as becoming so when worked by the gifted, who could encourage the spirit in the rock to make people heal.

Although different names were used for one, it is clear that both a red and a white chalk-like substance were used both for paint and medicine. The red substance, *pisappih* or *tempisa*, actually red rhyolitic tuff, was mixed with grease and used primarily as a paint or rouge. Two other minerals present in the *Tosawihi* Quarry area are used for blue and yellow paint, and one consultant told us about greenish small rocks that come from the north side of the quarry and also the Cortez area, which are tied in a bag and are used to spiritually cleanse springs.

White chalky tuff (*aipin*) was also used for paint. *Aipin* was used primarily as medicine, in a variety of contexts. It was put in pouches for power, and (historically) kept in jars as medicine. One person's grandmother used it in doctoring in a paste form mixed with buffalo water or deer water. She prayed with an eagle feather in conjunction with this treatment. This was used to treat diarrhea. Another person reported that it was mixed with water and drunk as a purifying agent after fasting.

In general, little specific information is available about the uses of medicines, because of religious prohibitions against talk about the sacred.

Spiritual Spots

The *Tosawihi* Quarry is at the heart of a larger area used for power, which extended along Willow Creek and included the Tuscarora and Midas areas. People who wanted to have power for healing or prowess in hunting and warfare could go to special places at *Tosawihi* and Rock Creek, where they fasted for four days and received visions.

That the *Tosawihi* Quarry was definitely included in this area is apparent in the following statement of one consultant:

> The White Knife [quarry area] is important to people...this is where they got their power. Doctoring comes from there.... It is a healing, gifted mountain.

Two places at *Tosawihi* were specifically mentioned in this context as places where vision quests were undertaken. Big Butte was a place to fast and pray, and people would leave offerings of white chert there. These offerings were said to resemble caches. Another area was identified north of Ivanhoe Creek where the edge of the mountain is especially steep. Both men and women who were gifted went often to many such places during their lifetimes. Often, they were given instructions by another medicine person regarding when to go.

In addition to using spiritual spots to receive special powers, young men would fast and spend the night on top of a high knob in order to be recognized as strong, brave men.

Trade in Medicine and Power

Some people felt that the primary trade extending from *Tosawihi* took place between medicine men. These gifted people exchanged "undeveloped" stone (quarry blanks, that is pieces of the material from which unworkable portions of the native rock had been removed) for elk, and also for antlers. They made knives for exchange to other gifted people as well. Individual trade for powerful objects was specifically noted between the *Tosawihi* and the Bannock. This was strongly differentiated from the utilitarian trade discussed below.

Special Qualities of White Opalite

It is clear that objects made of *Tosawihi* material were considered to be quite different from similar objects made of other materials. For example, carrying a white knife, sometimes in conjunction with *aipin*, was said to produce a powerful medicine that intimidated the Paiute, who were enemies. Alternately, a projectile point or knife wrapped in buckskin and worn around the neck could serve the same purpose.

A white opalite triangular tool (the size and shape of a Cottonwood projectile point) was also used in doctoring. The point was inserted into a split shaft, and hafted in the middle so that only a small portion of the pointed end protruded. This instrument was tapped with a small hammer against the skin of the knees, temple, arms, or legs, allowing bloodletting which was considered effective in treating various conditions, including high blood pressure. *Tosawihi* opalite was excellent for this purpose for various other reasons as well, including its durability, the quickness with which wounds healed, and the lack of scarring produced.

Medicine people also might instruct a patient to procure white chert as a protector. The patient might be told either to dig out a piece of rock that has never been touched by anyone, or to find an arrowhead envisioned by the medicine person. Some *Tosawihi* descendants would not collect a finished tool except when advised to do so by a medicine person. It is widely believed that perfect tools should not be collected, since they are either considered "owned" and therefore not available, or made by Coyote or a medicine person, rendering them potentially dangerous to the collector.

Tosawihi opalite was also considered an excellent material for projectile points used in warfare. Points were prayed to before fighting, and were considered to be capable of supernatural actions. For example, in one story, a *Tosawihi* man was visiting another tribe when it was attacked by people from the east. The warriors lined up, and the opponents' medicine man began riding back and forth in front of the line, taunting the warriors, and dodging arrows by ducking behind his horse's body. Then the *Tosawihi* man prayed to his point, and shot at the medicine man. His arrow went over the horse and killed the enemy medicine man. As a result, the enemy chief gave up.

In another story, the first contact one *Tosawihi* man had with Anglo-Americans occurred while he was hunting squirrels. The Anglo man waved his hands, then pulled a gun and shot. The opalite, however, protected the *Tosawihi*, causing the bullet to bounce off his chest, and the *Tosawihi* man drew an arrow and shot and killed the Anglo.

In yet another case, *Tosawihi* opalite made a man invulnerable to bullets. After breaking the law, he eluded police, and escaped first to the Ruby Mountains, and then to Duckwater, because of the chert medicine he possessed.

If *Tosawihi* opalite was primarily viewed as a protecting, healing substance, it could also harm. The red streaks in white chert were especially feared, and when encountered in pits, the pits were abandoned. This is thought to be the quarry's equivalent of menstrual blood, a powerful force that can kill. This symbolizes the female power of the quarry.

Economic Pursuits

Long before the mining of mercury and gold were envisioned there, the *Tosawihi* Quarry area was mined for the valuable white chert or opalite. This was not only used locally for tools, knives or arrow points, but was traded or bartered widely. The area was not only valuable economically for the chert, but it was also a place where game, various small animals and plants could be taken for food.

Tool Production

Trips to the *Tosawihi* Quarry in the past were envisioned as relatively quick visits by family groups, at the most consisting of 20 people. While everyone went to the quarry area, access to the toolstone was restricted to men and non-menstruating women. It was speculated that young men probably did most of the work in the quarry pits, with old men along as advisors. Most agreed that women were likely to have carried the opalite from the quarry. It was suspected that, just as families had separate sections of the river for salmon, they would also have had separate areas or routes through the quarries. Along these routes, bifaces and food were cached for the return trip in the fall, and while travelers could take other people's food caches if they were in need, caches of tools were owned by their makers. Such caches were often placed under overhangs in the canyons, and sometimes were marked with cairns.

Once out of the quarry area, both men and women apparently made the tools they needed from the bifaces they brought from the quarry. In one story, quarrying groups met at Izzenhood Ranch to hunt ducks, and competitive flintknapping took place between the women. In another, people placed bets on the prowess of various flintknappers. Women were seen as perfectly proficient flintknappers by most people, who reasoned that they made a great deal of use of knives, that they got good at making them because they did not have to move around as much as men, and that they would often need tools when there was no man around to make them. Women were regarded as naturally more competitive and so would strive for perfection in this pursuit. One person stated that women were the primary knappers because of their potential for destructiveness due to menstruation.

People were aware that heat-treating improved the workability of white chert, but only one person interviewed currently works it, and he has found it to be difficult to work. An attempt on his part to heat-treat the material was apparently not successful. Heat-treating consisted of digging a pit, placing the opalite in the pit, and covering it with dirt, then building a sage fire, and waiting for a day. This was said to maximize one of the excellences of the white chert: that it breaks in such large, long pieces.

The kinds of utilitarian items produced from white chert for local use varied. One woman compared these uses to a set of kitchen knives: a different size and shape biface for every purpose. Skinning was the most commonly cited use. Interestingly, unifaces were considered adequate for such jobs, while bifaces were the form in which toolstone was exported.

The way in which toolstone and various stages of workmanship was viewed is somewhat illuminated by the linguistic categories into which worked chert is divided. While *tempin* is rock, there are different words for toolstone, for example, obsidian is *puuppin* and chert is called *patsittempin* or *tosattempin*, the latter referring specifically to the white chert. All early-stage bifaces are called by the same term, which means approximately 'I am making this into a knife,' while late-stage bifaces are all called *Tosawihi* ('white knives'). A single term was used to refer to all of the flakes and chips produced while making a knife or other tool, but most people did not consider this debris to be worked stone.

Color preferences, or lack thereof, are also instructive regarding how toolstone was viewed. Except for medicine people and for making objects to be used as medicine, color was said not to make any difference, other than possibly the satisfaction of individual tastes. A wide range of white, pink, and grey cherts were glossed as "white" in the field. On the other hand, medicine people were said to have had specific color preferences (though these were not stated). Trade to the Sioux (possibly only taking place relatively recently) requires the export of pure white rock because of its symbolic association with purity.

Trade of Toolstone as a Commodity

People were ambivalent regarding the exclusive use of the quarry by the *Tosawihi* band. While some felt that trade accounted for all access to the toolstone by other people, others maintained that the quarry area was probably shared with neighboring Bannocks and Paiutes. One person even claimed that these Paiutes and Bannocks were also known as "White Knives," and that the quarry was host to four groups in four states. Other consultants disagreed strongly with this last assertion.

All agreed that *Tosawihi* opalite ended up very widely distributed. One man claimed it went to 11 western states, and was known far and wide for its quality, much as catlinite for pipestone achieved trans-American fame. It reportedly was traded as far southwest as Bishop, California, into Oregon and Washington (probably via the Nez Perce), and through direct contact as far north as Montana and as far east as South Dakota after horses were introduced. Trade relations were viewed as primarily coterminous with alliances, friendships, and shared territories. The Northwest Shoshone, or salmon-eaters, were close friends with the *Tosawihi*, and allowed them into their territory for fishing, for which they received opalite. The Bannock allowed access to elk and salmon in return for opalite. The pieces used in this trade were relatively early stage bifaces. The locations recalled for such trading encounters were both to the north and northwest; the Twin Falls and Weiser Crossing areas were singled out as important meeting places. Opalite was traded to the Nez Perce in exchange for horses.

As discussed more fully below, trips to the quarry were part of a seasonal round within the extended territory of the *Tosawihi* people. It was implied that the fall trip to the quarry was taken on the way to pine-nutting areas south of the Humboldt River, and that the caches retrieved at that point were either made into tools for personal use or traded to people around Wells or Ruby Valley.

Information on the state of the opalite when it was traded was somewhat speculative. One man, however, stated that large cores and early stage bifaces were probably too heavy to carry, and so would be reduced, but not to a finished knife, which would take too much time. One person stated that the Snakes wanted "undeveloped" toolstone in trade.

There was a strongly stated difference between trade and barter. Barter took place between individuals, and involved the exchange of finished knives for desired items such as quill or shell pendants. The trade of *Tosawihi*'s resources between medicine men, discussed above, was undertaken in this individualized manner.

The Quarry Within the Seasonal Round

No one described the *Tosawihi* Quarry area as a permanent or even semi-permanent living site; in fact, it was agreed that a person would visit *Tosawihi* to procure toolstone or medicine briefly on the way to other destinations. One person laid out in explicit terms the unsuitability of the *Tosawihi* area for habitation by saying that people needed water, ample building materials, plentiful food, and other people in an area where they would live. The *Tosawihi* area possesses none of these attributes.

Most of the "destinations" pinpointed by consultants were north of the quarry, at least for summer resources. The Owyhee River Canyon has a plentiful groundhog population in spring, and was visited for hunting. The Snake River's salmon resources were mentioned a great deal as summer fare, as was the Bruneau Harris Creek area for the same reason. These areas also supported elk populations, and the mountains provided access to deer earlier than the desert floor. Bannock country across the Snake was visited for antelope, and further north, for buffalo. Trade at these locations and at Weiser Crossing in eastern Idaho also encouraged movement in this direction.

A southward movement is implied by the places where people reported pine nutting grounds. *Tosawihi* people visited and intermingled with people at both Ruby Valley and Wells for these fall resources. Winters were spent at various locations around the Humboldt River, to facilitate access to spring waterfowl resources.

This is not to imply that the quarry area was perceived as utterly lacking in seasonal resources. Deer, groundhogs, ground squirrels, sage grouse, and more recently wild horses were said to be more plentiful in the past; their decline is attributed to the drying up of springs due to various mining episodes. All claimed that the exodus of buffalo and elk from the area occurred within the past 200 years. Several plant resources were also named, including Great Basin wild rye, wild carrot, and a plant with a big beet-like root (*dosa*), which is harvested in the fall, and which can be eaten, smoked or used as perfume. Another root plant, *suwegui*, which remains unidentified and is no longer in the area, was available in May when buttercups flowered. *Tuk*, a vine, had edible seeds and roots and was also used for cordage. The area between Big Butte and Squaw Valley was once rich in herbs, most of which have been destroyed by grazing.

All of these resources, and especially water, were more plentiful in the spring, and it was at this time that people thought the major quarry trips would take place en route to the north. Caches of bifaces and food resources were left in the quarry at this time for retrieval during a much briefer return in the fall.

Ethnic Identity

All of the consultants who identified themselves as *Tosawihi* descendants recognized that their band name was tied to the quarry north of Battle Mountain. Their understanding of past *Tosawihi* identity and the area and extent of their territory is not unaffected, however, by their knowledge of the more recent past when access to horses and variable reservation or colony affiliations modified prehistoric patterns. There was considerable variation, both from one consultant to another and among the various communities visited during this consultation, as to the composition of the *Tosawihi* band.

Many consultants agreed that the *Tosawihi* Band had been composed of "northerners" of one sort or another; some felt they had come from Montana, Wyoming, the Bruneau River, or the Columbia Plateau, and most stated that they traveled in the area encompassed by the Snake River on the north and the Humboldt to the south. One person asserted that the *Tosawihi* route involved a migration from Wyoming to Fort Hall, then to the Bruneau River, to Owyhee, across Sheep Creek, and finally to the Rock Creek area. Another claimed that the *Tosawihi* were the same people as the Bruneau ("northwestern") Shoshone, historically under Chief Pocatello, moving in from Paradise Valley to the north.

The time depth of the *Tosawihi* use of this area is unknown. While some implied a relatively recent arrival, it was pointed out by one consultant that the Comanche use the term "*Tosawihi*" to identify these people, and the Comanche left the northeastern part of Shoshone territory as much as 400 years ago, indicating considerable antiquity for the name.

Attempts to refine the past territory of the *Tosawihi* were muddied by the post- contact areas of residence, and provoked a list of the various towns, reservations, and colonies where *Tosawihi* were found in the late 1880s, such as Fort Hall, Owyhee, Golconda, Battle Mountain, Beowawe, Ruby Valley, Lee, Carlin, and Elko, which may or may not coincide with older patterns.

As the northernmost band of Western Shoshone, the *Tosawihi* occupied a buffer zone between neighboring tribes, including the Northern Paiute, Bannock, and Nez Perce, and were involved with these people in conflict and trade. The acquisition of the horse intensified relations with these, and even more remote, people. Contact with tribes of the Northern Plains, for example, appears to have increased; in the relatively recent past the *Tosawihi* traveled far north to go buffalo hunting, staying for as long as a year. Increasing mobility up to the present similarly encouraged relations with other reservations such as Fort Hall, where relatives lived, and the Sioux Reservation in Pine Ridge, South Dakota, where Sun Dances were performed.

One person suggested that identification with the quarry area intensified in historic times, when Chief *Tosawihi* "founded" the quarry. This consultant thought that the quarry and the people had another name before this.

Continuity and Change in Relationship to the Quarry

Obviously, much of the information above demonstrates that the quarry is still important enough to the *Tosawihi* people that even those who have never seen it knew about it, sometimes in great detail. Families continue to identify themselves as "*Tosawihi*" people, and to pass down their knowledge of the area.

Yet the immediately post-contact period did much to disrupt the relationship to the quarry, and to scatter the *Tosawihi* people far and wide. *Tosawihi* people dispersed, ending up in a number of different communities, working on a variety of ranches, and residing on widespread colonies and reservations.

During the early White settlement and reservation establishment period (1850-1900), visits to *Tosawihi* were probably impossible. First, it was very dangerous for an Indian person to be found in a "wild" area, since they were likely to be assumed "renegades" and shot on sight. Reservation people who wished to travel were required to carry passes that had to be stamped by the proper authority at their destination. Further, the suppression of native religion was still the official federal policy during this period, and if an agent even suspected that the quarry had religious significance, permission to visit would have been denied.

The forced schooling in government boarding schools of an entire generation of Shoshone had a more subtle but equally drastic effect. Taken from their families at an early age, and routinely discouraged from identifying as Indian in any way, these young people were deprived of the opportunity to learn tribal traditions from their parents. Much was lost, especially the kind of intimate knowledge of traditional territories that was necessary for a people who lived from hunting and gathering.

Visits to the *Tosawihi* vicinity in historic times usually occurred in the form of employment on the ranches and in the mines. *Tosawihi* people worked at the Silver Cloud mine south of the main quarry area, and at the Gold Circle Mine in Midas; some had mercury claims in the quarry area as well. Men were buckaroos in many ranches in the area, including the 25, Izzenhood, YP, Spanish, and Packer ranches, while the women often washed and cooked. They performed similar services in the small communities at Wells, Jiggs, and Golconda.

Through these people, and through others who continued to hunt or seek power in the quarry, specific information was passed on. Although doctoring had been outlawed on reservations, Jack Harris, a visiting anthropologist still remembered by some of the consultants, found that much knowledge of native healing practices was still retained in the mid-1930s. Today there is a resurgence in spiritual lifeways, and young people are becoming increasingly involved. It cannot be stressed enough how much information is retained in places like Owyhee, where people had never visited the quarry, but feel it is important to their lives and their identities.

PRESENT USES OF THE QUARRY

Although much of what we learned about the religious importance of the *Tosawihi* Quarry area related to the past (often the relatively recent past), it became clear during consultation that the use of the quarry area continues to be an important religious practice. More than one person noted that, due to the influence of Christianity and the long-established suppression of native religion, people were reluctant to talk about current traditional practices. Others expressed reluctance to talk about the sacred in general on religious grounds.

Medicine and Power

Both the red and white tuff and *Tosawihi* chert were displayed in people's homes during interviews, and were extensively collected during the field trip for medicinal purposes. The *Tosawihi* area in general is considered a power place; only Big Butte was specifically mentioned in this respect as still being used.

Trade as Medicine and Power

The main destination for *Tosawihi* chert outside of the immediate area mentioned by consultants is Pine Ridge, South Dakota. It is used in the Sun Dance, which is described below. At least one person still makes knives for healing.

Special Qualities of White Chert

People save worked opalite items as powerful heirlooms that are seen as "protectors"; sometimes people collect items for the same purpose. One person had a pouch containing what appeared to be an Eastgate point hung around his neck. He had it made by a professor from Idaho State, since he did not know a flintknapper, after being doctored and instructed that he and his family should wear such protectors. A second doctor, consulted by the patient later, confirmed the need for this.

Other people have collections of unworked opalite, tuff, and artifacts. One person knew of a private collection of 500 white chert points. Some felt that finished, complete tools should not be collected, while others believed that collection was acceptable if it is "alright in your heart." One man said that it was necessary to pray for luck in the search, and when an artifact was found, the knapper who made it should be thanked and something should be left in its place.

Tosawihi chert artifacts are seen as powerful items, particularly when in the hands of leaders and medicine men. Currently, the most actively pursued sacred use of *Tosawihi* opalite is within the context of the Sun Dance. The Sioux association of white with purity makes *Tosawihi* opalite and tuff especially suitable. It is uncertain how far back in time these practices extend, but one person claimed that 50 or 60 years ago people planned their seasonal schedules around dances at Fort Hall.

At the present time, the Sioux of Pine Ridge, South Dakota, use *Tosawihi* chert in their ceremonies. They hold it as sacred because it is pure white. They make from it a long, very slender, curved instrument, pointed at both ends, to pierce the pectorals in the Sun Dance, and use the triangular hafted form described above for bleeding the temples for purification. One person mentioned the use of "clappers" made of *Tosawihi* chert and hung around the neck, producing an identifiable ringing tone. A number of *Tosawihi* are Sun Dancers, and have close relations with the Sioux, serving as the source of the white chert for this purpose. One *Tosawihi* Sun Dancer had just returned from a trip to Pine Ridge a few days before we interviewed him.

Ground white tuff (*aipin*) is also used in connection with the Sun Dance. After fasting, this powder is mixed with water and drunk to settle the stomach before eating, and is also used in conjunction with purification in the sweatlodge.

Economic Pursuits

The economic pursuits at the *Tosawihi* Quarry now have little to do directly with the opalite. Some *Tosawihi* work in various northeastern Nevada mines. Families still hunt in the area, although they complain that the game is much depleted, but appear to do this as much as a cultural reaffirmation of "*Tosawihi*ness" as to obtain meat.

Ethnic Identity

In the present, identification as "*Tosawihi*" often centers around a demonstrable relationship to Chief *Tosawihi-so'op* and/or other *Tosawihi* signers of the Ruby Valley Treaty in 1863. The personality, actions, and associations of these ancestors are relevant to the present-day locations, alliances, and animosities of the *Tosawihi* descendants, and so bear review.

Chief *Tosawihi*, as he was referred to by several consultants, is invariably viewed as a prominent man, although stress is alternately laid upon his status as a decision-maker and as a medicine man. Care was taken by several consultants to debunk the rumor that he and Chief Temoak were brothers, or related, although one person felt that they might have been fictively related as blood brothers. He is viewed by at least two consultants as the "founder" of the quarry, and the progenitor of its name. In one story, he was a medicine man who fasted at Rock Creek for power, and remained in that area because "something drew him like a magnet" to the quarry. He reportedly lived and died in the area, bequeathing his name to it.

In any case, the dispersal of the *Tosawihi* people occurred during the lifetime and leadership of the various signers of the 1863 Treaty. In one story, Chief Temoak had differences with Chief *Tosawihi* because *Tosawihi*'s band was raiding the routes along the Humboldt, taken by emigrants from the United States. Temoak was always very friendly with the Anglo-Americans and so he sent out scouts with the cavalry to identify the friendly bands in the area. A band of *Tosawihi* under Captain Sam was not so identified, and so they were captured, marched to Carlin, and stockaded there. When their relatives found out that they were about to be shipped to Fort Hall, they begged Chief Tutua (of Austin) for help. Tutua sent a runner with a message that he could identify some of these people, who were left off at Owyhee under the leadership of Captain Sam, while the remaining unidentified individuals were taken on to Fort Hall.

Others *Tosawihi* people fared worse. According to another story, when the Anglo-Americans first came from Utah, they found 1500 Indians camped at Secret Pass in Starr Valley, all of whom were leaving the Humboldt to avoid contact with the foreigners. Soldiers from Fort Halleck were notified, and they burned the huts and tried to rape the women. *Tosawihi* people then scattered, some camping around Elko looking for work.

Still another story of conflict concerns the sighting of the cavalry while *Tosawihi* people were gathered at the quarry. In one version, Chief Tutua was their leader. People saw the swords glinting in the sun and ran all the way to the Humboldt. It is said that a similar gathering of the *Tosawihi* never happened again.

Some of the *Tosawihi* moved to Ruby Valley, but did not get along with Chief Temoak, who ran them off in 1865. When they left for Owyhee, they reportedly took with them 500 head of cattle given to Temoak. Others moved to Lee, where they remained, in spite of government encouragement to go to Fort Hall.

Other *Tosawihi* lived at Carlin Farms, a temporary but successful operation. When water rights became an issue with local Anglo ranchers, however, the farms foundered, and the government stopped providing aid and food. Finally an edict forced them to choose another reservation. Chief Buffalo, whose territory was around Halleck and Beowawe, led his people to Owyhee. Other accounts credit this leadership to Chief Sam.

In sum, the *Tosawihi* were scattered, yet the ethnic identification as *Tosawihi* continues. People have become members of their present separate communities, and are to a great extent identified on this basis, so there is some feeling that one locational group or the other constitutes the "true" *Tosawihi*, which works against cooperative action. On the other hand, the term *Tosawihi* is meaningful to individuals in each group. Moreover, in spite of differences of opinion about various events in the past, all *Tosawihi* descendants consulted were strongly united about the importance of the quarry as a traditional *Tosawihi* place.

INITIAL RECOMMENDATIONS

An important part of the consultation process was to obtain the views of tribal organizations and *Tosawihi* descendants as to how the *Tosawihi* Quarry area should be managed. Several tribal council representatives and *Tosawihi* descendants interviewed individually by project staff and/or present at a visit to the quarry volunteered opinions about this matter. These individuals were concerned with receiving information from the government and the mining corporation about plans, and wanted assurance that their access to the quarry would be guaranteed. They were virtually united in the conviction that the preservation of the natural and religious resources of the *Tosawihi* Quarry should be protected for the *Tosawihi* people and other Western Shoshone.

Interview Information

The concerns expressed during interviews related to the need for information about, access to, and protection of the quarry. Many groups felt that they had not been sufficiently informed at the onset of mining, and wondered why the current study began four years after mining for gold had actually begun. All wished to continue to be informed about and included in future decision-making regarding the quarry, and many people helped identify people likely to have concerns. Some groups wanted copies of the archaeological reports generated at the quarry.

Access to the quarry is important for all of the current uses listed above, and some felt that access would become even more important in the future. Several people noted that younger people today are seeking links with the past, and that, if anything, *Tosawihi* Quarry is becoming more important. A few people are trying to rejuvenate flintknapping, a skill which they want to pass on to their children. In addition, there is a revitalization of Indian spiritual ways, which are closely linked with the quarry.

The kind of protection desired for the quarry varies. One consultant felt that the mine should be built because people needed the jobs. This consultant, however, was not a *Tosawihi* descendant, and others felt that he may have animosity towards *Tosawihi* people that would be satisfied if the mine destroyed the quarry. He and others felt that if the mine could not be stopped, it was still on Indian land, and some payment should be made, and/or Indian people hired.

Others felt it should be given some sort of designation as an historic place, and either fenced off or just left alone. Opinions about archaeological mitigation again varied; some felt that things were left where they were for a reason, and should not be disturbed, but most agreed that it was preferable to remove them if they were in danger of imminent destruction. People were concerned that such collections be made available to the Indian people, but were divided on whether the best way to do this was through a museum or simply a return of the artifacts to the tribe.

By far, the most common opinion was that the quarry should be protected for future generations. This opinion was closely linked to the larger issue of Western Shoshone land claims, and several consultants expressed the opinion that the Western Shoshone and not the federal government should manage the land and make decisions as to whether it should be leased for mining and, if so, what terms were acceptable.

The Western Shoshone land claims issue is relevant to any discussion of land management within the territory covered by the 1863 Treaty of Ruby Valley. In 1985 the U.S. Supreme Court, in the Dann case, decided that the Western Shoshone people had been paid for the land, which the Indian Claims Commission had assumed they had lost "by gradual encroachment" on or before July 1, 1872. The issue, however, cannot be considered settled. Neither the Claims Commission nor the Supreme Court examined the arguments of the Western Shoshone traditionalists that the land had never been ceded. Moreover, the only court which did examine this issue--the 9th Circuit Court of Appeals in an earlier stage of the Dann case--agreed with the traditionalist position. The Western Shoshone traditionalists continue to assert their land claims vigorously.

In reference to the *Tosawihi* Quarry, these assertions include:

1. The quarry is on traditional Western Shoshone land; Western Shoshone people do not need anyone's permission to go on it;

2. The Western Shoshone should be paid rent by the mining company if they are going to mine this land;

3. The Western Shoshone should determine what happens to the artifacts taken from the land.

These assertions are essentially the ones made through the Western Shoshone National Council and various other groups to the executive branch of the federal government, to Congress, and to the general public.

Discussions During the Quarry Trip

The trip to the quarries provided a different view of the issues, since both the resource and the impacts on it were clearly at hand. In some cases, people were able to be much more specific in their recommendations. On the issue of the acceptability of the collection of artifacts, people behaved

differently than the interview data alone would have suggested. For these reasons, the observations made on this trip are treated separately.

The general consensus on the quarry trip and at the initial meetings was that the mine should not destroy this resource. Among other kinds of values, the most common concerned the availability of *pisappih* and *aipin*, medicines made by powdering tuff, and access to opalite as a primarily protective device, for example to use as a uniquely White Knife talisman or in the Sun Dance.

In the meetings that followed the quarry trip, much of the focus revolved around the appropriate mitigative measures to be taken. Many felt that a part of the archaeological collection should be available to *Tosawihi* people through a museum exhibit; some felt that all artifacts should be returned to the tribe.

At least one consultant felt that the undisturbed cache that they were shown should be collected by *Tosawihi* people to protect it.

During the field trip, no specific locations were pinpointed on the ground to be particularly culturally or religiously significant. Instead, the entire quarry area was regarded as sacred and important to their people. The participants provided little specific information beyond identifying the connection of the quarry with their identity, recognizing the white chert which many had as heirlooms at home, and identifying the presence of *pisappih* and *aipin*.

People felt strongly that the quarry should be preserved for their children, and several people noted that the generation now in their thirties was quite concerned about revitalizing their identity and passing it on to their children. Pieces of tuff and non-tool white chert were collected by many to take home.

In addition to these concerns, people interviewed as well as others visiting the quarry were also worried about water and air quality, and felt that they needed to look beyond the religious aspects of the quarry. The potential for leaks in the cyanide leach pad was an issue of concern, as was the amount of water being drained from local springs to supply the mine. People believed the *Tosawihi* springs to have been drying up for several years now, with a resultant decline in game.

In summary, there appears to be great interest and concern among tribal organizations and *Tosawihi* descendants about the fate of the *Tosawihi* Quarry, and a strong need for information, access, and protection, and the leadership of various groups is mobilizing Indian people for action. Many stated that people only now were rediscovering the importance of *Tosawihi*. As noted above, the Battle Mountain Band Council has passed a Resolution protesting the potential destruction of the quarry, and other such resolutions may follow.

One man summed up everyone's feelings eloquently: "Medicine, survival, trade, identity: everything is done better with chert."

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Discussion

Consultation with Native American tribal groups and individuals was undertaken in compliance with AIRFA and related legislation to determine the effects of additional mining in the Ivanhoe Mining District on these groups and individuals. In addition to a determination of effects, the purpose of the consultation was to elicit recommendations from Native American consultants concerning procedures which would avoid adverse effects or, in the event these effects are unavoidable, would mitigate them.

A preliminary literature review was made to summarize existing ethnographic and ethnohistorical information about the affected tribal groups, specifically the *Tosawihi* subgroup of the Western Shoshone. The most clearly relevant information was recently collected and reported by Richard Clemmer (1990a, 1990b). He was able to interview 22 Western Shoshone, who were self-identified and/or identified by others as descendants of the *Tosawihi* subgroup. To insure that the present study enlisted as many individuals who are knowledgeable about the former and present uses of the *Tosawihi* Quarry area as possible, Clemmer and other recognized authorities on the Western Shoshone were contacted. From information they supplied it was possible to compile a list of tribal groups and individuals to contact (Appendix 1).

Tribal councils of eight Western Shoshone tribal groups, the Western Shoshone Council of Elders and the Western Shoshone National Council were contacted, as well as several individual descendants of the *Tosawihi* Band of Western Shoshone, including religious leaders. Meetings were held in Battle Mountain, Elko, Lee, Wells and Owyhee, Nevada; the nature of the proposed mining development was explained and a map of the quarry area and color slides of prominent landmarks and archaeological remains in the area were shown. Interviews were conducted with eleven individuals following the orientation meetings. The last part of the initial consultation was a field trip to the *Tosawihi* Quarry area, which in turn was preceded and followed by additional meetings. Western Shoshone participants in this consultation are listed in Appendix 1.

Results of the initial consultation were drafted for the final report and summarized and sent to all participants for their comments and corrections. Finally, two additional meetings were held, one at the Elko Colony Arts and Crafts building and at the Owyhee Tribal building, to review the draft results summary and to arrive at specific recommendations. Following these meetings, the draft summary of results of consultation was revised to take comments and corrections into consideration, and now comprises the section of this report immediately preceding the present one. The following recommendations were drafted on the basis of discussion at the meetings.

Conclusions

Much of the *Tosawihi* Quarry area has been regarded by the BLM, at least since 1982, as eligible for the National Register on the basis of its scientific (archaeological) values. This has provided a measure of protection for scientific, but not necessarily religious and cultural values. Subsequently the BLM became aware of the quarry area's cultural and religious values as well. It was the purpose of the Native American consultation reported here to determine what cultural and religious values the area may have for contemporary Native American people, to document a preliminary finding of eligibility for the National Register under criterion A (36 CFR 60.4) and to use this information as a basis for planning appropriate management procedures.

The findings of this study support the conclusion that the *Tosawihi* Quarry area is a culturally and religiously significant area in the traditional homeland of Western Shoshone people. It thus meets the criterion for eligibility on the National Register as a Traditional Cultural Property (36 CFR 60.4) following guidelines set forth in the National Register Bulletin 38 (Parker and King 1990).

The specific findings of this study document the past and present importance of the *Tosawihi* Quarry area as follows:

1. The area is regarded as a sacred place by many Western Shoshone people today as a source of medicine traditionally used for power in healing and for protection and success in warfare;

2. It is the location of special power spots used traditionally in vision or power quests;

3. It is remembered in the oral tradition of Western Shoshone people as an economically important place visited regularly on their seasonal treks between the Humboldt and the Snake River valleys;

4. The use of the area to procure a highly knappable opalite, as well as a large variety of both large and small game and edible plants, is both recalled and confirmed by archaeological study of the area for at least 10,000 years;

5. Numerous open camp sites and rockshelters are present in the area attesting to its seasonal occupation throughout the use of the quarry, confirming the oral tradition recalled for this study;

6. The use of the area both as a source of religiously important materials and as the location of power spots continues to be a major part of the religious practice of many Western Shoshone people today, particularly those who identify themselves as descendants of the *Tosawihi* band;

7. The *Tosawihi* opalite, when made into a knife or other implement by a gifted healer, is known to be used in contemporary traditional religious, healing rituals throughout the western United States, according to Western Shoshone religious practitioners; the white chert is valued by Sun Dancers on the Pine Ridge reservation in South Dakota as well as to Western Shoshone Sun Dancers;

8. Finally, in addition to providing the setting for important traditional religious practices, the *Tosawihi* Quarry area is central to the ethnic identity of these people; those who still go to the area to hunt or to collect the medicines continually renew their ties to the area.

The above findings strongly support an evaluation of cultural and religious significance of the study area in terms of eligibility for the National Register as a Traditional Cultural Property. As such, both its cultural and religious values merit protection from the potential impacts of the proposed mining project and any archaeological investigations which may precede it. As a place central to Western Shoshone traditional religious practices and beliefs, it falls under the protection of AIRFA. Although most impacts

that the proposed project may have on archaeological sites or historic structures can be mitigated by a program of archaeological and historic data collection prior to the mining, it is unclear whether the concept of mitigation is relevant to a potential infringement of a traditional cultural and religious practice that remains important to *Tosawihi* descendants. In the paper cited earlier, the author points out that

> ...agencies remain vulnerable to claims of infringement if they cannot document that the issue of potential religious infringement has been evaluated and weighed against a compelling public need (Laidlaw 1990:241).

However, in the event the agency can demonstrate compelling public need, Native Americans may find it in their interest to introduce the idea of mitigation in negotiation with land managers and other interested parties. The mitigation concept would enable the *Tosawihi* descendants to pose alternative government actions that would allow them to continue their traditional religious practices in the *Tosawihi* Quarry area, although with some limitations imposed by continued mining.

Recommendations for the protection of the *Tosawihi* Quarry area and some proposed actions that might protect some of its traditional cultural and religious values were made during the consultation, including the two final meetings.

Recommendations

The consultation process resulted in two kinds of recommendations: those recommendations on which participants reached consensus or near consensus and those made by smaller subsets of the participants. The first included the "no action" alternative and the recommendation for continued consultation with the *Tosawihi* and the tribal groups of which they are members concerning management decisions about the *Tosawihi* Quarry. The second set of recommendations were primarily concerned with mitigation procedures to be adopted if the government decides against the no action alternative. These are discussed further below.

The No Action Alternative and Continued Consultation

Tosawihi descendants and tribal representatives present at the final two meetings were able to reach consensus on two recommendations:

1. No further mining or other destructive activities, including archaeological study, should be undertaken in the quarry area.

For tribal elders and many of the younger tribal members consulted no mitigation is actually possible for the destruction of sacred and culturally significant places in their traditional homeland. These individuals were unable or unwilling to contemplate any government actions or programs that would lessen the effect of this destruction on their lives.

One consultant, a religious leader, expressed it this way:

> That's the reason why I've been in that Rock Creek prayin' for a long time, you know, this *Tosawihi* Quarry. Even the White Man begin to understand today what it means to have those things preserved. I think that if enough of us, Indian and White together, we can have it preserved for the future use.... See this White Knife quarry...this is where we use for doctorin', for healing. We use it for a lot of things...knife, arrowheads, skinnin' deer with. Today we still use it some places....

Another consultant, a member of a *Tosawihi* family by marriage, wrote the following:

> ...everything possible should be done to encourage the Government and the mining company to preserve the site [the quarry area] as a Cultural Site not just for the Shoshone people, but to contribute to the history of Nevada and the United States. This society seems to be rushing pell-mell into cultural oblivion. Perhaps that is because so many of the people that have immigrated to this country left their culture behind in what ever foreign country they came from. We must find ways to retain the culture indigenous to this country.... We are so concerned about exploring space that we have no time for an ancient society here on earth if it stands in the way of "progress."

A younger *Tosawihi* descendant asked about the No Action Alternative:

> One question I'd like to ask...is about this No Action Alternative...a lot of Indians are comin' to think, "Well, this is what we're faced with." It's kind of like, you know, this is what the government's gonna tell us. It's what's gonna happen. We have other alternatives. We got this No Action Alternative which means the further protection of this mine [quarry area]...maybe we should use this as a basis to start callin' our Congressional people for the change of the 1872 [mining] law... for protection of cultural and historic sites.

Other individuals and tribal representatives, who agreed that "no action" was the preferable alternative, could nevertheless envision mitigation measures. Some of these individuals, in fact, were skeptical that the no action alternative was feasible, and believed it was necessary to find other acceptable alternatives. The entire group, however, could agree on the need for their continued involvement in planning and decision-making.

2. Tribes and *Tosawihi* descendants should be notified of further planning and decisions about the quarry area, and provisions should be made for their participation in planning and decision-making.

For the individuals and tribal representatives who were interested in developing various mitigation procedures, this continued involvement was viewed as essential. They envisioned a process of negotiation to work out the details of adequate mitigation procedures. The following recommendations are for general mitigation procedures.

Native American Recommendations for Procedures to Mitigate Additional Adverse Effects on the *Tosawihi* Quarry Area by Mining

The following five mitigation procedures were made by individuals present at the two final meetings or were otherwise communicated to the project staff. They are listed in what appeared to authors of this report to represent the highest level of consensus.

The first two mitigation recommendations received almost general agreement except for those traditional religious practitioners who believe that the destruction of sacred sites in their traditional homeland is such an overwhelming disaster that no mitigation is possible.

1. A significant portion of the quarry area should be set aside for preservation and dedicated to the free access and use of the *Tosawihi* and other Western Shoshone Indians for religious and cultural activities.

2. Access to the quarry area by Indian people should be guaranteed.

The protected area should be large enough to permit the collection of *Tosawihi* chert artifacts and other medicinal minerals for use in healing and religious rituals. Velvet Canyon was suggested by some participants as the area to be protected and set aside for this purpose. The protected area should also include Big Butte, so that it could continue to be used in vision quests.

The next two recommendations refer to the removal and protection of sacred objects from the *Tosawihi* Quarry Area prior to any additional mining or other destructive action.

3. *Tosawihi* chert and other sacred mineral resources in the quarry area should be moved under Indian supervision prior to any additional mining. It should be placed in an appropriate, secure place for the continued use by Indian people for religious and cultural purposes.

Before mining, all *Tosawihi* chert, *pisappih* and *aipin* should be removed carefully and placed in a safe place for the subsequent use of Indian people. Some participants suggested that a securely fenced area within the general quarry area would be appropriate.

4. Archaeological excavation and the curation of archaeological artifacts prior to any additional mining was recommended by some participants in the consultation process.

Excavation of artifacts should be done carefully. A cooperative effort of archaeologists and *Tosawihi* descendants and tribal representatives was seen as needed. Curation of artifacts should be in a museum where *Tosawihi* people and other Western Shoshone can have ready access to see exhibits and collections;

a. Such a museum should be in *Tosawihi* country such as the existing Northeastern Nevada Museum in Elko;

b. A tribally-operated and controlled museum was envisioned by some participants.

A need for the involvement of tribes and individually concerned Indians was seen as an essential part of either alternative.

Finally, one mitigation measure was proposed by a single tribal leader, reiterating a response he had made at an earlier date to an inquiry from the BLM.

5. Economic measures to mitigate adverse effects was proposed by one tribal leader, not a *Tosawihi* descendant. In his view, the destruction of the area due to mining was inevitable. It was his opinion that the Western Shoshone people should be paid rent for this use of their traditional land and that there should be employment at the mine for tribal members.

The tribal leader who proposed this alternative was interviewed during this study, but not present at the field trip or any of the meetings. No other participant in the consultation process brought up the matter of economic compensation as the sole appropriate mitigation measure.

CUMULATIVE IMPACTS ON CULTURAL VALUES OF NATIVE AMERICANS

Cumulative impacts on cultural values of Native Americans can include actions not directly related to the proposed mining development, and can include impact on values outside the geographic area of direct impact as well. Actions that can impact these values include studies undertaken prior to the proposed mining development, including archaeological, geological and other studies and construction activities (such as road-building) that may involve alteration of the surface of the earth. Because the mining development brings people into the area, increasing the traffic into and throughout the quarry area, the surrounding countryside can be subject to impact. The geographic area of cumulative impact is shown on Figure 3. It is in the south central portion of the traditional homeland of the *Tosawihi* people, which extends from the Humboldt Valley between Golconda and Rock Creek, north and northeast to the South Fork of the Owyhee River and along that river valley north to the Snake River Valley.

Consultants have identified a series of areas near and within the *Tosawihi* Quarry area that are of equal or near-equal importance as the quarry itself. These include:

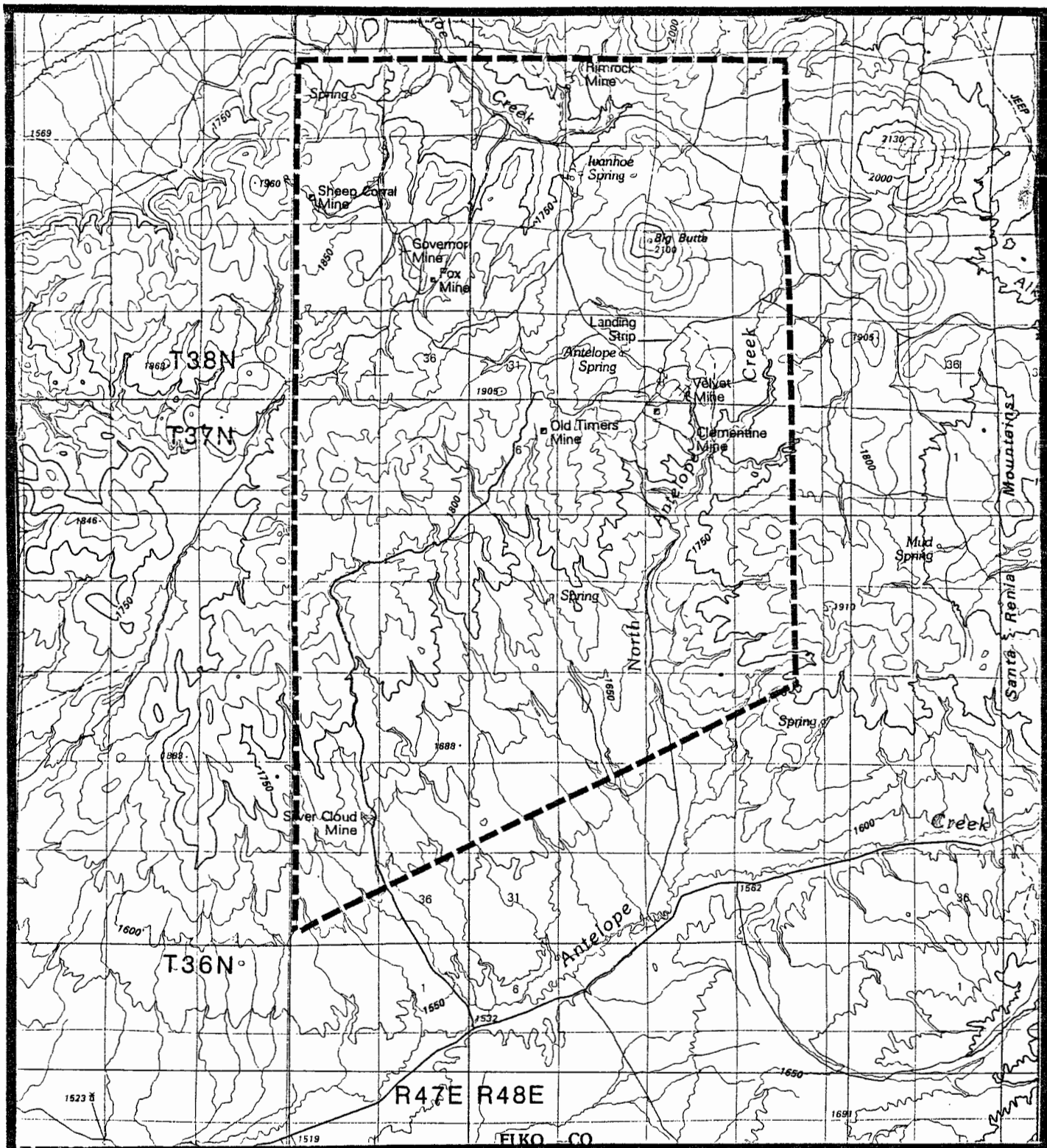
1. Known historic burial sites and a traditional power or vision quest spot on Rock Creek, near a proposed dam site, south of the quarry area;

2. The confluence of a hot creek and cold creek where Rock Creek enters a steep canyon northwest of the proposed mining development;

3. Two springs, one hot and one cold in the Tuscarora Mountains;

4. The creek below Midas;

as well as more distant areas within traditional Western Shoshone country.



Taken from USGS Tuscarora, Nev. 1982

ARCHAEOLOGICAL RESEARCH SERVICES, INC.

Figure 3. Cumulative Impact Area Location Map.

Within the cumulative impact area, specifically sacred spots include:

1. All water sources, specifically several springs near Big Butte, including Antelope Spring, Buttercup Spring, Ivanhoe Spring and another spring at the head of Little Antelope Creek, approximately one kilometer east of the cumulative impact area;

2. Big Butte, itself, just north of the proposed mining development;

3. All sources of the *Tosawihi* chert and the other medicinal minerals discussed above.

Archaeological studies, including those completed for earlier mining developments in the quarry area, have an impact on traditional religious beliefs. Traditional *Tosawihi* religious practitioners believe the artifacts collected may have religious power in the hands of gifted individuals. They are valued by them as amulets or for use in ceremonies. Those individuals who are not religious specialists also see the artifacts as being of particular value to them as examples of their heritage. They strongly object to their being curated in a fashion which would not permit Western Shoshone people and particularly Tosawihi descendants to see them.

As in the case of the *Tosawihi* Quarry area, there is a conflict between the archaeological and scientific significance of artifacts and their religious significance to the *Tosawihi* people.

One of the most serious threats they see from any potential mining development is that it would prevent their access to these objects, if it does not result in their actual destruction.

Finally, any adverse effects that the proposed mining development may have on water and air quality would affect the faunal and floral resources of the area. It has been pointed out that many *Tosawihi* descendants like to hunt in the quarry area, primarily because of their ethnic ties there. Religious leaders deplore these adverse environmental effects because of their strong identification of themselves as stewards for Mother Earth.

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Lee, Nevada 89829

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APPENDIX TO

AN INTENSIVE RECONNAISSANCE OF THE TOSAWIHI QUARRIES ARCHAEOLOGICAL DISTRICT (Site 26Ek3032)

by

Robert G. Elston, PhD
Christopher Raven, PhD
and
Elizabeth E. Budy, PhD

Intermountain Research Project No. 611
Intermountain Research Cultural Resources Use Permit N-39918
Bureau of Land Management Cultural Resources Report No. 1-1101(P)

Prepared for
Touchstone Resources Company
101-9 Carson Road
Box 73
Battle Mountain, Nevada 89820

Prepared by
Intermountain Research
Drawer A
Silver City, Nevada 89428

September 1987

INTERMOUNTAIN RESEARCH
REPORTS



This appendix is comprised of an Intermountain Antiquities Computer System Site Form for site 26Ek3032, the Tosawihi Quarries Archaeological District. Included with the site form are descriptions and USGS topographic map plots for each of 219 prehistoric localities observed in June-July, 1987.

This volume contains specific archaeological site location information which should not be made available to the general public.

IMACS SITE FORM

Part A - Administrative Data

*1. State No. 26Ek3032
*2. Agency No. CrNv-12-2020
3. Temp No.

4. State: Nevada County: Elko
5. Project: IMR #611 - Ivanhoe Project (Touchstone Resources Co.)
*6. Report No.: 1-0312(P)
7. Site Name: Tosawihi Quarries (Rusco 1983)
8. Class: Prehistoric
9. Site Type: Chert quarry complex
*10. Elevation: 500 ft. to 6125 ft.

*11. UTM Grid: Zone 11

Northernmost NW Corner		535100 m E, 4552800 m N
	South to	535100 m E, 4552300 m N
	West to	534340 m E, 4552300 m N
	South to	534340 m E, 4551560 m N
	East to	535100 m E, 4551560 m N
	South to	535100 m E, 4551210 m N
	East to	535600 m E, 4551220 m N
	South to	535600 m E, 4551100 m N
	East to	535720 m E, 4551100 m N
	South to	535700 m E, 4550960 m N
	East to	535840 m E, 4550960 m N
	South to	535840 m E, 4550500 m N
	East to	535960 m E, 4550500 m N
	South to	535960 m E, 4550340 m N
	East to	536460 m E, 4550340 m N
	North to	536460 m E, 4550960 m N
	East to	536720 m E, 4550960 m N
	North to	536720 m E, 4551460 m N
	West to	536440 m E, 4551460 m N
Northernmost NE Corner	North to	536460 m E, 4552800 m N

*12. of of most of Section 4, T37N, R48E
portion of Section 5, T37N, R48E
small portion of Section 9, T37N, R48E
portions of Sections 32 and 33, T38N, R48E

*13. Meridian: Mt. Diablo
*14. Map Reference: Willow Creek Reservoir SE Quad., USGS;
Willow Creek Reservoir Quad., USGS
7.5 min. Series

15. Aerial Photo: N/A
16. Location and Access:
*17. Land Owner: Bureau of Land Management
*18. Federal Administrative Units: Elko District, Elko Resource Area
*19. Management Units (USFS only):

Part A - Administrative Data (Continued)

20. Site Description: Site is comprised of 219 localities each of which represents one of the following eight tentatively isolated locality types: open residential, rockshelter, reduction station, quarry pit, outcrop quarry, surface cobble quarry, undifferentiated lithic scatter, and isolated artifact. A description of each locality is attached.
*21. Site Condition: Good (B)
*22. Impact Agent(s): Mining, roads, grazing, casual collection
*23. Nat. Register Status: Significant (C)
Justify: National Register nomination is in draft (Rusco 6/83).
24. Photos: IMR Project #611: many rolls
25. Recorded by: E. Budy, R.G. Elston
*26. Survey Organization: Intermountain Research
27. Assisting Crew Members: K. Juell, C. Raven, D. Schmitt, M. Drews, B. Clerico
*28. Survey Date: 7/15/87

Part A - Environmental Data

Site No.(s): 26Ek3032

*29. Slope Complex (Degrees) Multiple Aspect (Degrees)

*30. Distance to Permanent Water: 0 x 100 Meters
*Type of Water Source: Spring/Seep (A)
Name of Water Source: Unnamed spring, on site
Distance to Nearest Other Water Source/Type: Antelope Spring, 400 meters

*31. Geographic Unit: Willow Creek Valley

*32. Topographic Location (check one under each heading):

PRIMARY LANDFORM	PRIMARY POSITION	SECONDARY LANDFORM	SECONDARY POSITION
valley (E)	edge (B)	mesa/butte (L)	top/crest/peak (A)
			edge (B)
			slope (C)
			toe/foot/bottom/ mouth (D)

Describe: Quarries occur on large but low butte, overlooking lowlands to north. Quarries extend from butte top to bottom slopes, ranging in elevation from 6125 feet ASL to 5500 feet.

*33. On-site Depositional Context: Colluvium (I)
Description of Soil: Tan sandy silt, gravels on surface variable.

34. Vegetation
*a. Life Zone: Upper Sonoran (E)
*b. Community
Primary On-Site: (Q) Low Sagebrush
Secondary On-Site: (P) Tall Sagebrush
Surrounding Site: (Q) Low Sagebrush

Describe: Low sagebrush, big sagebrush, wheatgrass, rye grass, rabbitbrush.

*35. Miscellaneous Text:

36. Comments/Continuations/Location of Curated Materials and Records:

List of Attachments: Topo Map
219 Locality descriptions with topo map plots

*Encoded data items

1987

IMACS ENCODING FORM

To be completed for each site form.
For instructions and codes, see IMACS Users Guide.

Encoder's Name: kn

A

1 State Site Number: 26-EK-0030312
2 Agency Site Number: 12-020200
6 Agency Report Number: 001/031/12
10 Elevation: 05880
11

Zone	Easting	Northing
11	535100	4552800
11	534340	4551560
11	535960	4550340
11	536460	4552800

12

1/4	1/4	1/4	Sec.	T.	R.
			04	37 N	048 E
		NE	05	37 N	048 E
		SE	32	38 N	048 E
		SW	33	38 N	048 E

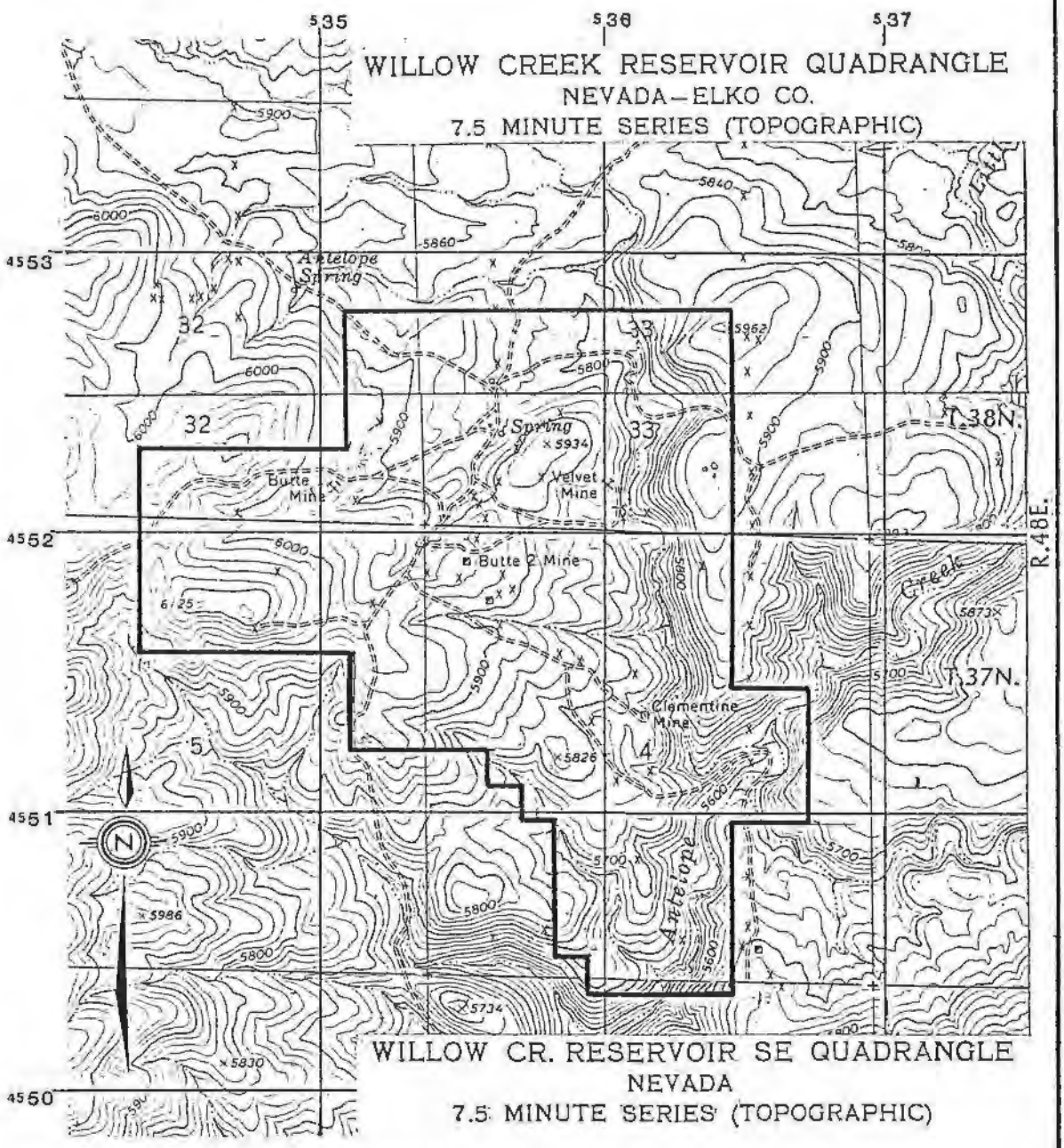
13 Merid.: 7
14 USGS Map: WILLOWCREEK RESERVOIR SE
17 Owner: LM
18 Fed. Admin. Units: BB
19 Mgmt. Unit:
21 Cond.: B
22 Impacts: PR RC GR
23 N.R.: B
26 Organ.: IF
28 Survey Date: 07-15-87
29 Slope: 98 Aspect:
30 Water: distance/type: 000 A
31 Geog. Unit: BIV
32 Location: 1st EB 2nd LA
33 Dep.: I
34 Vegetation: 1 E 2 QPQ 3
35 Misc. Text: TOSAWIHI CHERT QUARRIES

B

2 Culture/Dating Method:
3 Area:
4 Collect:
5 Depth:
6 Excav. Status:
7 Artifacts: # / type:
8 Lithic Tools: # / type:
9 # Flaking Stages:
11 Ceramics: # / type:
13 Features: # / type:
14 Architecture: # / material / type:

C

2 Historic Themes:
3 Cultures / Dating Method:
4 Dates:
5 Area:
6 Collect.:
7 Depth:
8 Excav. Status:
9 Artifacts: # / type:
10 Ceramics: paste / glaze / decoration / pattern / form / #:
Trademarks:
11 Glass: #/mnft./color/func./trdmrk./dec.:
13 Features: # / type:
14 Architecture: # / material / type:



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Locality No.: 1 (Face Rock) Type: Small Outcrop Quarry

UTM: 536160E/4504000N

Size: 60m NS/15m EW Max. Area (m^2): 900

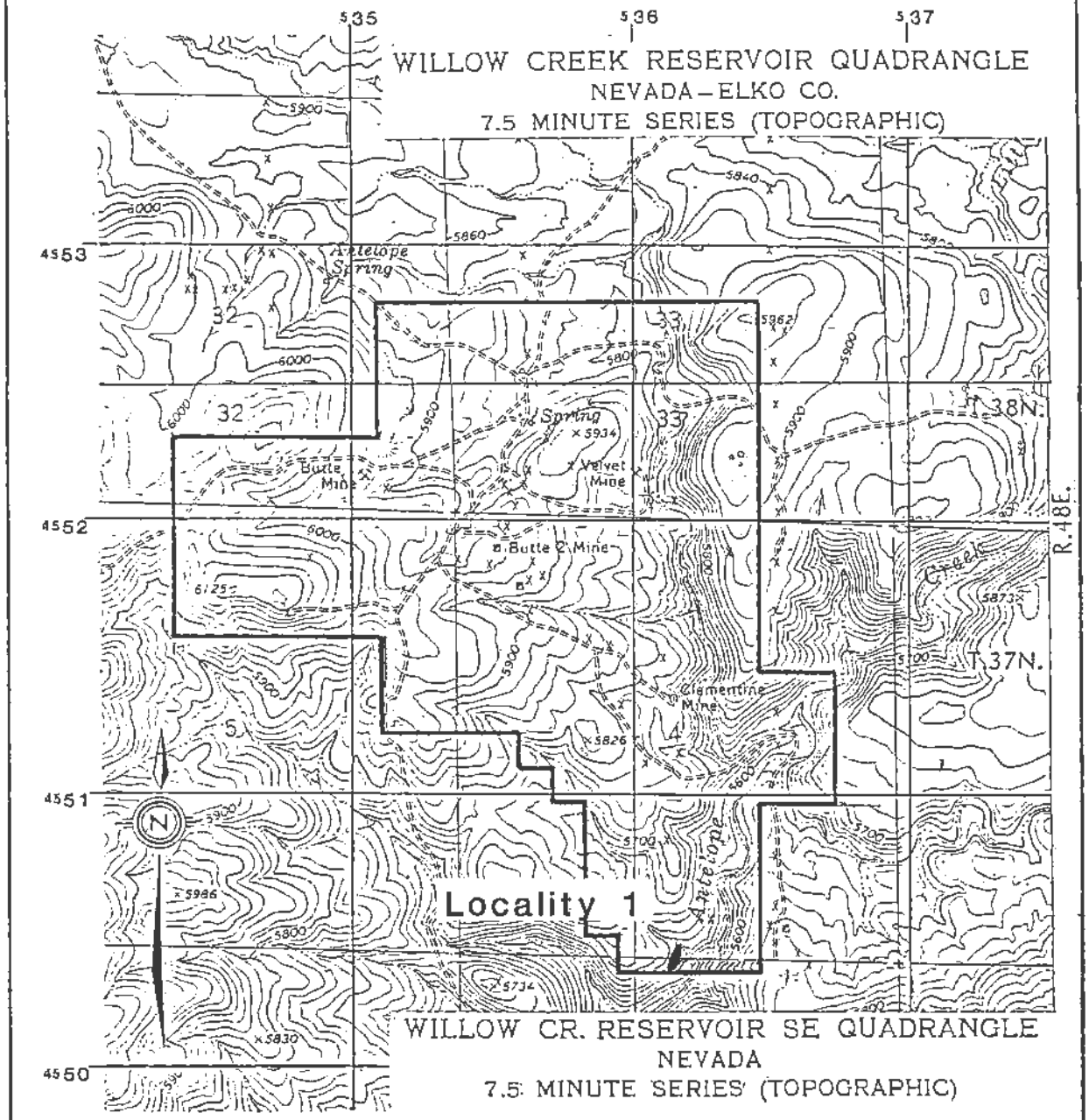
Topographic Data: Located on top of rimrock, near Standing Rock, north side of Little Antelope Canyon, above Confusion Gorge.

Quarry Data: Localized poor quality white chert cobbles outcrop at edge rimrock.

Description: Moderate density reduction scatter of poor quality white opalite flakes associated with reduction of weathered bedrock cobbles quarried at the edge of the rimrock (quarry source is designated 67-18A).

Site Condition: Undisturbed

Remarks: Good opportunity to investigate use of small expedient quarry; nearby reduction station at Locality 216 includes 11 rejected, early stage bifaces from this poor quality source.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe **September 1987**

SCALE 1:24000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Locality No.: 2 Type: Isolated Quarry Pit

UTM: 536140 E / 4550460 N

Size: 3m diameter Max. Area (m^2): 15

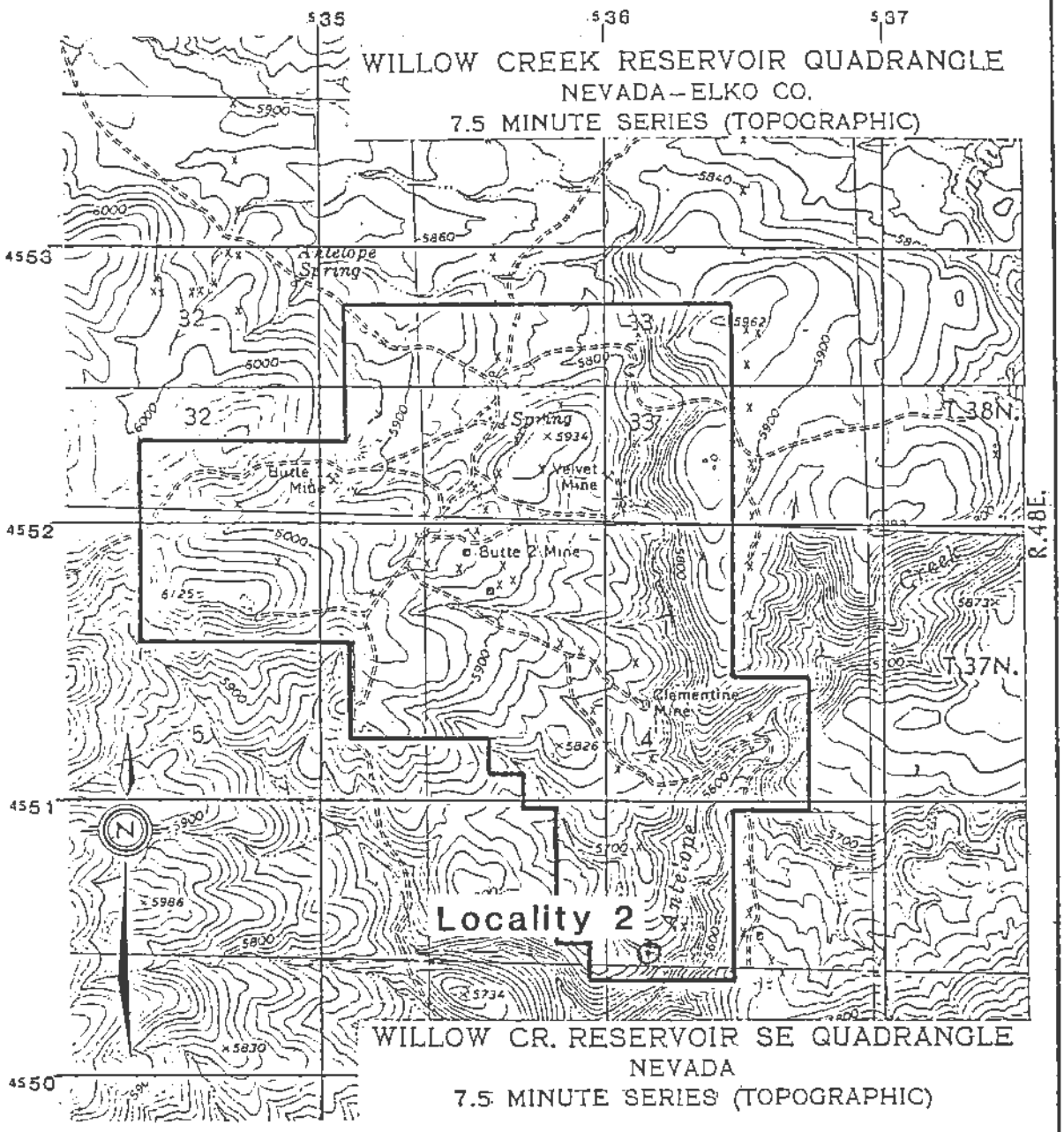
Topographic Data: Located on moderately steep (20%), SE facing, slope above rimrock, west side of Little Antelope Canyon.

Quarry Data: Localized source (unspecified).

Description: Isolated prehistoric pit (feature 67-17) with light to moderate density flake density and one rhyolite hammerstone. Abundant shatter suggests historic disturbance.

Site Condition: Likely historic disturbance.

Remarks: Whether there is historical disturbance or not is unknown. Research potential unclear.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Site Locality No.: 3 Type: Rockshelter (Reduction Station)

UTM: 536180E/4550420N

Size: 4m long/ 1m deep Max. Area (m^2): 50

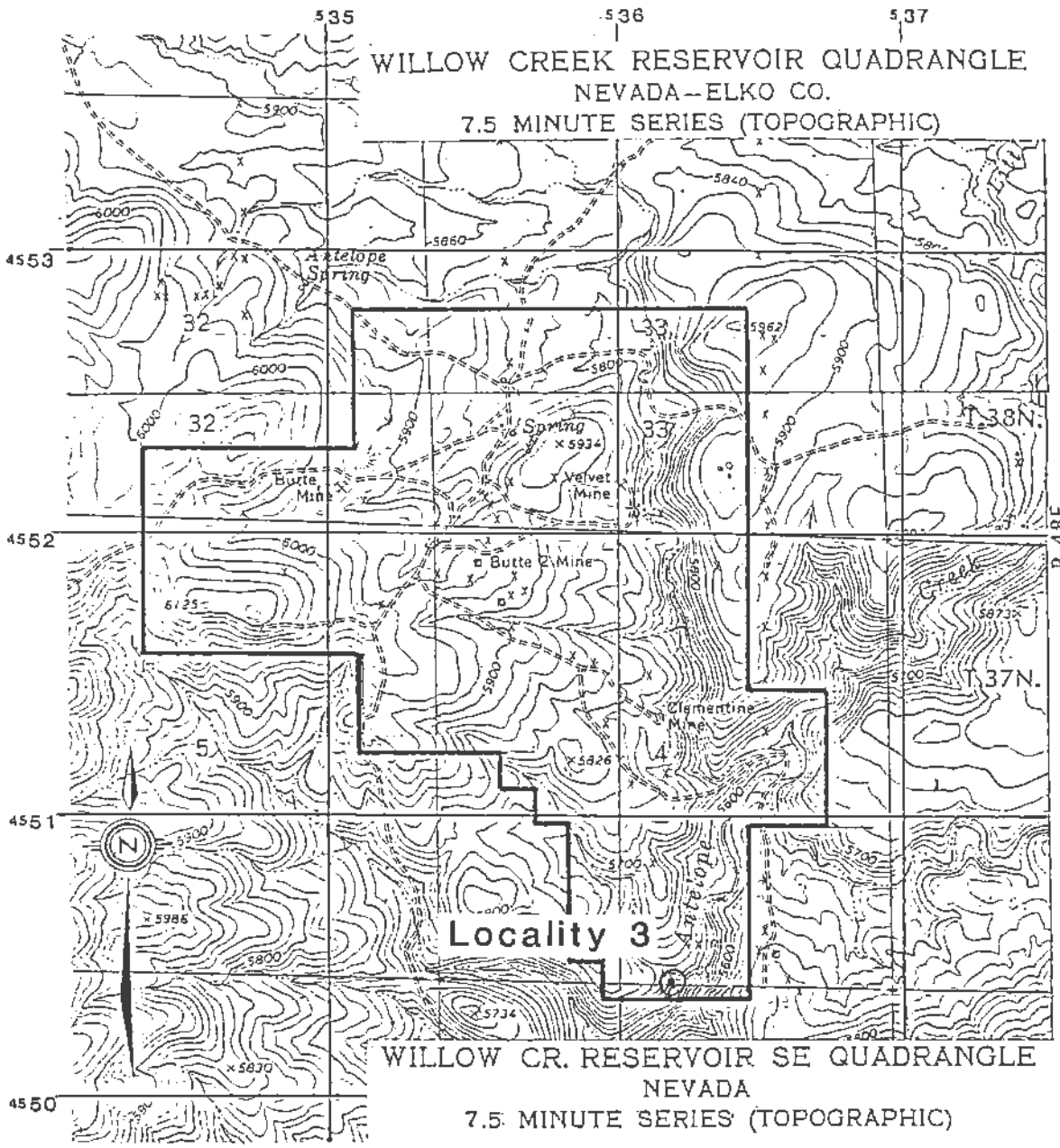
Topographic Data: Shelter is located in small drainage, near upper edge rimrock, on steep (50%) western slope of Little Antelope Canyon.

Quarry Data: Localized, poor quality quarry source on rimrock directly above shelter (see Locality 1).

Description: Discrete light density scatter of ca. 200 secondary flakes in small shelter alcove (feature 68-15).

Site Condition: Undisturbed

Remarks: Seems to be limited use reduction station related to quarry source at Locality 1.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24 000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Site Locality No.: 4 (Rose Leap Shelter) Type: Rockshelter (Residential)

UTM: 536220 E/4550 440 N

Size: 3m wide/1.5m high/8m deep Max. Area (m^2): 200

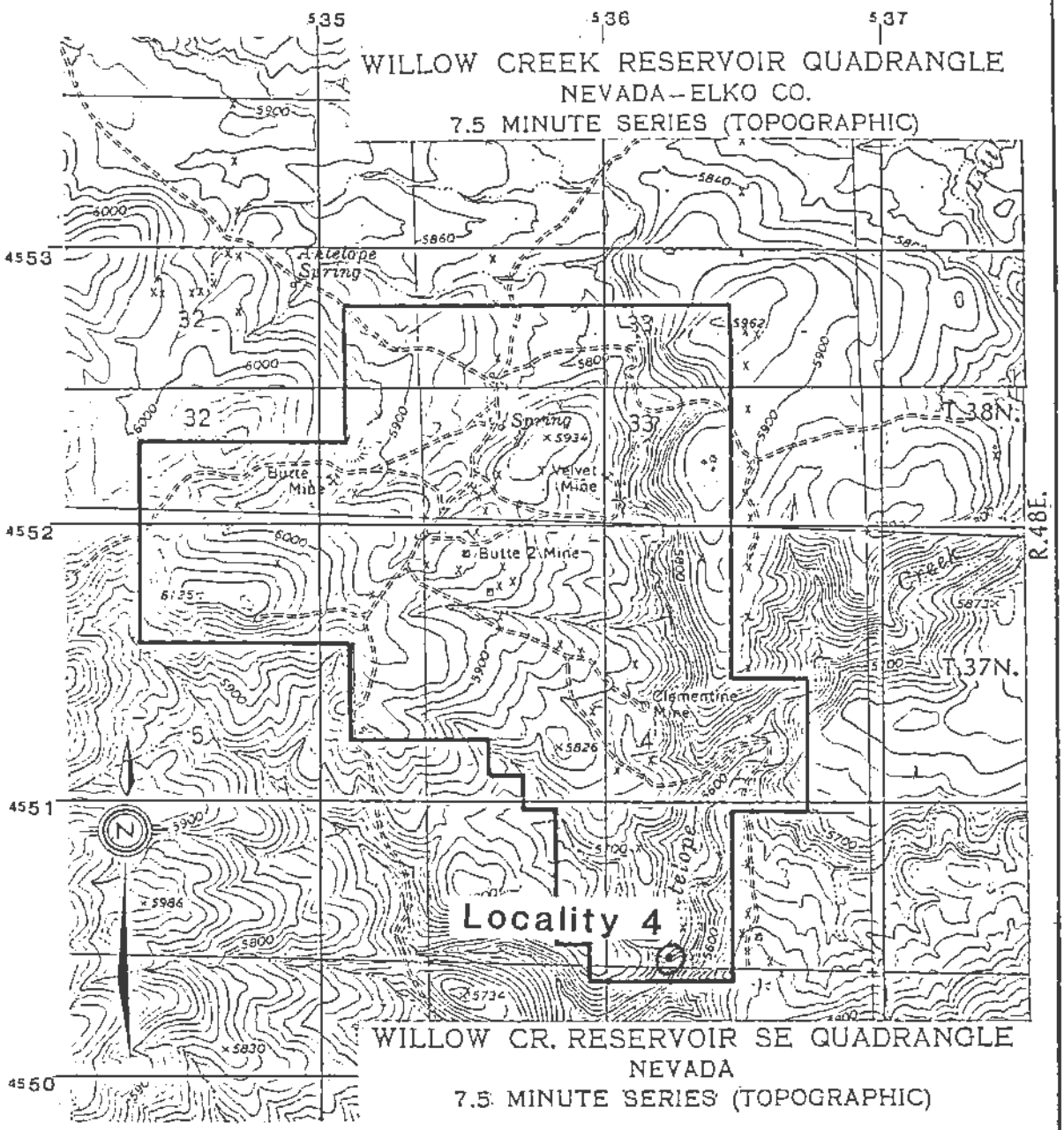
Topographic Data: Located in canyon wall, facing SE, ca. 25m above drainage bottom in L. Antelope Canyon.

Quarry Data: No on-site source.

Description: Small habitation shelter with significant subsurface deposits (feature 69-12). Thick accumulation debitage and numerous bifaces on apron. Tools include metate, obsidian projectile point (Cottonwood Triangular), drill, and bipoint.

Site Condition: Essentially intact, but mining claim post at mouth shelter and rodent turbation on apron.

Remarks: High research potential. Sensitive and significant.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Site Locality No.: 5 Type: Rockshelter (Reduction Station)

UTM: 536240 E / 4550480

Size: 5m wide/2m high/1m deep Max. Area (m^2): 25

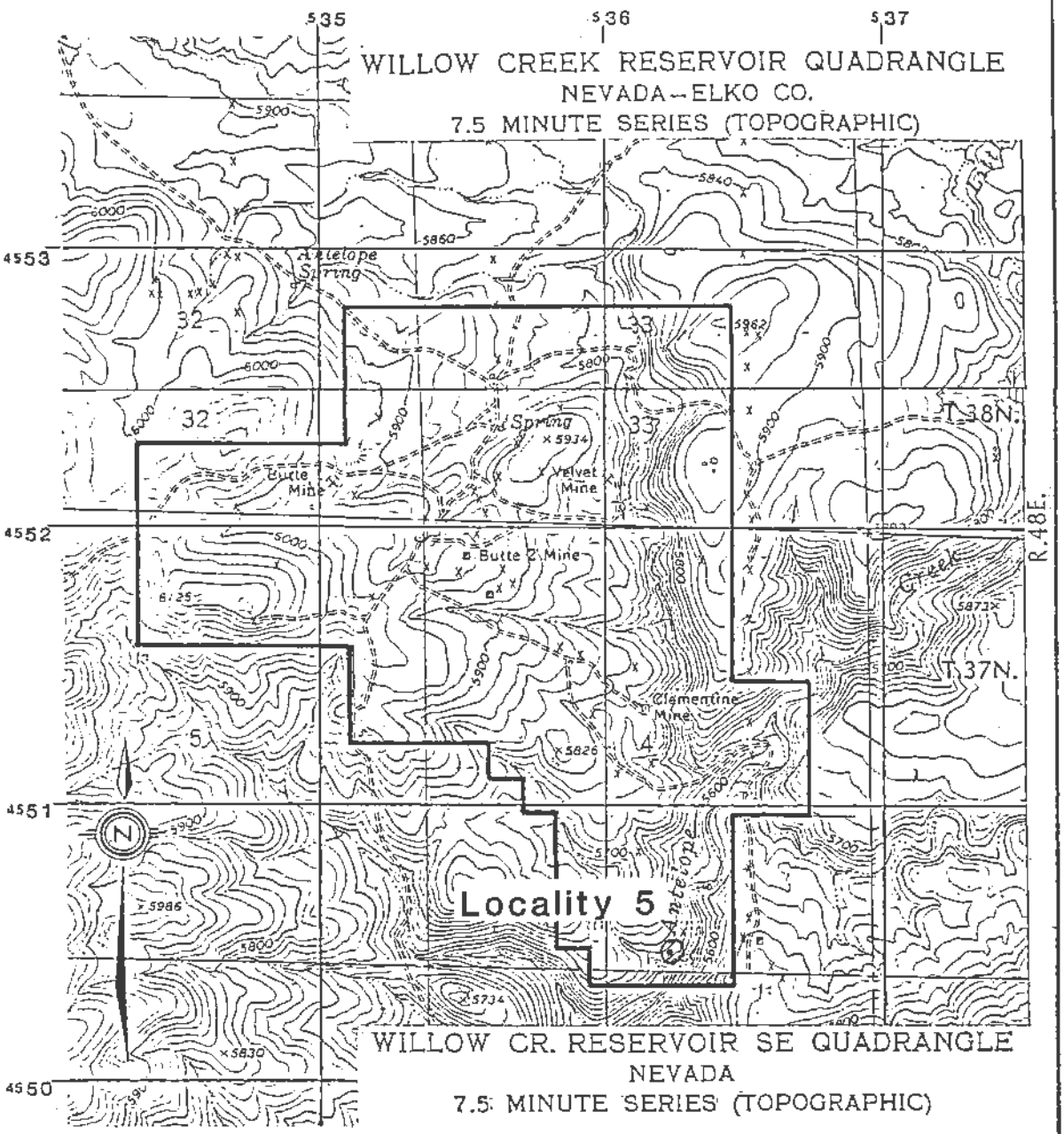
Topographic Data: Located in canyon wall, facing E, about 30 m above drainage bottom, in Little Antelope Canyon.

Quarry Data: No on-site source.

Description: Discrete flake scatter eroding downslope from base of small shelter overhang (70-3). Seems to be limited use involving biface thinning with ca. 500 items, predominantly secondary flakes.

Site Condition: Redistributed by erosion but otherwise intact.

Remarks: Good example discrete activity. No depth indicated or likely.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Site Locality No.: 6 Type: Rockshelter (Reduction Station)

UTM: 536260E/4550440N

Size: 3m wide/2m deep Max. Area (m^2): 15

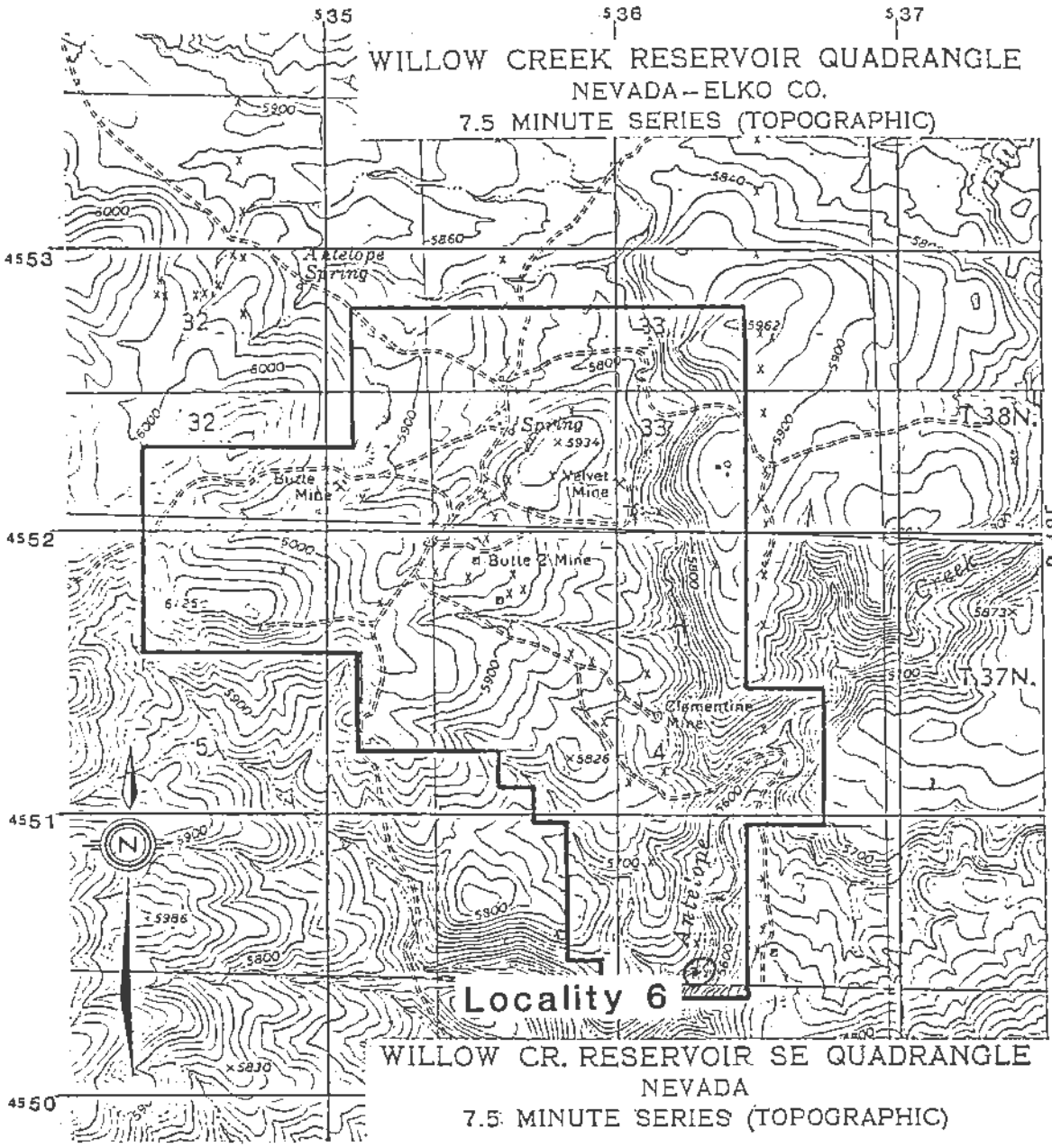
Topographic Data: Located about 2 meters above drainage bottom, north-facing, at base of Little Antelope Canyon.

Quarry Data: No on-site opalite source.

Description: Small triangular overhang with sparse flake scatter. Only a few white opalite biface thinning flakes were noted on surface. Shallow cultural deposit (bedrock controlled).

Site Condition: Apparently intact.

Remarks: Unclear research potential. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Locality No.: 7 Type: Rockshelters (Reduction Stations)

UTM: 536260E/4550460N

Size: 8m x 3m (each) Max. Area (m^2): 50

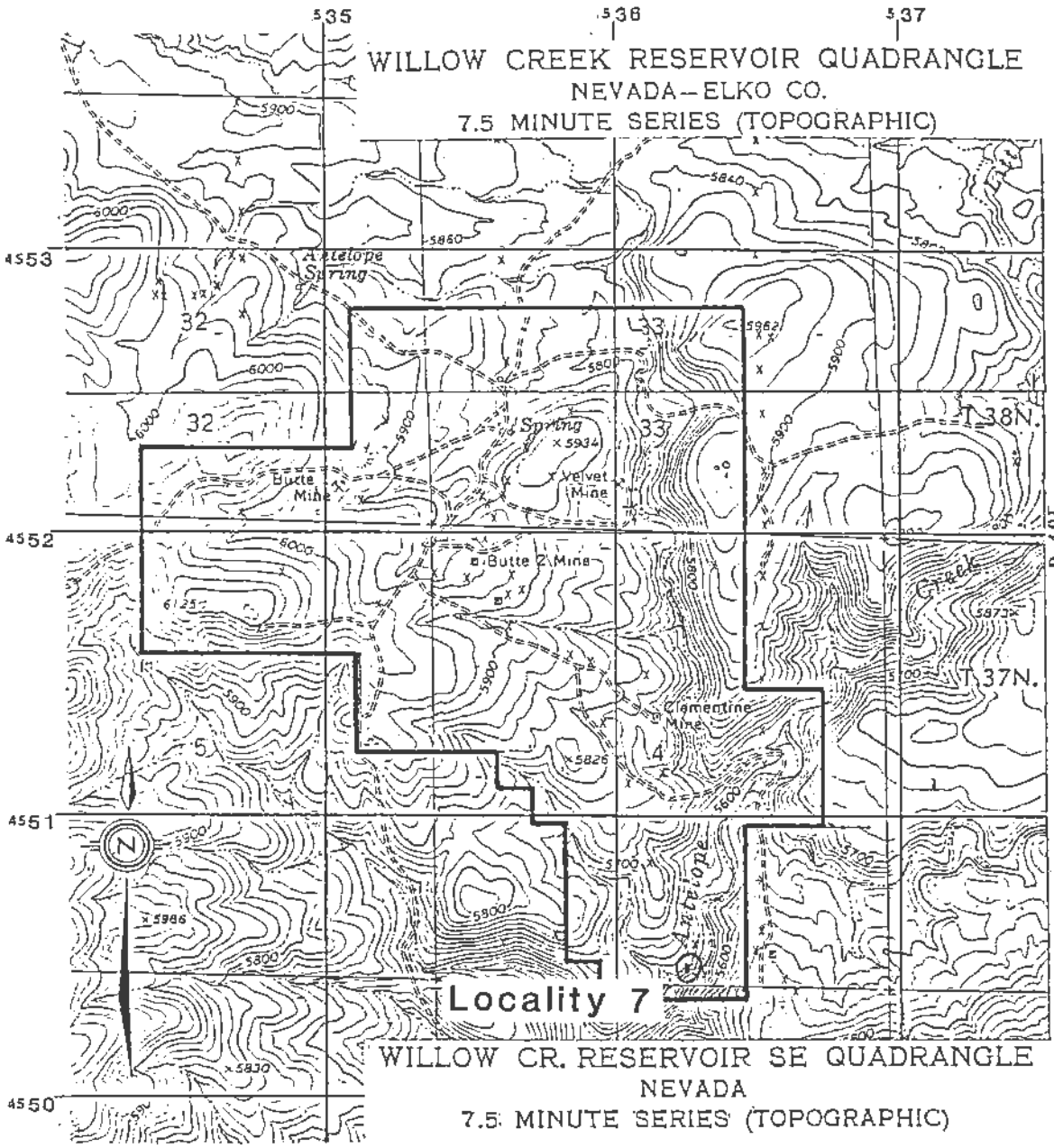
Topographic Data: Two small alcoves one to three meters above drainage bottom, south-facing, in Little Antelope Canyon.

Quarry Data: No on-site opalite source.

Description: Two small flaking stations associated with slight shelter overhangs (feature 71-5). Artifacts include light to moderate density flake scatters and bifaces; all are of white opalite.

Site Condition: Undisturbed.

Remarks: Seem to be 2 discrete, limited use reduction stations. No depth indicated.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Locality No.: 8 Type: Rockshelter (Reduction Station)

UTM: 536280E/4550500N

Size: 1m x 3m Max. Area (m^2): 15

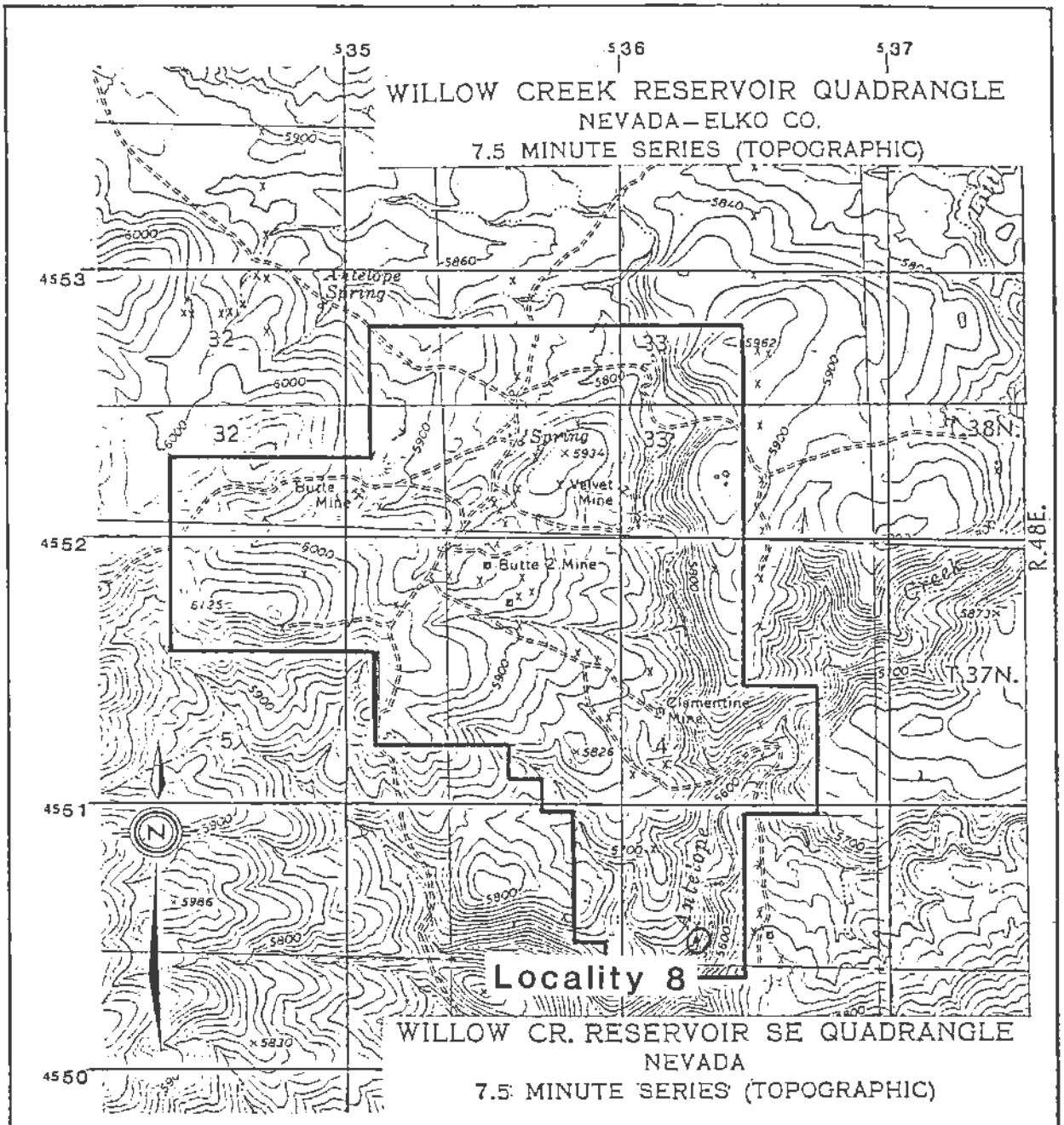
Topographic Data: Located at upper edge rimrock on the west side of Little Antelope Canyon.

Quarry Data: No on-site opalite source.

Description: Small, discrete biface thinning station under shallow rock overhang (feature 71-1). Artifacts include one white opalite biface and a few thinning flakes.

Site Condition: Undisturbed.

Remarks: Apparently limited use site with biface thinning. No depth indicated.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Locality No: 9 Type: Small Reduction Station

UTM: 536240E/4550540N

Size: 20m diameter Max. Area (m^2): 300

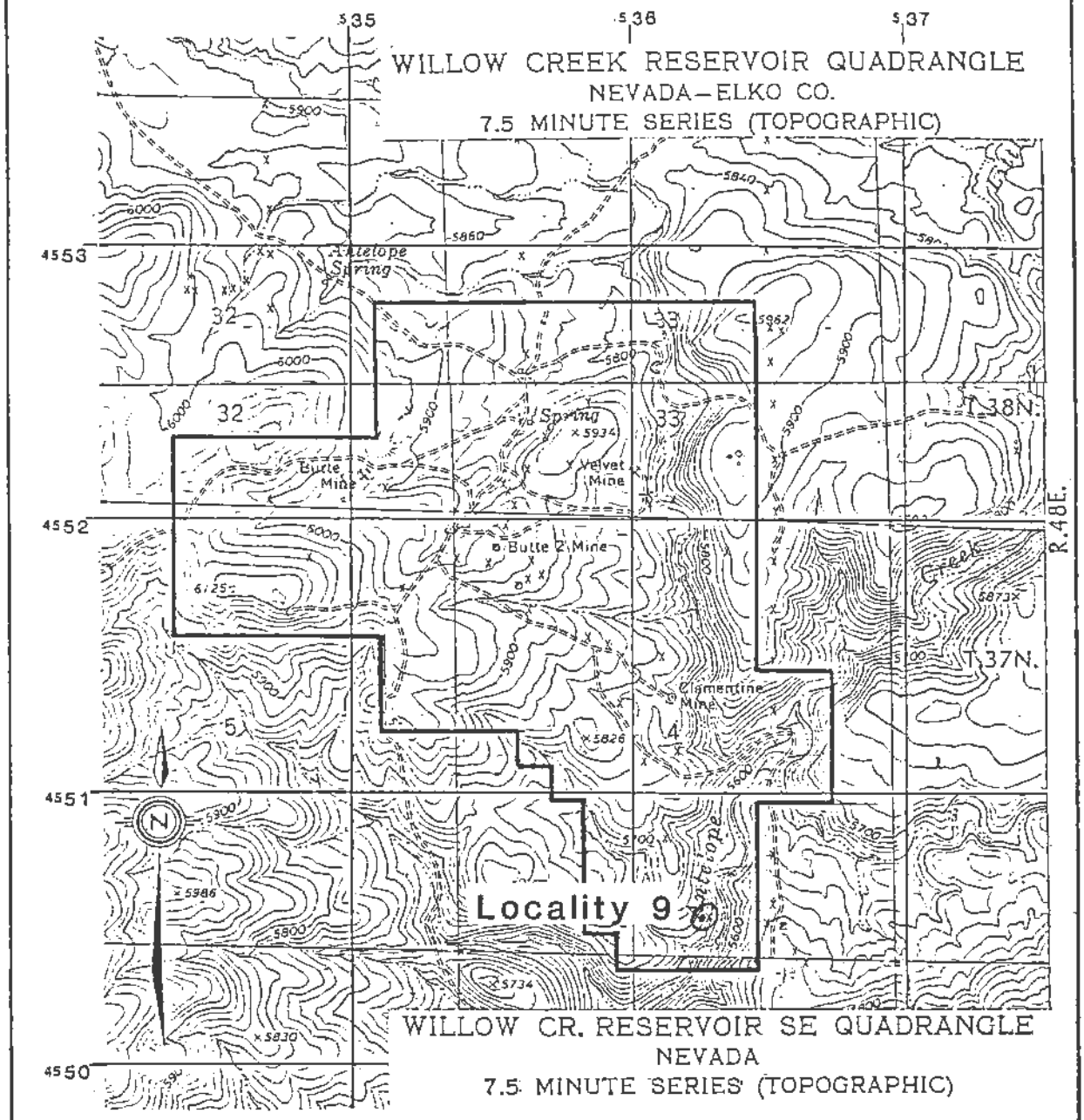
Topographic Data: Located on small bench on moderately steep (15%), south-east facing slope, overlooking Little Antelope Canyon.

Quarry Data: No on-site opalite source.

Description: Multiple biface reduction station in moderate density flake scatter (feature 70-4). Biface thinning flakes and early stage bifaces most abundant components in site assemblage.

Site Condition: Essentially undisturbed, but vegetation was burned recently.

Remarks: Discrete activity area outside quarry heartland.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Station R (Holmes Ridge)

Locality No.: 10 Type: Quarry Pit Complex/ Cobbles in Colluvium

UTM: 536120E/4550720N

Size: 100 m NS/ 100 m EW Max. Area (m^2): 10,000

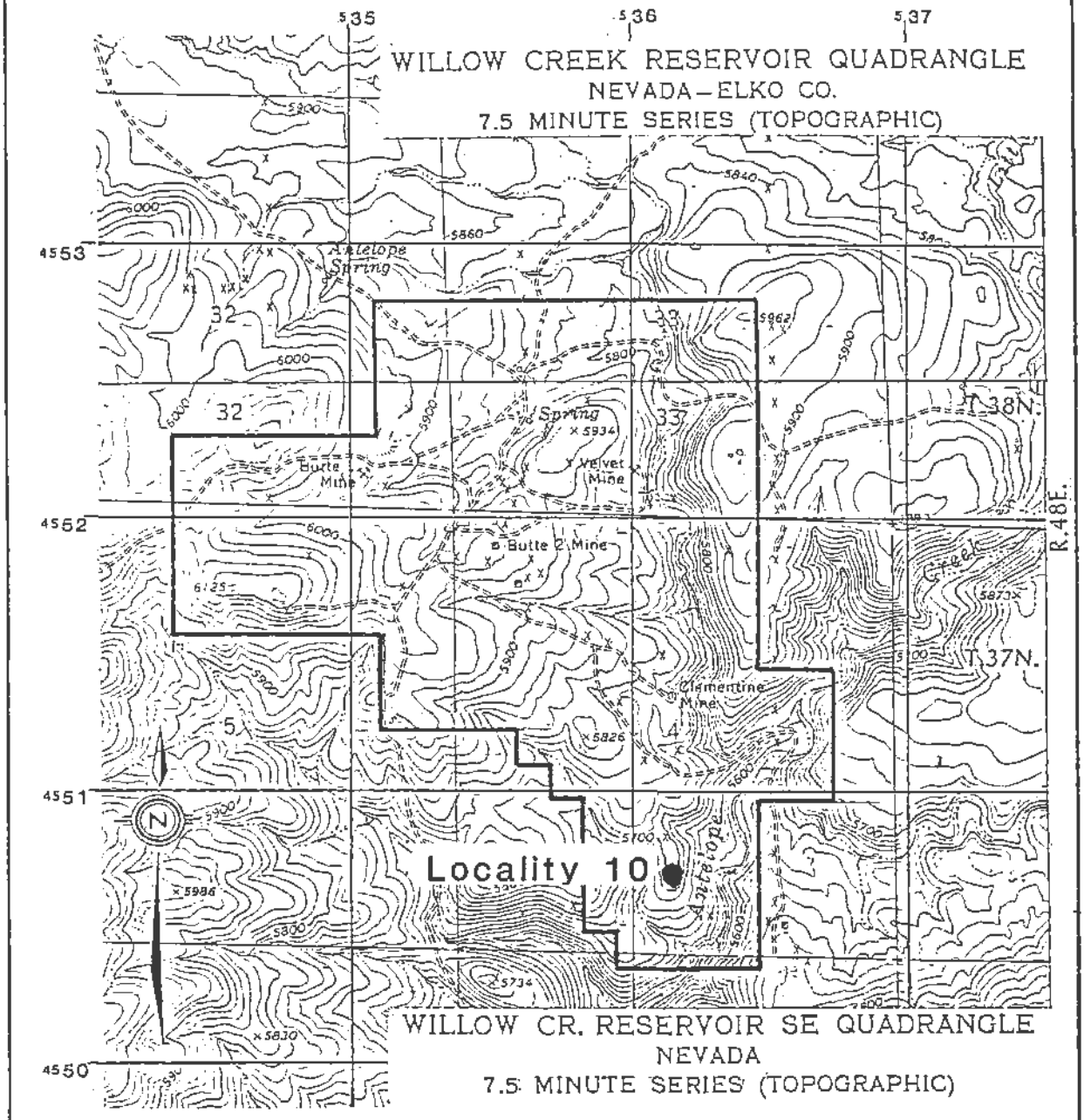
Topographic Data: Top and gentle to moderate slopes (10%) of south-trending ridge overlooking Little Antelope Canyon.

Quarry Data: Cobbles and boulders occur in colluvial mantle and are comprised of both unsilicified tuff and opalite (may be derived from a tuff-chert breccia). Few cobbles or larger sized pieces of opalite present on surface, yet has thick accumulation of reduction flakes. Quality and colors quite variable.

Description: Quarry pit complex in moderate density flake scatter. Features include two large coalescing pits (66-23) on ridge top and a discrete flaking station (65-16) on southwest slope. Cores, bifaces, and hammerstones are notable for their absence.

Site Condition: Fair. Existing road through east edge site; extensive rodent turbation.

Remarks: Absence of all but a few cobble and larger-sized opalite nodules, and presence of conspicuous unsilicified tuff nodules, all occurring in thick reduction flake accumulation raises many questions about this site. Were on-site sources used up? Did the site serve as a 'way station' where bifaces from elsewhere in the quarry heartland were thinned 'to reduce load'? However, this does not seem very likely, given the large quarry pit. This may be a deposit of angular, multicolored cherts similar to that at locality 31.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 11 Type: Isolated Quarry Pit

UTM: 536220E/4550700N

Size: pit=5 m diameter Max. Area (m^2): 100

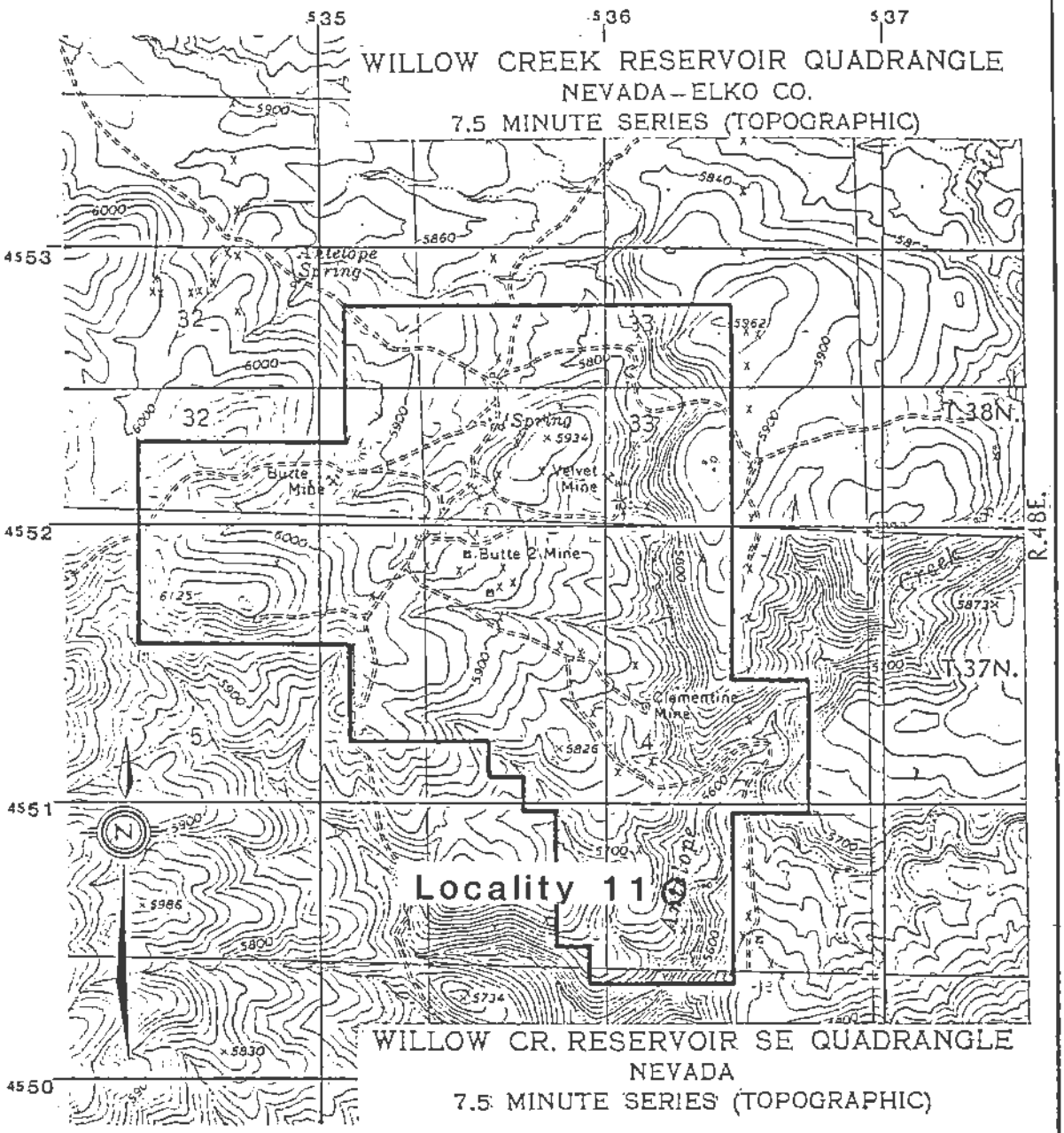
Topographic Data: Very steep (50%) slope, east-facing, overlooking Little Antelope Canyon.

Quarry Data: A small amount of dark, blood red (jasper-like) toolstone was quarried from a small outcrop zone. Numerous nonsiliceous powdery cobbles dominate residual lag. Opalite sources are rare in vicinity.

Description: Small, isolated quarry pit apparently focused on a distinctive dark, blood-red toolstone source (70-6). Only a sparse scatter of flakes and shatter with one broken biface remain, but the considerable energy invested is reflected a quantity of nonsiliceous lag cobbles forming pit berm.

Site Condition: Probably intact.

Remarks: Interesting for amount of energy invested in removing non-toolstone materials to access small quantity of knappable stone. Distinctive red material strongly resembles one bifacial tool noted at Rose Leap Shelter (Site Locality 4).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Red Hill Ridge

Locality No.: 12 Type: Small Outcrop Assay Quarry

UTM: 535800E/4550540N

Size: 15m x 10m Max. Area (m^2): 150

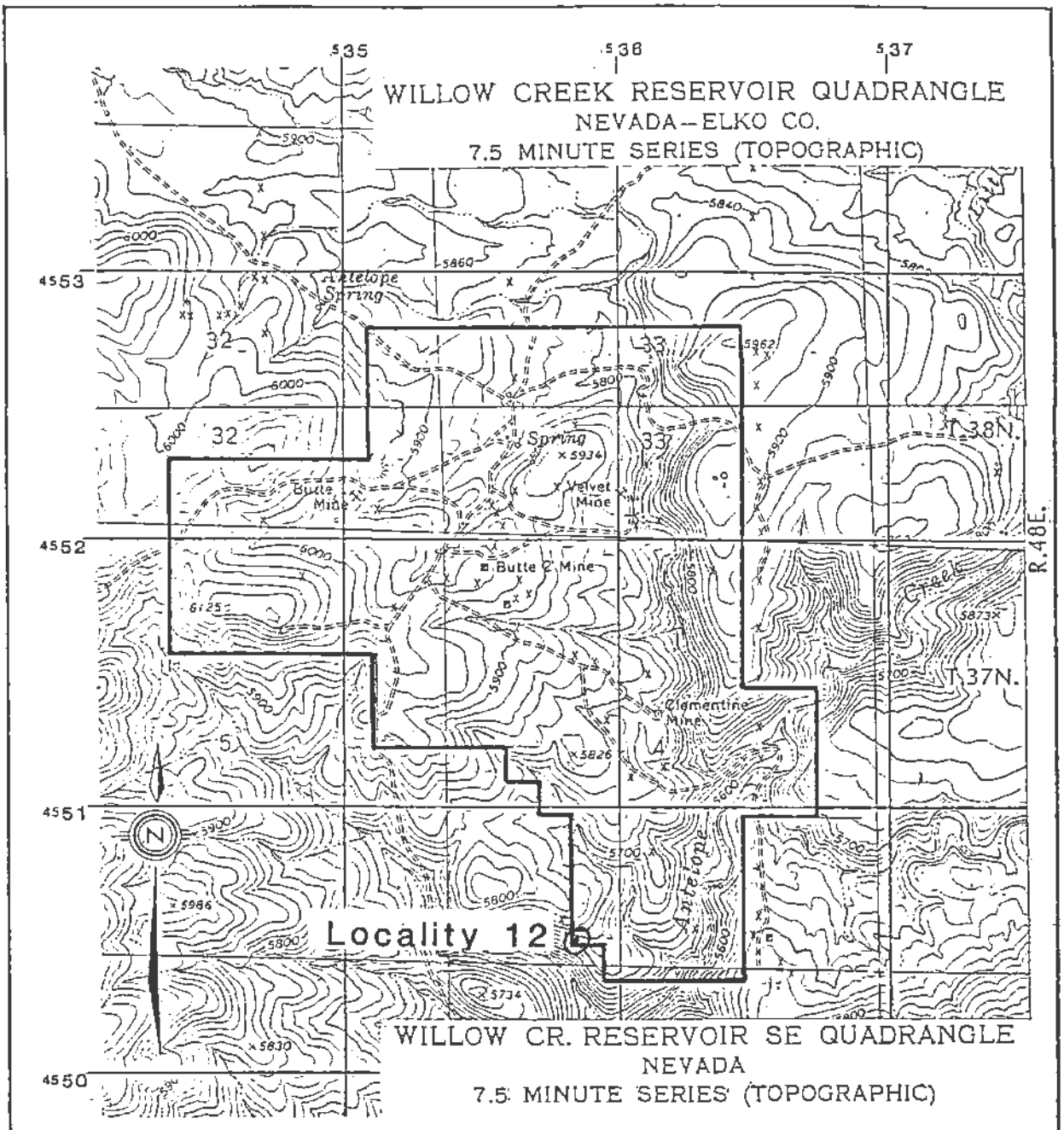
Topographic Data: Located on very steep (50%) south-facing slope overlooking unnamed canyon tributary to Little Antelope.

Quarry Data: On-site bedrock opalite outcrop.

Description: The small bedrock quarry (feature 57-10) is characterized by a moderate density scatter of primary reduction debitage and several biface fragments.

Site Condition: Apparently undisturbed.

Remarks: Site is a highly localized outcrop well outside the quarry heartland. Is predominance of shatter and primary reduction a reflection of poor toolstone quality? Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24 000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Red Hill Ridge

Locality No.: 13 Type: Small Outcrop Quarry

UTM: 535800E/4550620N

Size: 25m x 15m Max. Area (m^2): 375

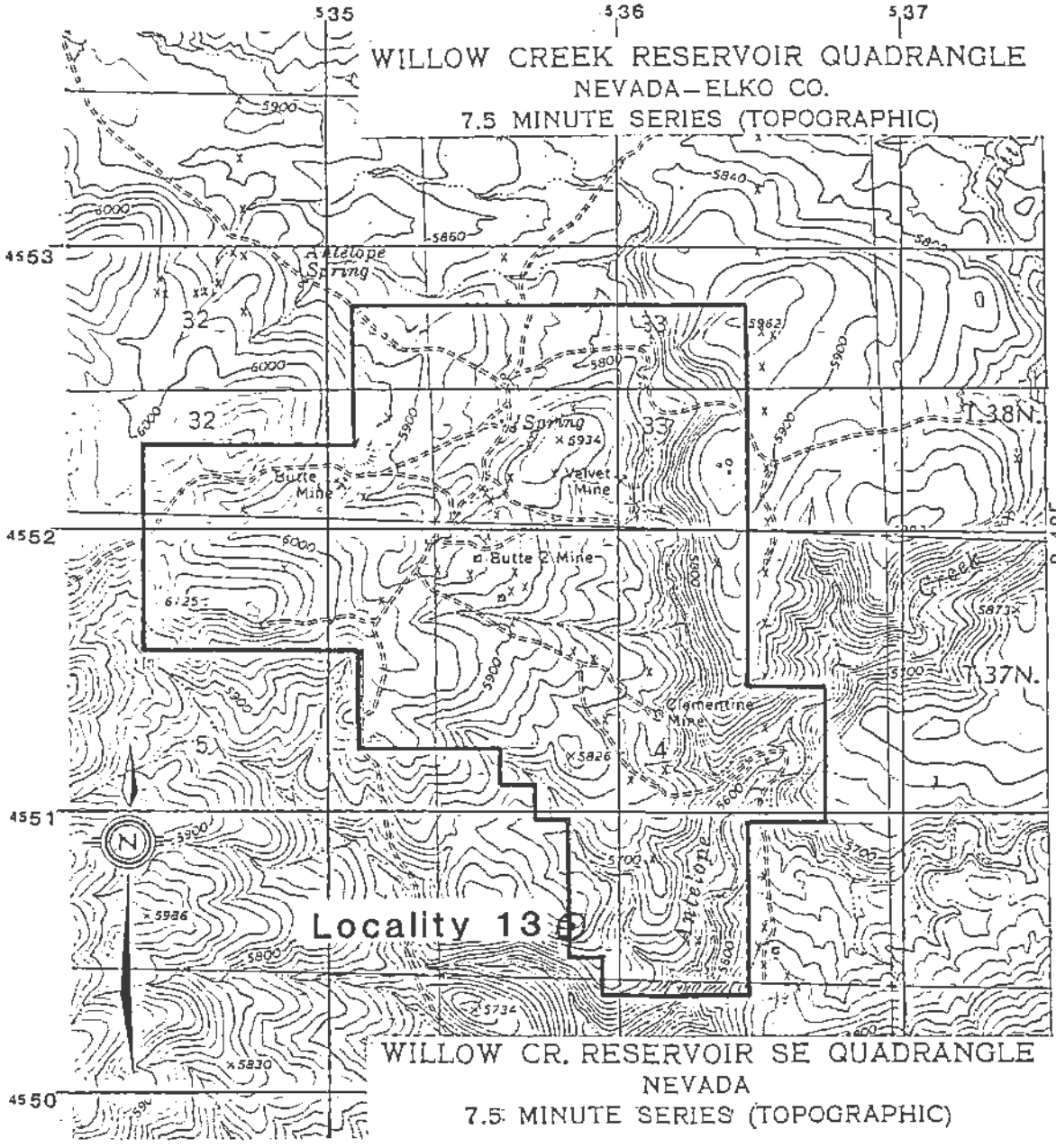
Topographic Data: Outcrop along upper edges of flat bench, at edge moderately steep (25%), south-facing slope, overlooking unnamed tributary to Little Antelope Canyon.

Quarry Data: Small bedrock ledge opalite outcrop.

Description: Outcrop evidences two heavily battered vertical faces with thick accumulation of primary flakes and shatter (feature 57-11). Bifaces and secondary flakes were also well represented; basalt hammerstones (and scattered basalt flakes) also conspicuous.

Site Condition: Disturbed by existing road and historic blade cut.

Remarks: Representative of localized outcrop quarry well outside quarry heartland. Associated reduction debris suggests high energy expended for extraction but good quality toolstone was available. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 14 Type: Rockshelter (Reduction Station)

UTM: 536280E/4550660N

Size: 1m x 3m (shelter) Max. Area (m^2): 50

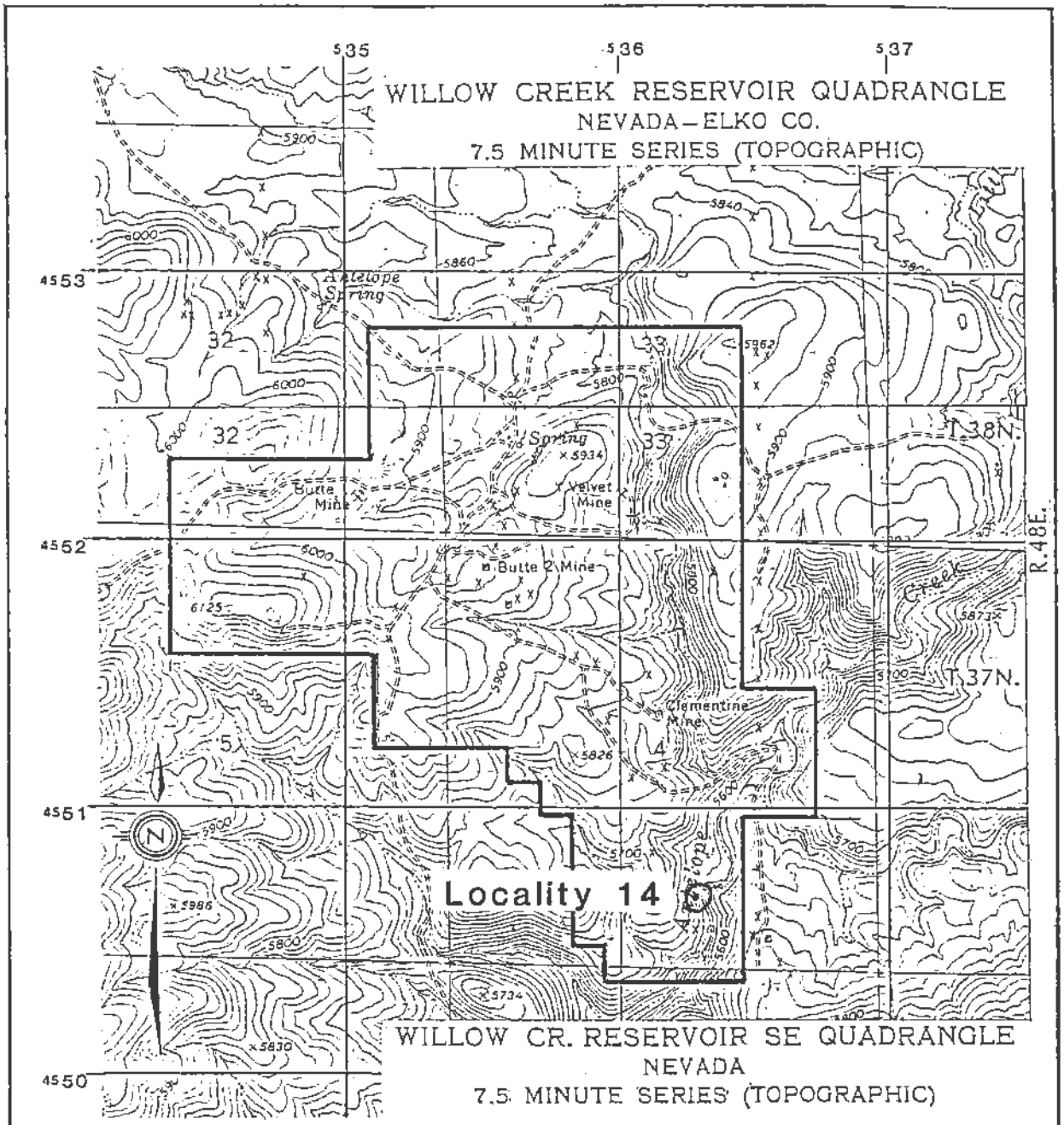
Topographic Data: Located in east-facing cliffs edging Little Antelope Canyon.

Quarry Data: No on-site opalite source, but large ledge outcrop (intensively quarried, see Locality 15) is located directly across drainage to the east.

Description: Small shelter with scatter of debitage in front (feature 71-8). White and purple cherts include 4 large bifaces, biface thinning flakes, cores and reduction debris. One opalite biface and two very large white opalite flakes noted on slope above shelter.

Site Condition: Undisturbed.

Remarks: Discrete, limited use, reduction area. No depth indicated or likely.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 15 Type: Quarry Pit Complex

UTM: 536280E/4550680N

Size: 180m NS/60m EW Max. Area (m^2): 10,800

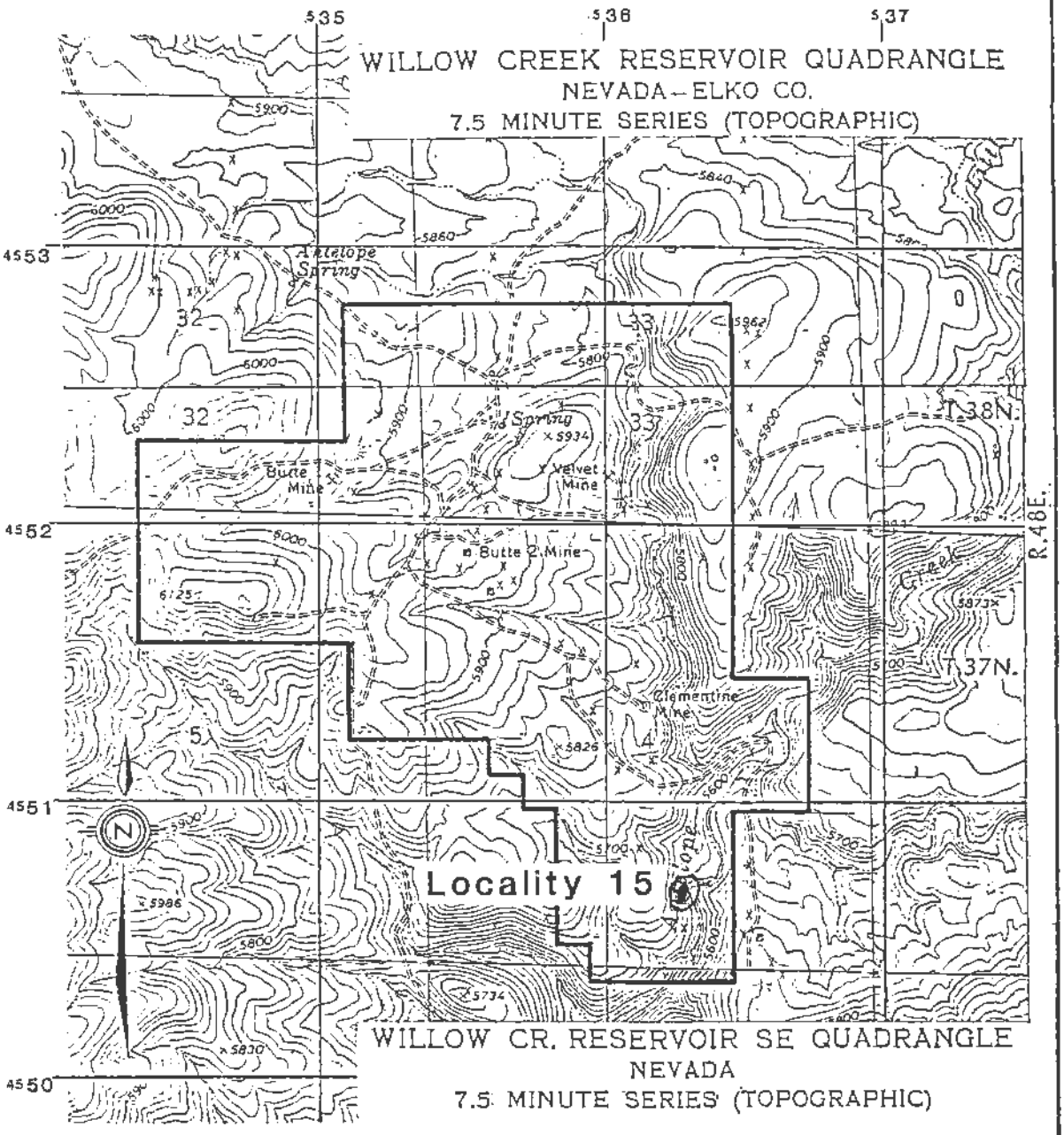
Topographic Data: Large opalite bedrock ledge exposed near the base, and on the east side, of Little Antelope Canyon. Ledge rises a maximum of 30 meters (in elevation) above drainage bottom.

Quarry Data: High quality opalite is available near the top of the bedrock ledge where the outcrop contacts colluvium. The most intensive quarrying was conducted by shallow pit excavations along this contact.

Description: Locality 15 is an intensively quarried bedrock outcrop; 13 pits (feature 74-S5) were excavated into the top of the ledge, near the colluvium contact. Pits vary in size from small (1 m diameter) and shallow (15 cm deep) to large (8 m diameter) and deep (2 m deep) excavations. Small rockshelter at base of outcrop is designated separately as Locality 126.

Site Condition: Undisturbed.

Remarks: Example of large, intensively quarried bedrock exposure.



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Tosawihi-Ivanhoe

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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 16 Type: Rockshelters (Reduction Stations)

UTM: 536360 E / 4550700 N

Size: each =1m x 2m Max. Area (m^2): 10

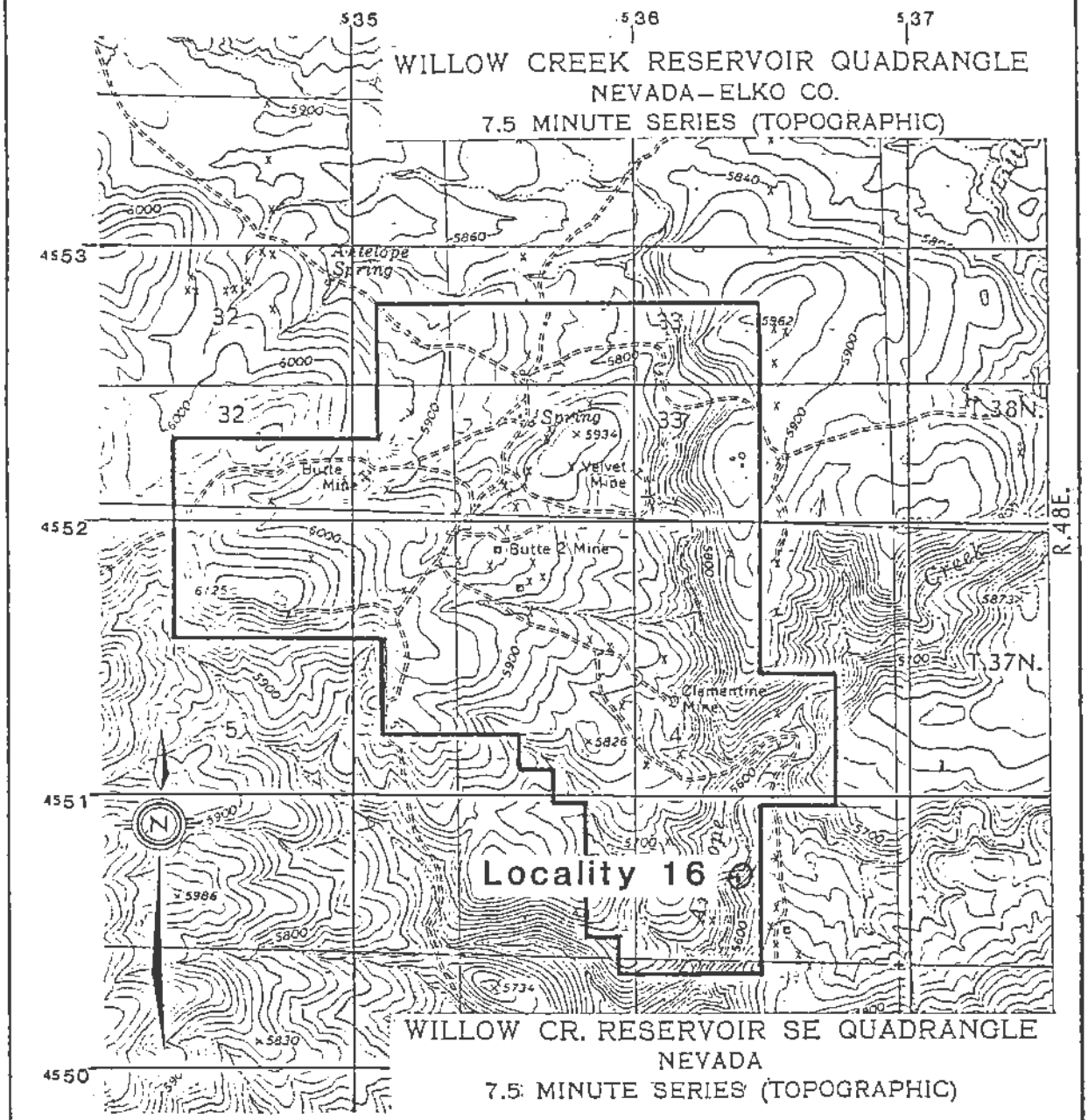
Topographic Data: Located in the rimrock on the east side of Little Antelope Canyon, on very steep slope (+50%), NW aspect.

Quarry Data: No on-site opalite source.

Description: Two small, adjacent shelters with sparse to light scatter of white opalite reduction flakes (feature 75-S2).

Site Condition: Excellent.

Remarks: Discrete, very short-term activity area. Has packrat nest.



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September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 17 Type: Reduction Station Complex

UTM: 536360E/4550760N

Size: 30m EW/15m NS Max. Area (m^2): 450

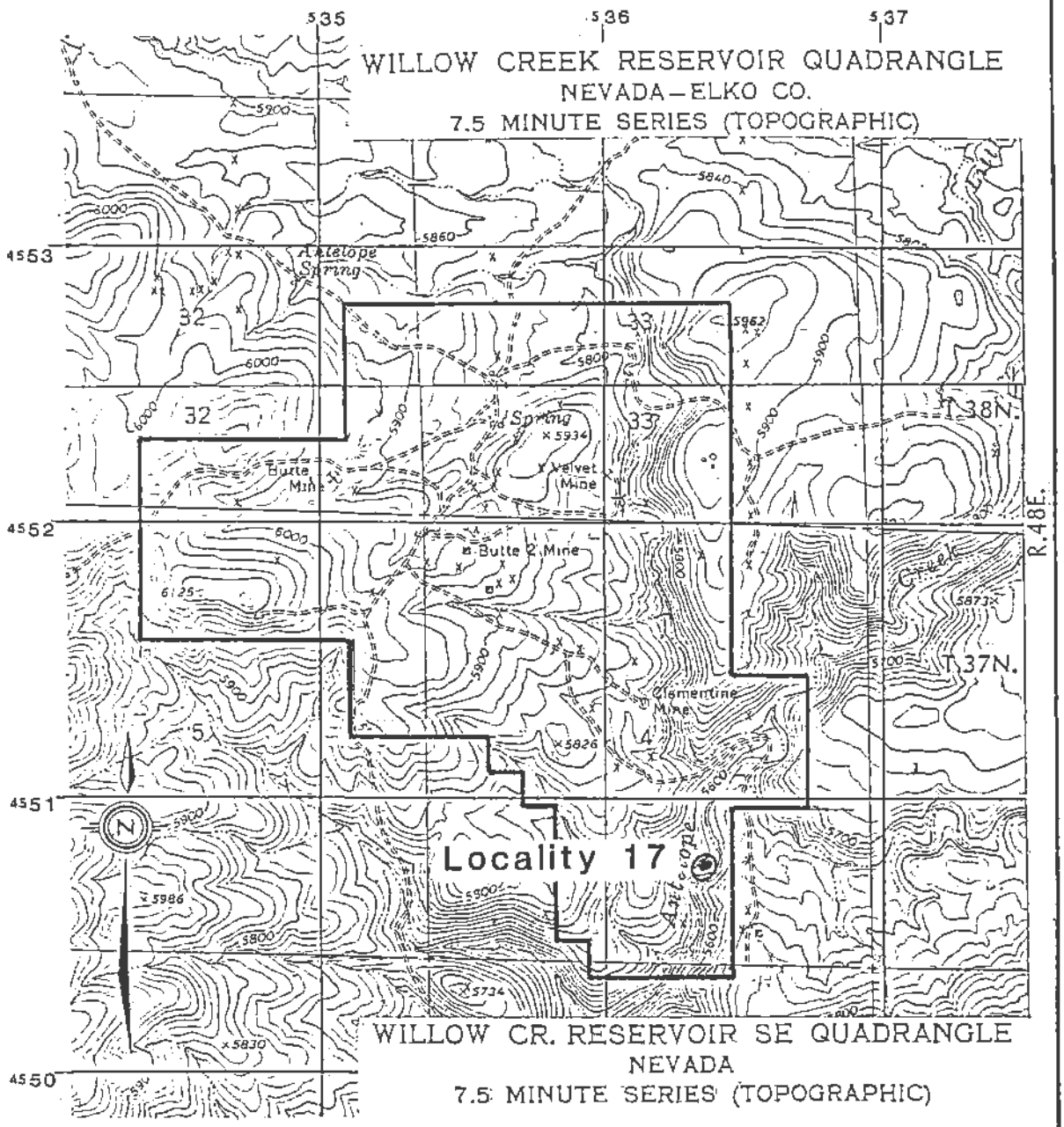
Topographic Data: Located along the lower edge of a knoll on the west side of Little Antelope Canyon, about 10 meters (elevation) above drainage bottom.

Quarry Data: No on-site source, but intensive quarry (Locality 15) located 30 meters south.

Description: Abundant scatter of bifaces, biface thinning, and secondary flakes; undifferentiated complex of reduction stations.

Site Condition: Undisturbed.

Remarks: Possibly reflects an area where bifacial roughouts from Locality 15 were further thinned and trimmed.



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 18 Type: Isolated Quarry Pit

UTM: 536340E/4550820N

Size: pit=6m NS/3m EW Max. Area (m^2): 150

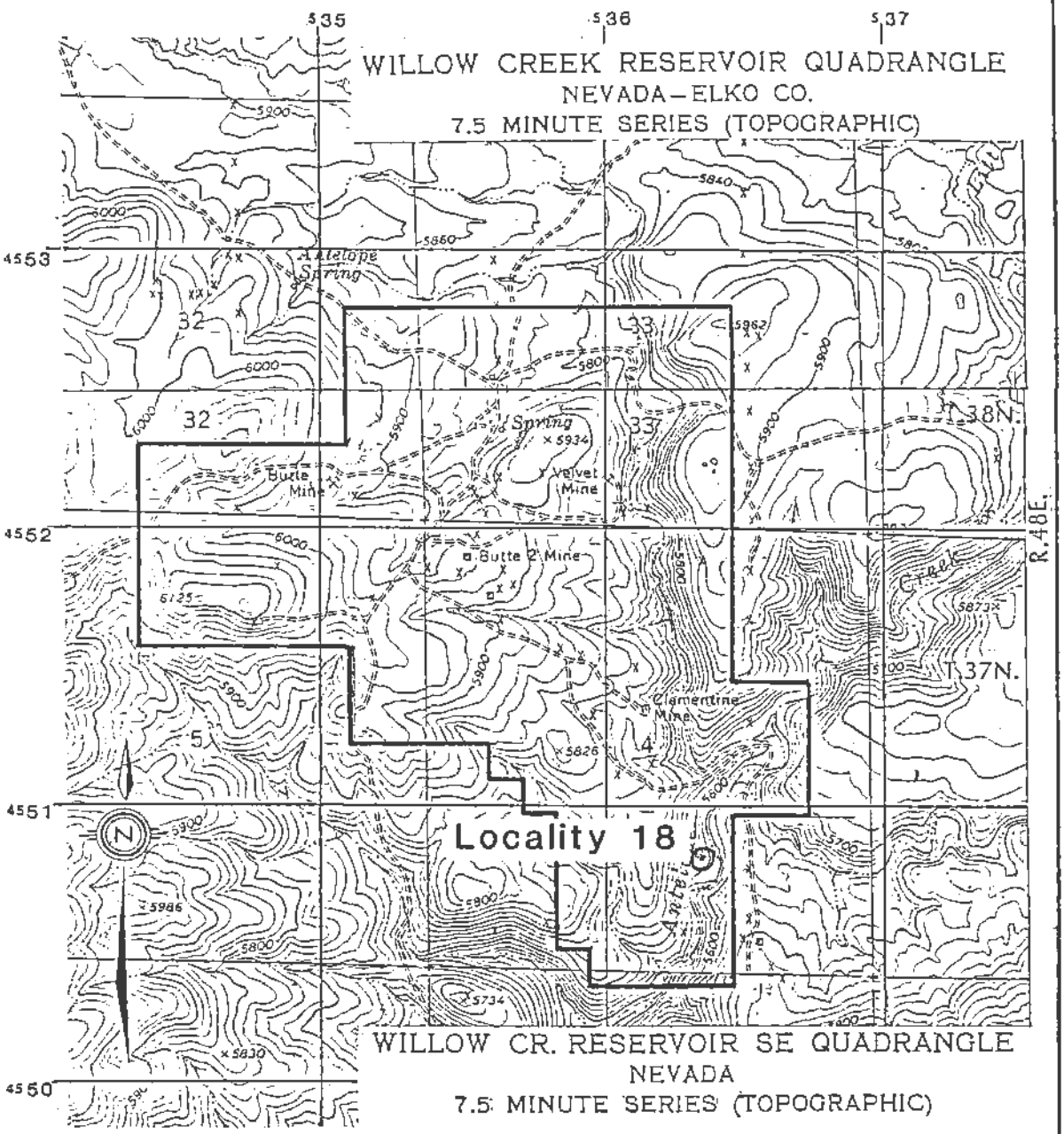
Topographic Data: Small bedrock ledge on knoll, lower Antelope Canyon, east facing.

Quarry Data: Small mustard yellow opalite outcrop. Good quality toolstone.

Description: Isolated pit quarry (feature 74-S3) in ledge. Dense reduction debris includes cores, chunks, abundant shatter as well as biface thinning flakes and 6 rhyolite hammerstones.

Site Condition: Undisturbed.

Remarks: May be clear example of opalite extraction techniques; perhaps single pit was excavated by one group during a single excursion. How much effort? How many bifaces extracted?



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 19 Type: Small Open Residential

UTM: 536300 E/4550860 N

Size: 3m x 3m Max. Area (m^2): 10

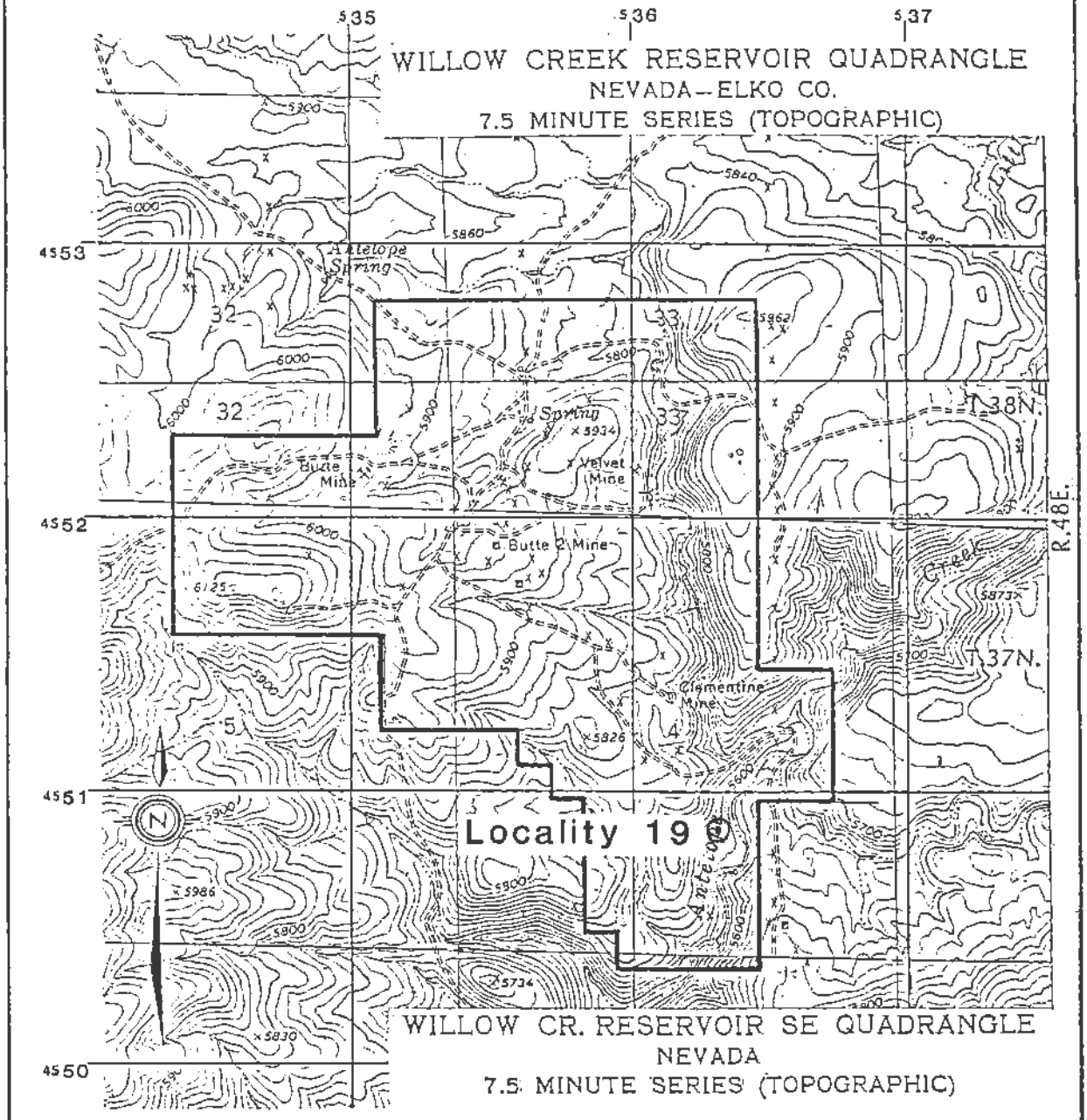
Topographic Data: Small flat on southeast trending ridge above Little Antelope Canyon.

Quarry Data: No on-site opalite source.

Description: Small flake scatter with large basalt metate (feature 72-4). Flakes are quite variable in color and small in size. Suggests short term camp.

Site Condition: Undisturbed.

Remarks: May be unique in district. Should be assessed by excavation.



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 20 Type: Quarry Pit/Cobble Field

UTM: 536400 E/4550880 N

Size: 20m diameter Max. Area (m^2): 200

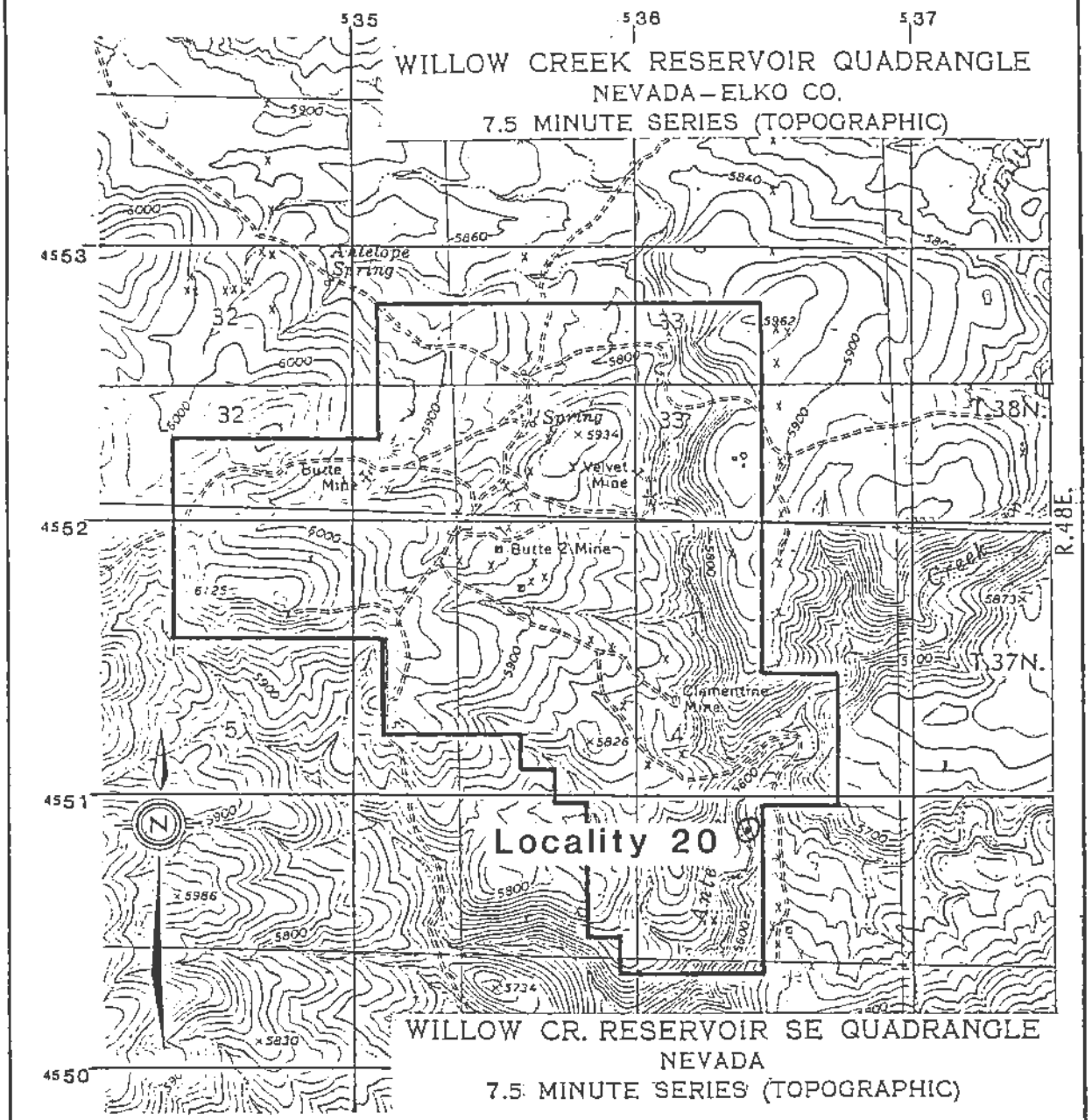
Topographic Data: In boulders on east slope Little Antelope Canyon, 5 meters above drainage bottom.

Quarry Data: Opalite cobbles found among large boulders. White.

Description: Primary reduction of chert cobbles with abundant shatter and cores; few biface thinning flakes. Small (3m diameter), shallow (20 cm deep) pit reflects quarry excavation (feature 75-S1).

Site Condition: Undisturbed.

Remarks: This portion of Little Antelope Canyon has relatively few quarry features.



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SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 21 Type: Small Reduction Station

UTM: 536360E/4550920N

Size: 10m x 10m Max. Area (m^2): 100

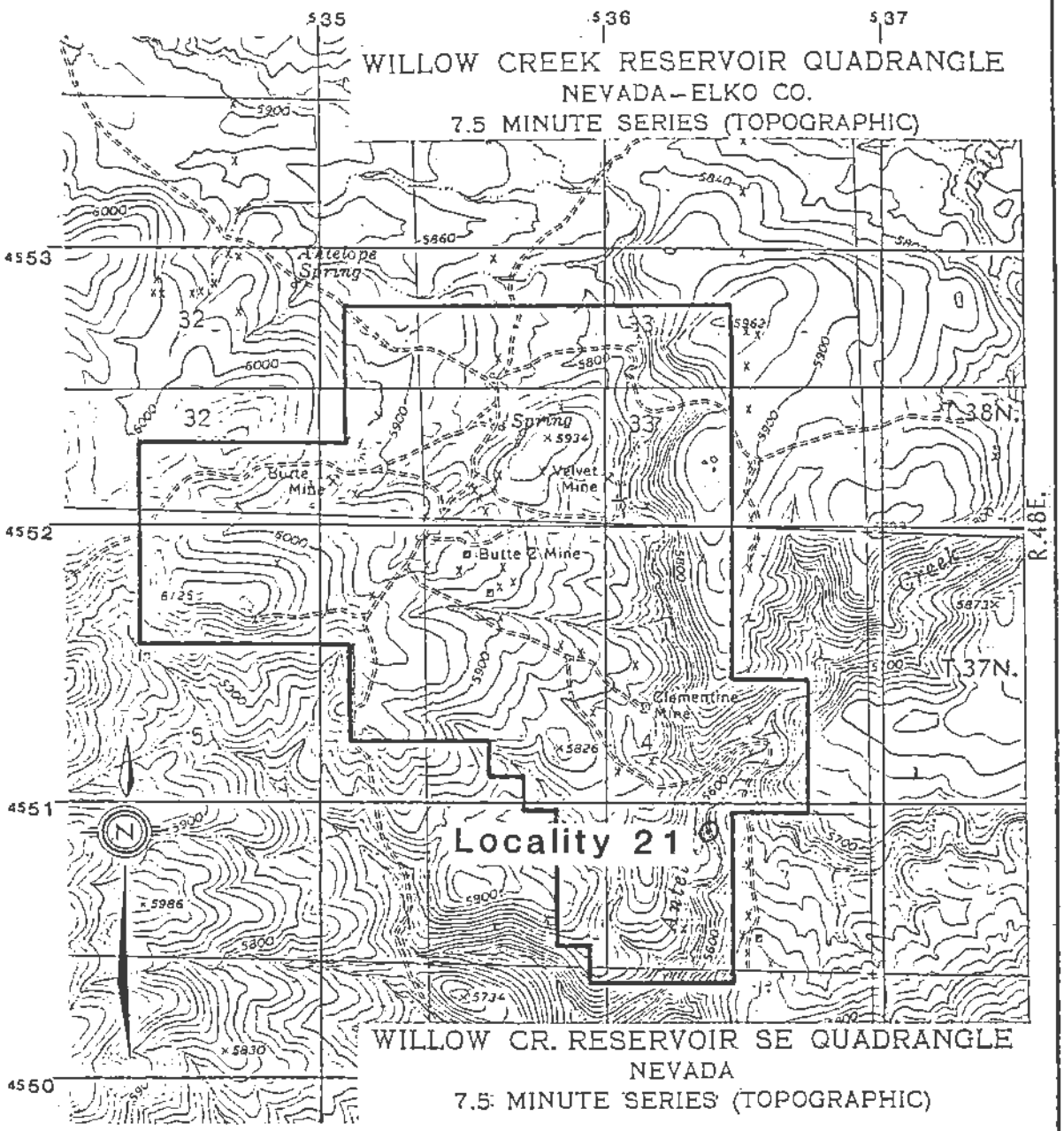
Topographic Data: Located near small pool (intermittent spring?) in bottom Little Antelope Canyon.

Quarry Data: No on-site source.

Description: Small cluster of white cores and nodules (feature 74-S2) noted among light flake scatter at edge stream.

Site Condition: Badger turbation.

Remarks: Opalite cores and nodules apparently transported to streamside for further reduction. Similar to Locality 22.



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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 22 Type: Small Reduction Station

UTM: 536360E/4550940N

Size: 5m NS/ 1mEW Max. Area (m^2): 5

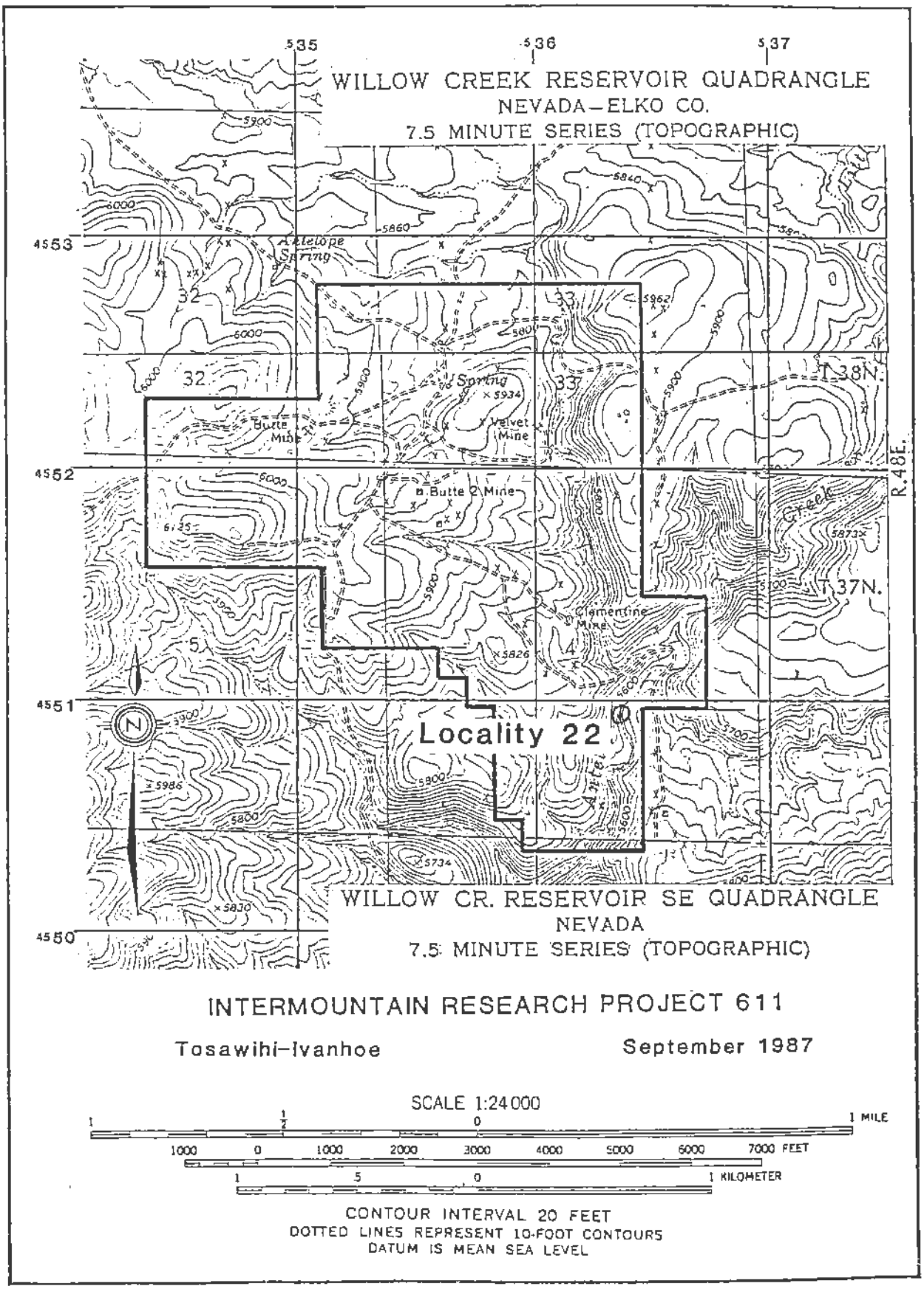
Topographic Data: Located at edge intermittent stream in bottom Little Antelope Canyon.

Quarry Data: No on-site opalite source.

Description: Small, discrete core reduction station (feature 74-S1) with 1 core, 1 nodule, several large thin flakes, and shatter; all of white opalite.

Site Condition: Badger turbation.

Remarks: Similar to Locality 21. What is the source of the core and nodule?



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 23 Type: Isolated Quarry Pit

UTM: 536420E/4550960N

Size: 6m x 4m (1 m deep) Max. Area (m^2): 30

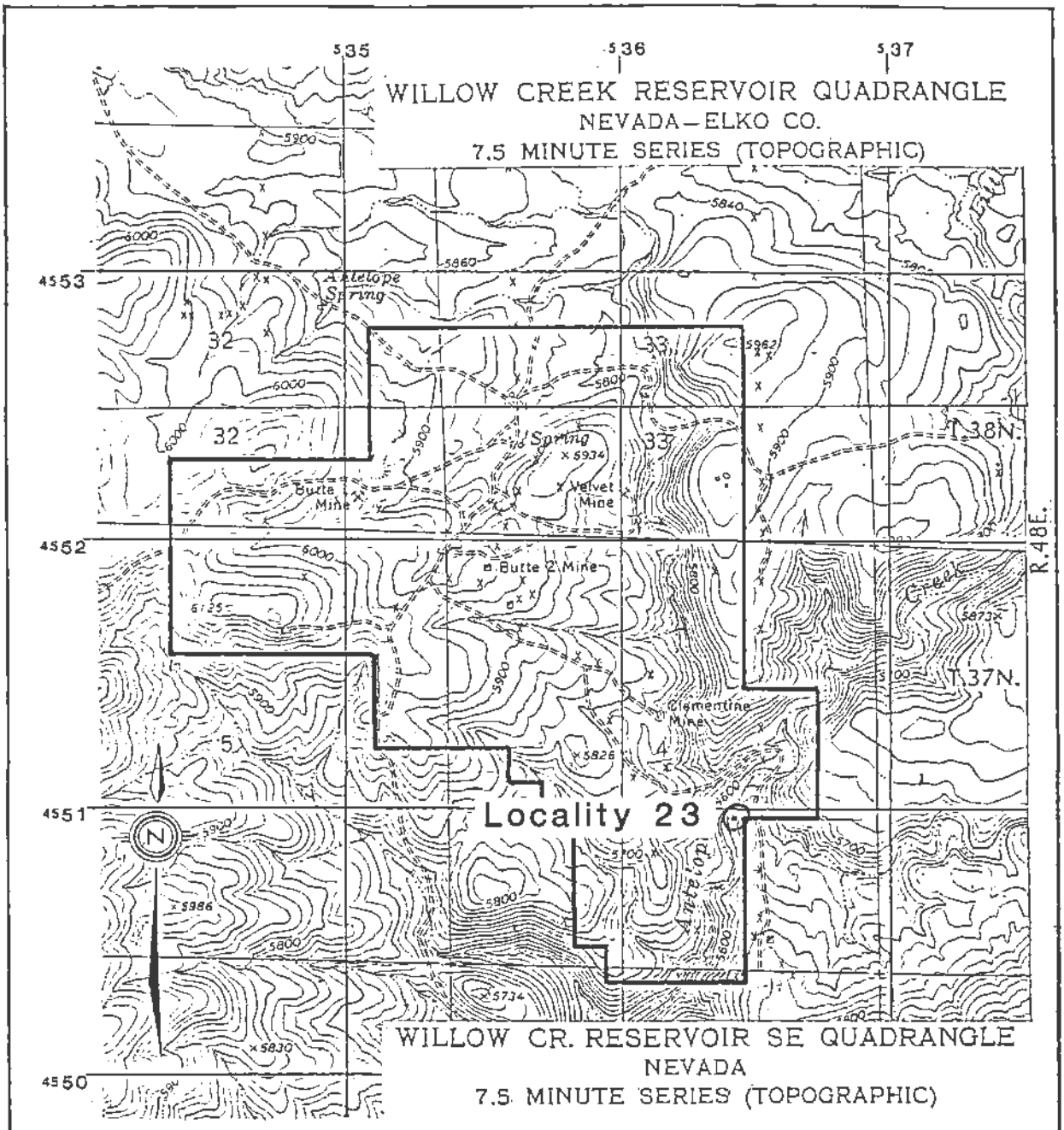
Topographic Data: On moderately steep (20%), west-facing slope, lower east side of Little Antelope Canyon.

Quarry Data: Localized white and pink source.

Description: Isolated pit quarry (feature 76-S1); moderate flake scatter.

Site Condition: not specified.

Remarks: Insufficient information; needs assessment.



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September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 24 Type: Quarry Pit Complex

UTM: 536120 E/4550920 N

Size: 90m NS/ 100m EW Max. Area (m^2): 9,000

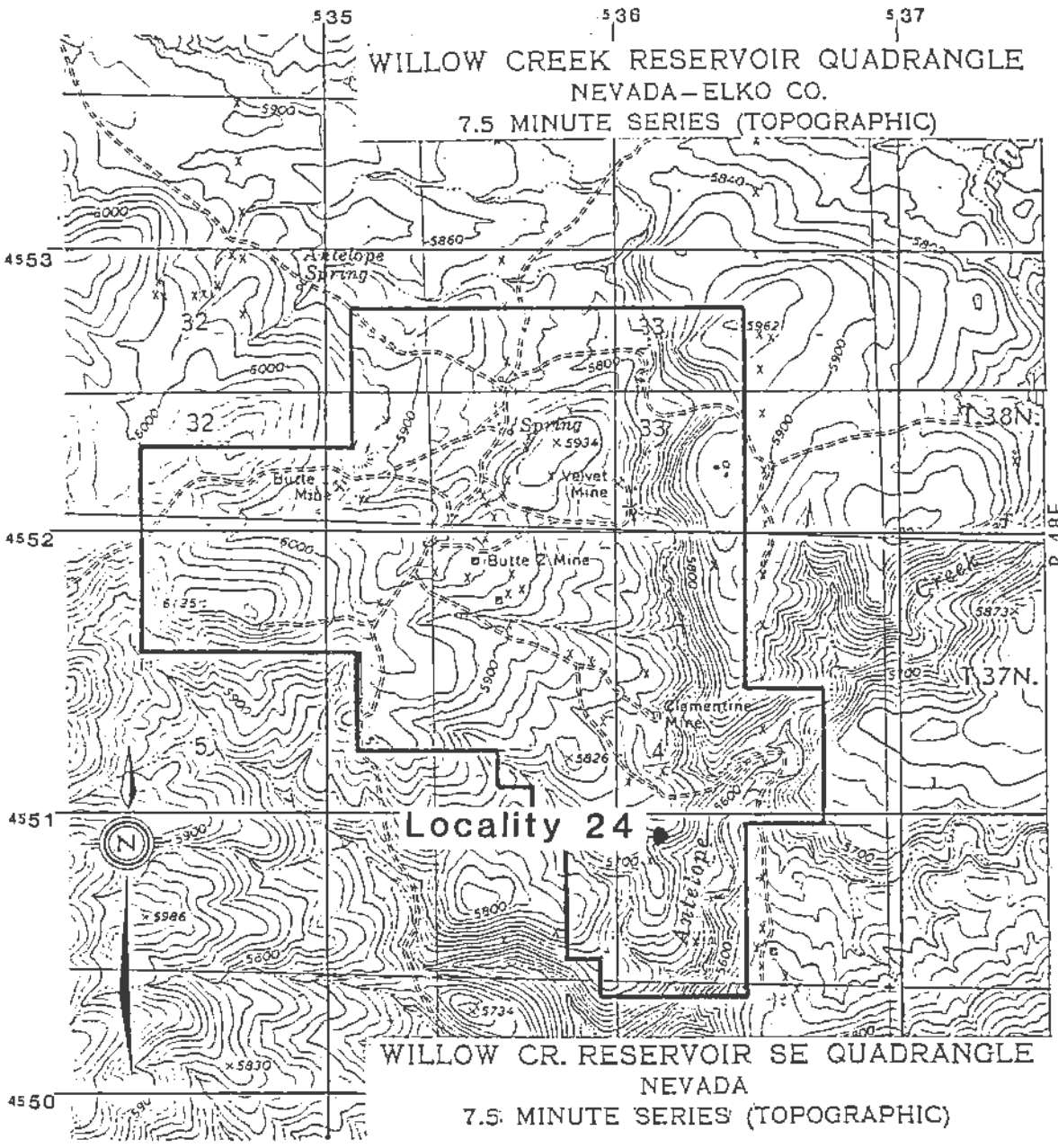
Topographic Data: Bedrock ledge outcrop at break in slope on south-facing ridge; strongly sloping (10%) to moderately steep (25%).

Quarry Data: Bedrock ledge outcrop is not knappable material, but good quality cobbles and boulders were quarried from the colluvium upslope and overlying the ledge.

Description: Quarry complex with two distinct pit complexes (features 66-20 and 67-16). Cobble and boulder-sized opalite was quarried from the colluvial slopes and talus; numerous pieces of unsilicified tuff form lag along edges of quarry pits. Most debitage in 67-16 seems to relate to core reduction; several rhyolite hammerstones. Other pits are dominated by biface thinning flakes and have few tools or cores. Small rockshelter is located in the base of the outcrop on the south and east edges of the pit complex; rockshelter is designated separately as Locality 164.

Site Condition: Historic trenching on the upper edge of the pit complexes, but prehistoric pit features seem generally intact.

Remarks: Represents good example of pit excavations into colluvium; contained area, considerable variability in pit size and associated artifacts.



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SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 25 Type: Reduction Station Complex/ Outcrop Assay

UTM: 536060E/4550840N

Size: 75m EW/ 30m NS Max. Area (m^2): 2,250

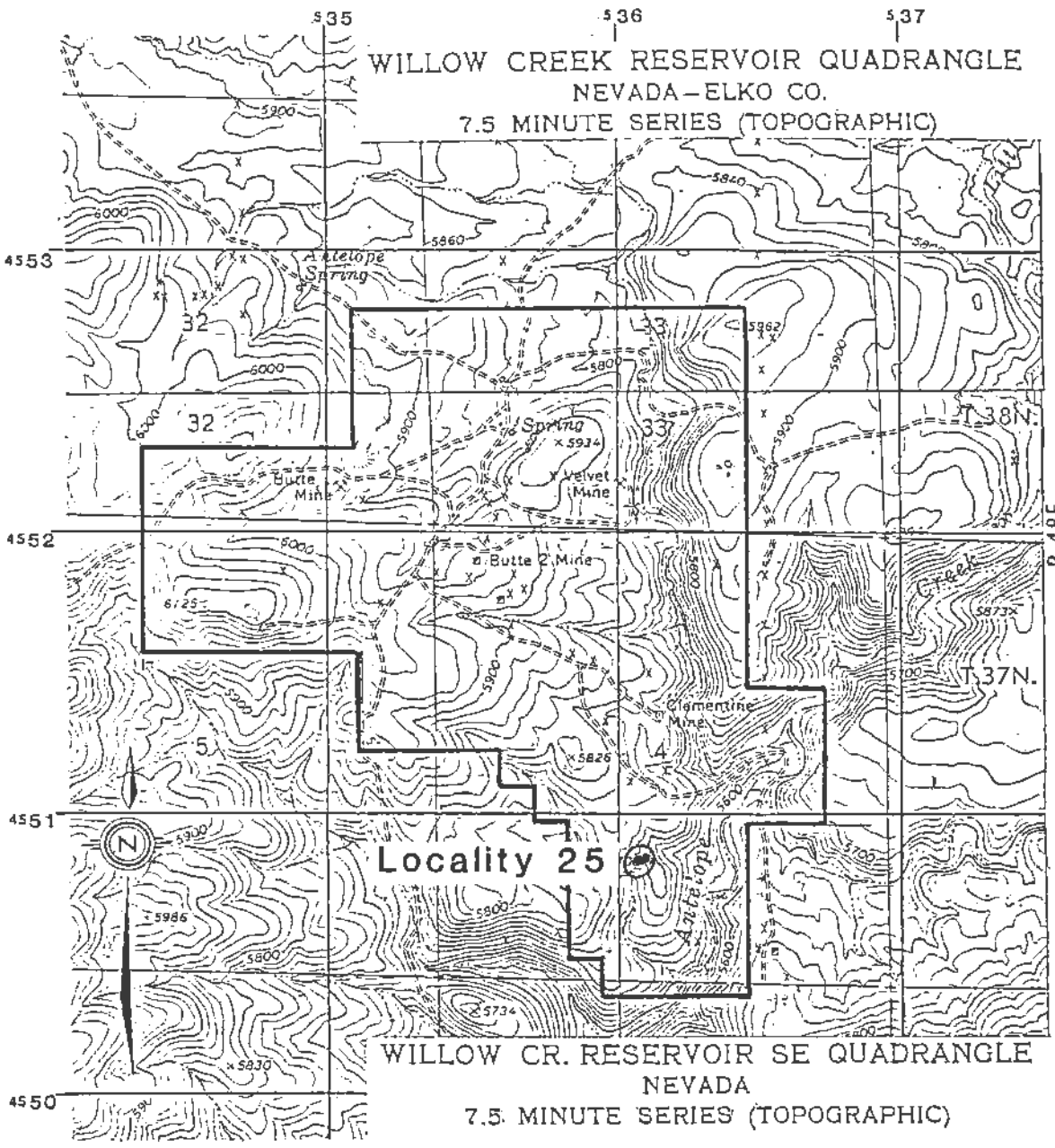
Topographic Data: Associated with low (1m high) bedrock ledge forming break in slope along western rim of southeast-trending ridge.

Quarry Data: Battered ledge of fractured, very poor quality opalite is doubtful source of toolstone.

Description: More than 30 small debitage clusters along a low bedrock ledge. Poor quality opalite in bedrock ledge (65-15) may have been quarried, or merely prospected, but discrete flaking stations (64-10) have artifacts from good quality source (likely from Locality 24).

Site Condition: Fair. Road through site center. Discrete stations essentially undisturbed.

Remarks: The battered ledge may not reflect prehistoric quarrying, but rather, assaying (prehistoric or recent). Locality needs closer field scrutiny.



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Big Meadows

Locality No.: 26 Type: Quarry Pit Complex/ Small Outcrop

UTM: 536460E/4551040N

Size: 15m x 10m Max. Area (m^2): 150

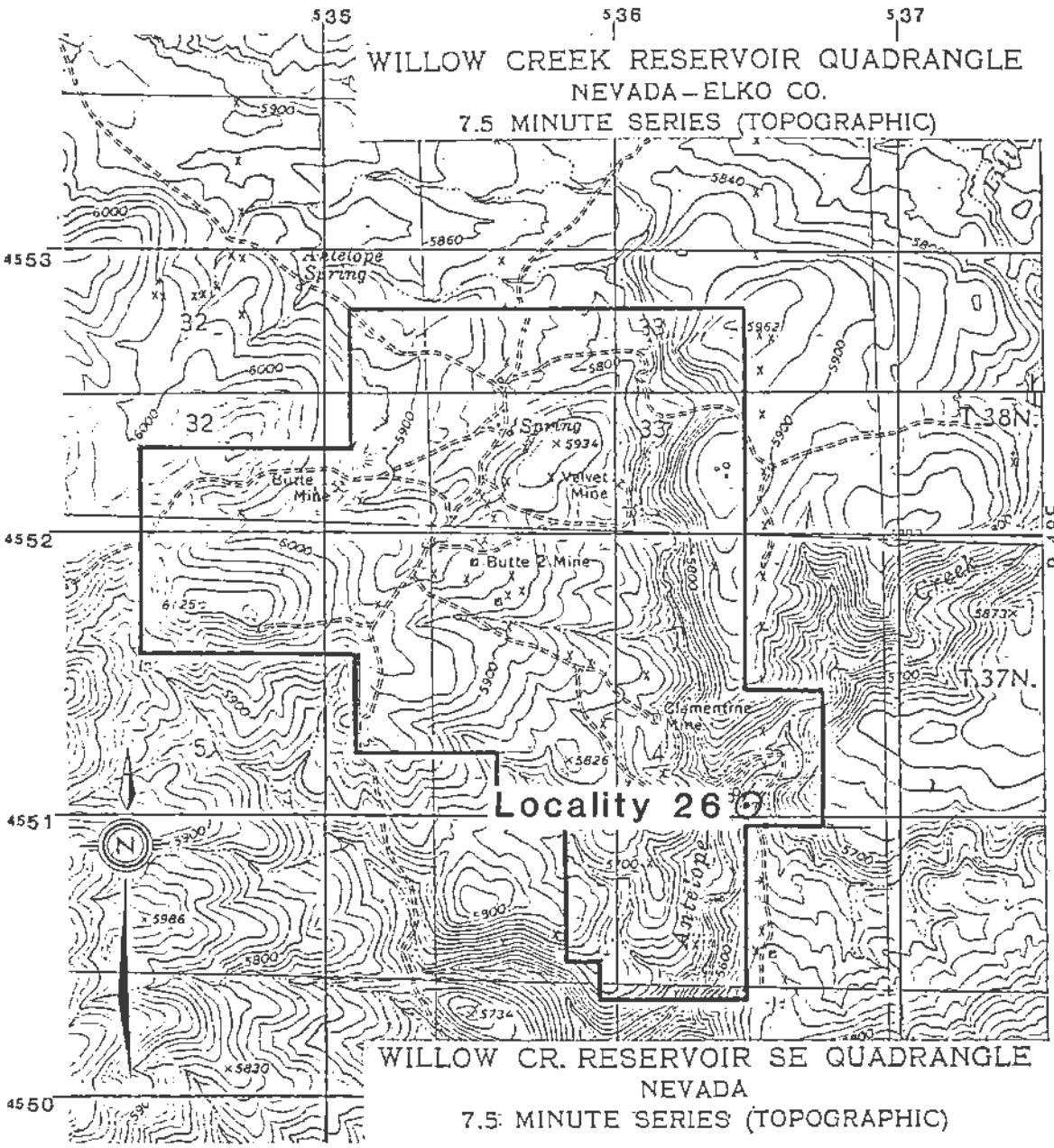
Topographic Data: Small outcrop exposure on east edge Little Antelope Canyon, adjacent meadow at Velvet/Little Antelope confluence; gently sloping (5%), north-facing.

Quarry Data: High quality on-site source, quite limited in extent.

Description: Three quarry pits in small opalite outcrop exposure (feature 77-2); dense flake scatter with notable accumulation of bifaces, biface thinning flakes, primary debitage, and hammerstones.

Site Condition: Essentially undisturbed.

Remarks: Interesting for its small size and proximity to habitation sites in meadow canyon confluence.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Big Meadows

Locality No.: 27 Type: Large Open Residential

UTM: 536500 E/4551100N

Size: 90m NS/75m EW Max. Area (m^2): 6,750

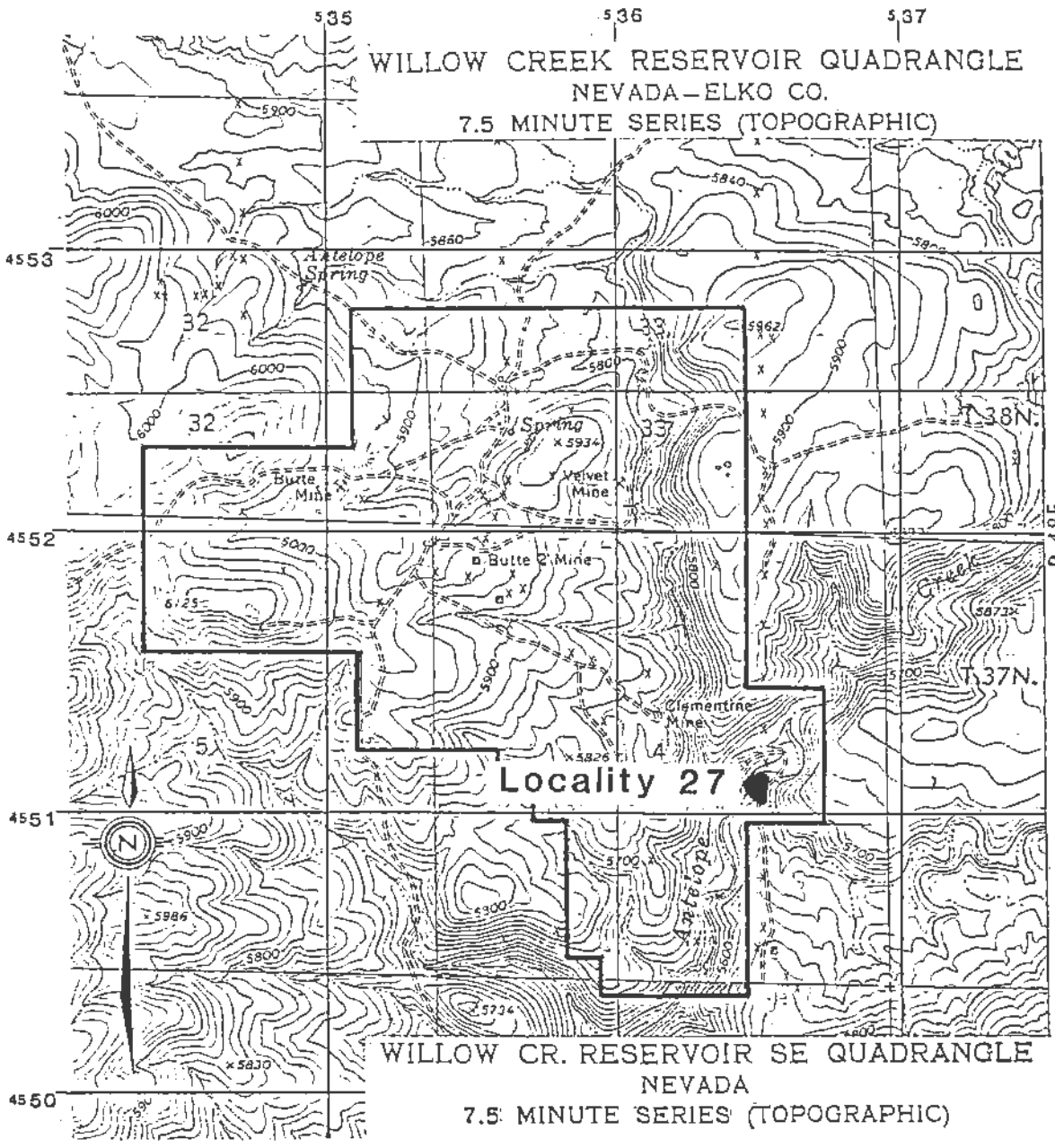
Topographic Data: Level grassy meadow at confluence Velvet and Little Antelope canyons. Numerous seeps (pools) in drainage noted in early summer (but most dried up by mid-July). One developed spring may be perennial flow.

Quarry Data: Cobbles available in stream bottom.

Description: Seems to be a series of (overlapping) small camps and numerous reduction stations; all with an overlay of historic habitation debris. Feature 78-1 is small depression with shaped mano in large area of light to moderate flake scatter. Flakes are of many colors and sizes. Features 79-1 and 79-2 are flake scatters with conspicuous bifaces and biface thinning flakes, several groundstone implements, and historic debris scatters.

Site Condition: Minimal disturbance by roads; probable historic camping throughout meadow; spring development; rodent and cow turbation. These uses are probably not significant impacts to site.

Remarks: May yield chronological and subsistence data; compare uses to Tosawihi and Hunting Blind springs. One of only a few sites with groundstone.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

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SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Big Meadows

Locality No.: 28 Type: Large Open Residential

UTM: 536600E/4551200N

Size: 180m NS/120m EW Max. Area (m^2): 21,600

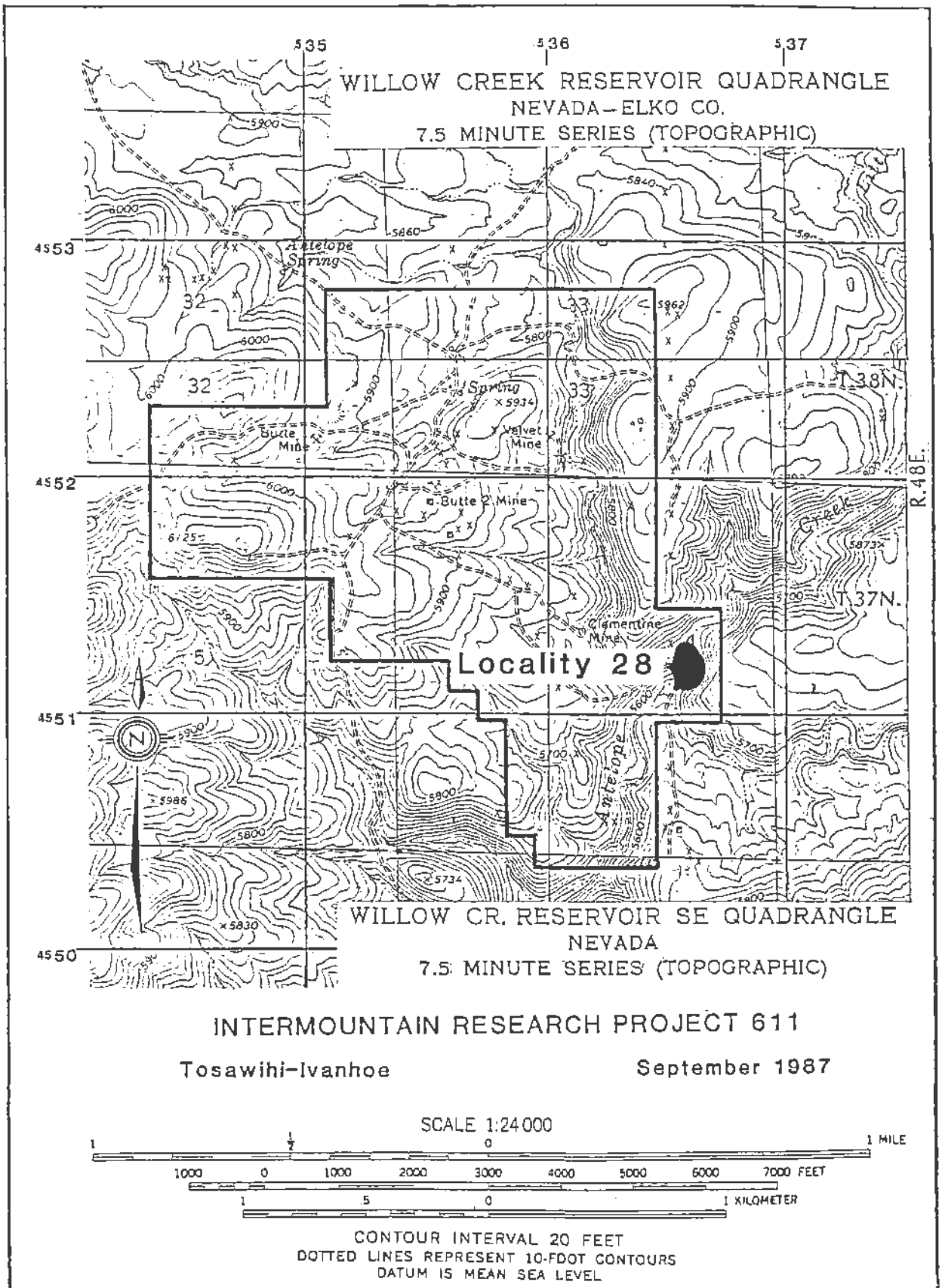
Topographic Data: Located on the lowest stream terrace on both sides of the creek at the north edge of Big Meadow, confluence of Velvet and Little Antelope canyons.

Quarry Data: No on-site opalite source; cobbles available in stream.

Description: Locality is a large, diverse lithic scatter with quantities of secondary reduction flakes from many different sources. A white chert projectile point base (Gatecliff Contracting Stem) was collected at Feature 81-1; material diversity here suggests residential use. Features 82-1 and 82-2 are concentrations of biface thinning flakes associated with deep soil pockets (Big Sagebrush mounds); both are located on the north side of the drainage and seem to be partially buried by colluvium from the adjacent steep slope.

Site Condition: Good.

Remarks: Compare residential localities 27, 151, and 19.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Badger Spur

Locality No.: 29 Type: Quarry Pit Complex/ Reduction Station

UTM: 536440E/4551180N

Size: 30m NS/75m EW Max. Area (m^2): 2,250

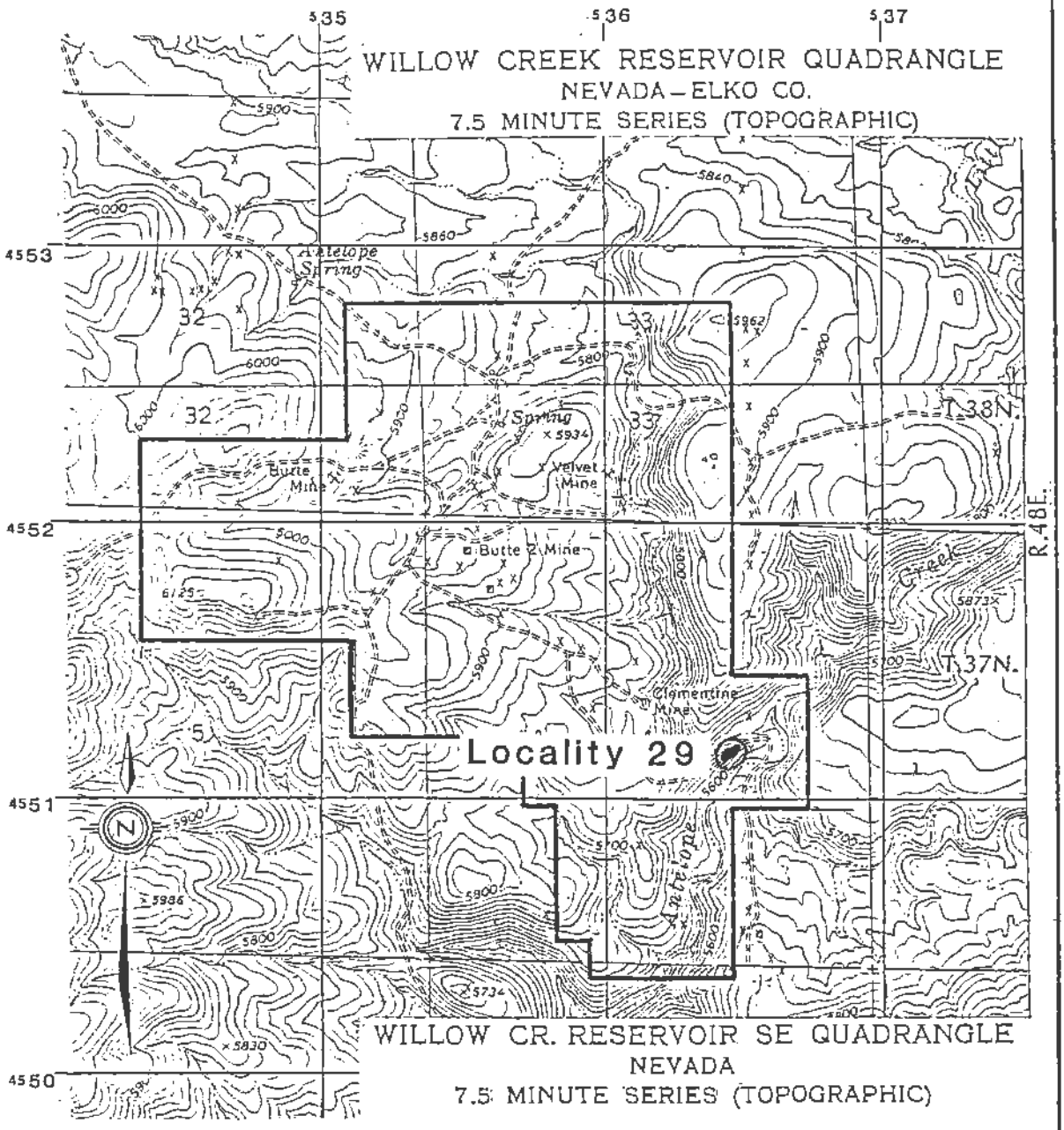
Topographic Data: On top of narrow, northeast-trending ridge at central confluence Velvet and Little Antelope canyons.

Quarry Data: High quality cream to light yellow opalite source; similar in quality and color to large ledge outcrop at nearby Locality 30.

Description: Small quarry pit complex (feature 77-3) and discrete biface thinning station (78-2) of same material. Very dense accumulation of primary debitage as well as biface thinning flakes, numerous bifaces, large and small shaped rhyolite hammerstones in 7 quarry pits.

Site Condition: North edge cut by road, but most of site is intact.

Remarks: Very interesting site complex. An example of intensive quarrying and secondary reduction of a high quality toolstone source, yet restricted to a small area (narrow ridge top) and consequently seems unmuddled by overlapping uses or massive slope accumulations. Note the variety of hammerstones (possibly shaped for different specialized uses), small size area (manageable research area), and discrete nature of quarry and biface reduction components (clarity).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 30 Type: Outcrop Quarry Complex

UTM: 536380E/4551240N

Size: 150m NS/ 75m EW Max. Area (m^2): 11,250

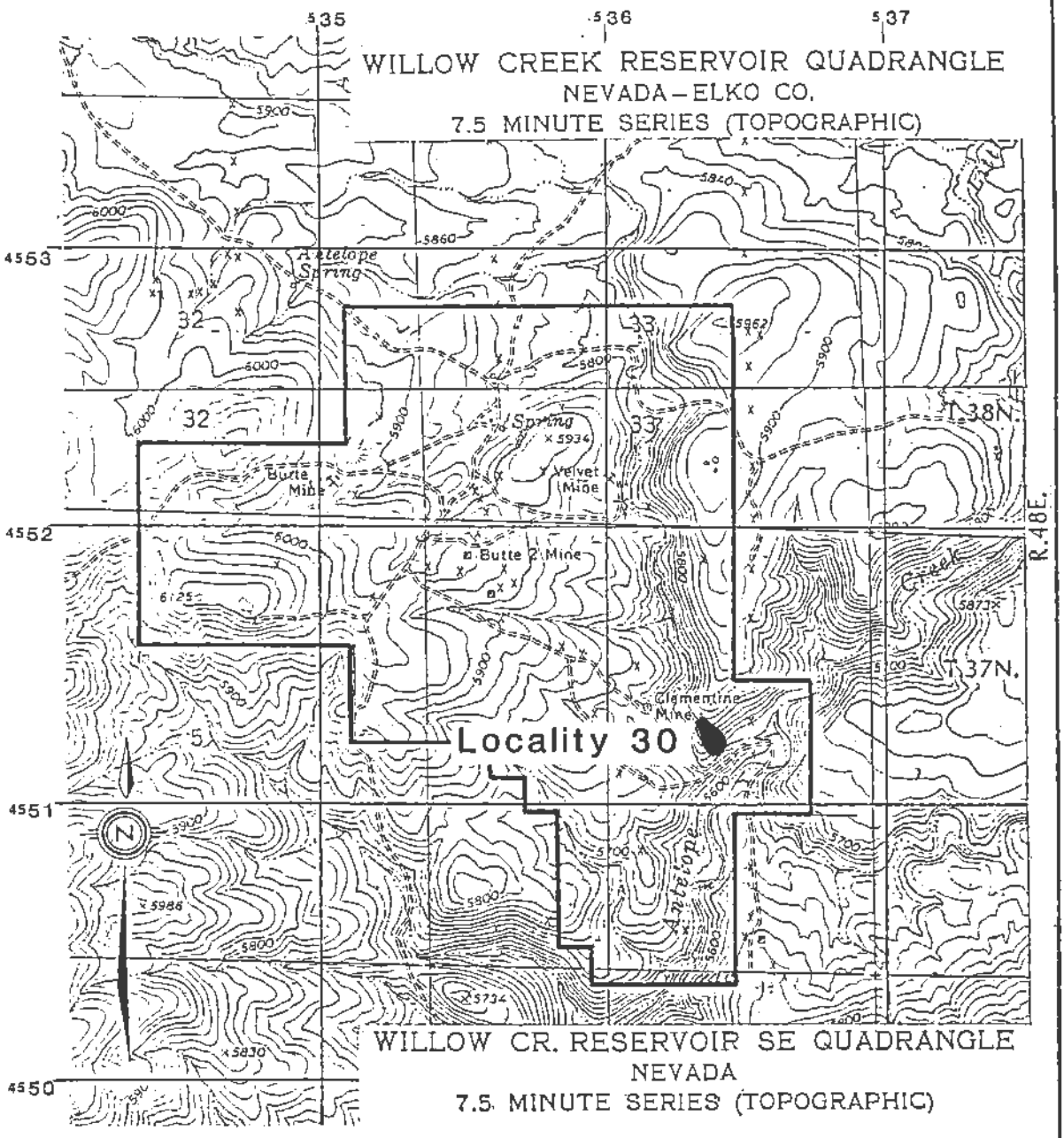
Topographic Data: Toe and south-facing slopes of narrow, moderately steep (20%) ridge at confluence Velvet and Little Antelope canyons.

Quarry Data: Very high quality opalite outcrop; forms series of terraced bedrock ledges near base of drainage; creamy light yellow. Higher on the ridge slope (above mapped locality), material is poor quality and largely unsilicified.

Description: Large, intensively quarried opalite outcrop (features 74-E5 and 73-K4). Reduction debris forms thick talus on slopes. Numerous small pits excavated into the base of the ledges; several adit-like horizontal explorations into rock. Good collection of rhyolite hammerstones. Wide range of core and early stage biface forms.

Site Condition: Excellent except for natural talus movement.

Remarks: Represents an amazing amount of activity overall, but not a good place to figure out discrete activities.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 31

Type: Quarry Pit Complex/ Cobble Field

UTM: 536260E/4551120N

Size: 75m NS/ 45m EW

Max. Area (m^2): 3,375

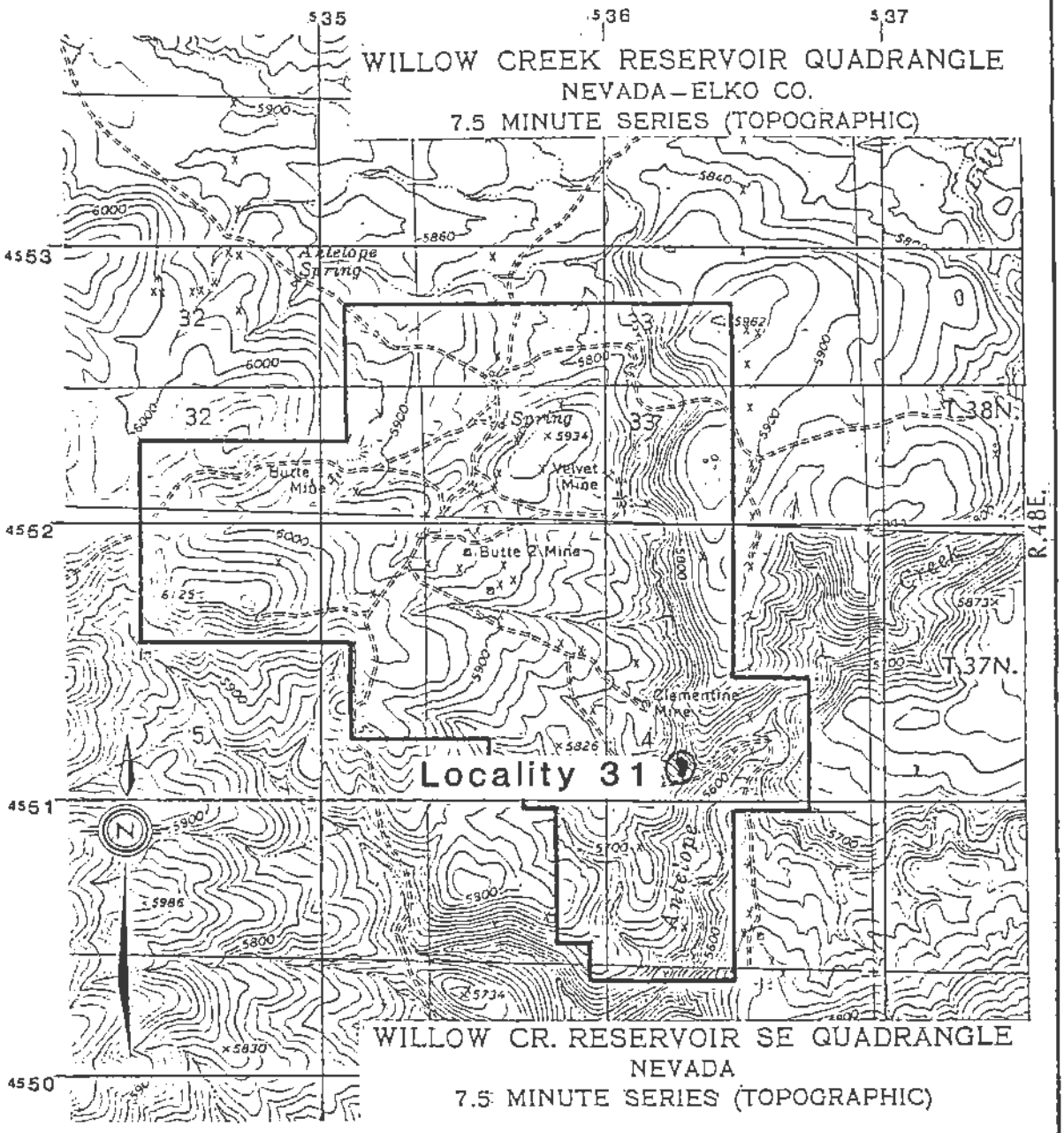
Topographic Data: On two small benches (breaks in slope) along moderately steep (15%) slopes of narrow, east-trending ridge.

Quarry Data: Seem to be two different opalite sources. Small, angular multi-colored cobbles occur on surface of upper bench, a possible alluvial fan remnant. Near break in slope just above lower bench, a narrow lens of white to bluish white opalite occurs near surface.

Description: On top upper bench and slope, multi-colored opalite cobbles in colluvium were used as encountered. At lower break in slope, a series of 4 pits (feature 71-9) were excavated into base of slope to extract opalite bedrock. Neither source is very high quality, evidence the large amount of angular shatter and relatively few controlled flakes.

Site Condition: Good.

Remarks: Deposits with small, angular multicolored cobbles resemble alluvial fans, but Touchstone geologists suggest that these deposits were created along faults. In any case, the site illustrates both use of small surface cobbles as well as excavation for larger toolstone. Only one other source of angular, multicolored toolstones is known in the district (see locality 10).



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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Clementine Ridge

Locality No.: 32 (Raven Shelter) Type: Rockshelter (Residential)

UTM: 536200E/4551180N

Size: 7m wide x 3m deep x 1.5 m high Max. Area (m^2): 70

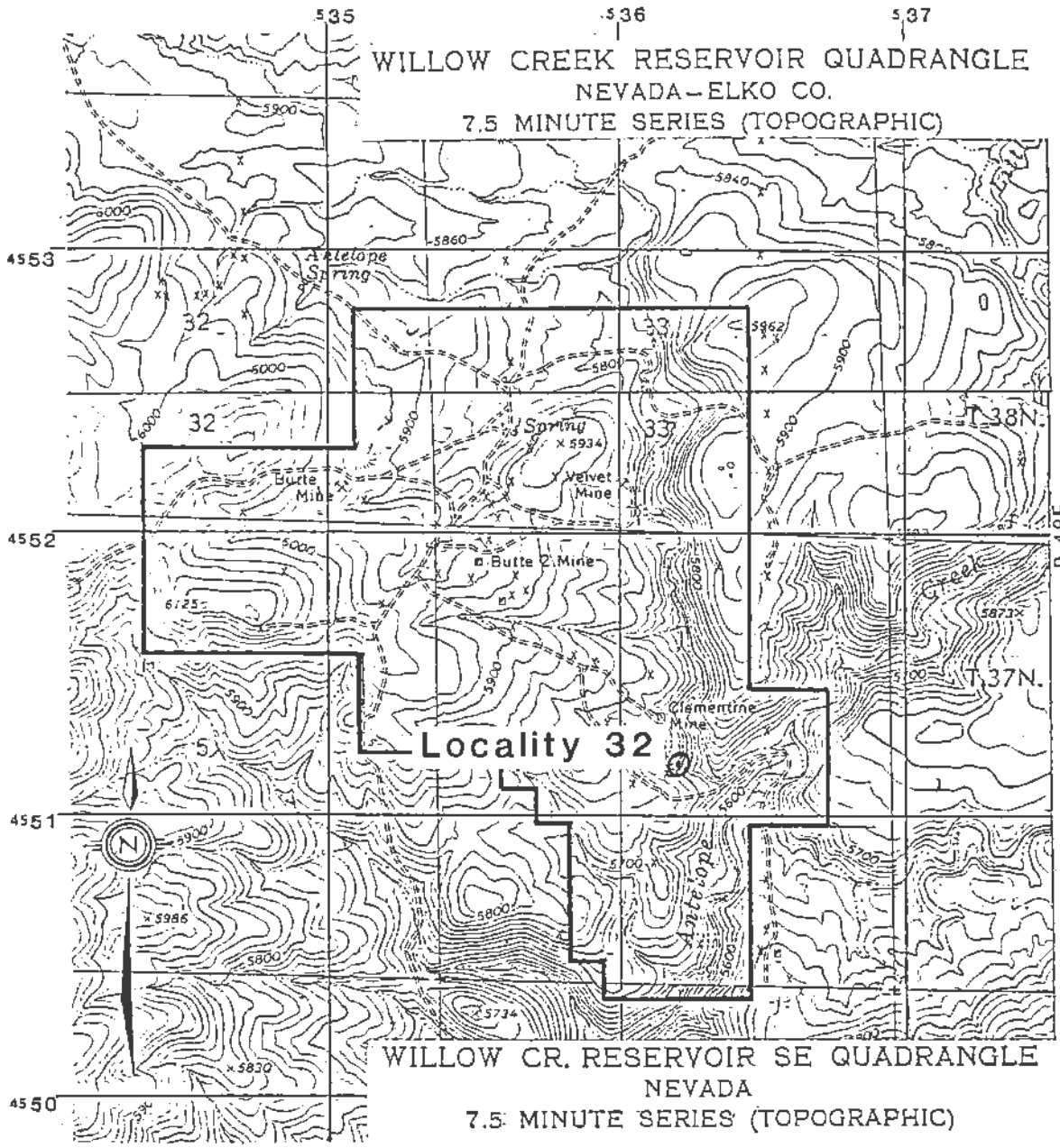
Topographic Data: Located in rimrock edging a small drainage tributary to Velvet Canyon, southeast-facing.

Quarry Data: No on-site source.

Description: Small rockshelter likely used as residential site; potential for subsurface dry deposits; diverse flake types and colors; bifaces abundant on apron slope.

Site Condition: Possibly vandalized; 3/8 inch shaker screen on slope below.

Remarks: Potentially significant; should be evaluated by testing.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 MILE

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1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Clementine Ridge

Locality No.: 33 Type: Reduction Station Complex

UTM: 536120E/4551260N

Size: 90m NS/30m EW Max. Area (m^2): 2,700

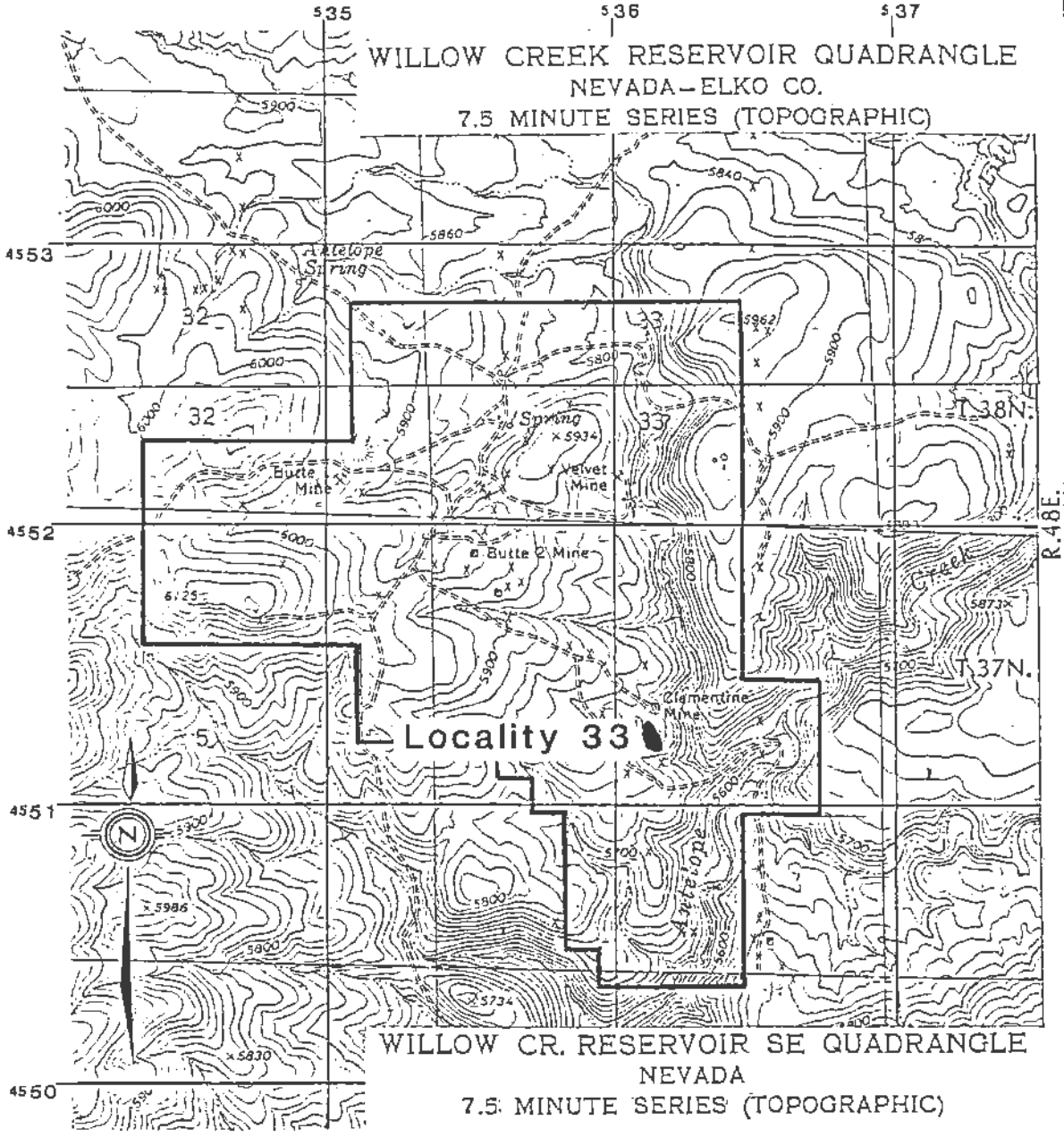
Topographic Data: Top and western slopes of a round bedrock outcrop and small saddle at north edge outcrop.

Quarry Data: Outcrop is nonsilicified and unsuitable for toolstone; some small use of cobbles quarried from colluvium is indicated on saddle at north edge of outcrop.

Description: Large, diffuse flake scatter on western edge and slopes of outcrop with numerous discrete flaking stations (feature 66-13). Biface thinning notable on west; chunky shatter notable on the north. Quarry pit at north end site (undesignated feature) was excavated into colluvium over bedrock (bedrock exposed in bottom pit).

Site Condition: Flaking stations along west edge site are undisturbed. On north, prehistoric quarrying is obscured by intensive historic disturbance from the Clementine Mine and its milling complex (see site H1).

Remarks: Site lacks clarity (in actual physical distribution of activity zones); needs further field assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

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1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 34 Type: Small Reduction Station

UTM: 536140E/4551120N

Size: 23m NS/15m EW Max. Area (m^2): 345

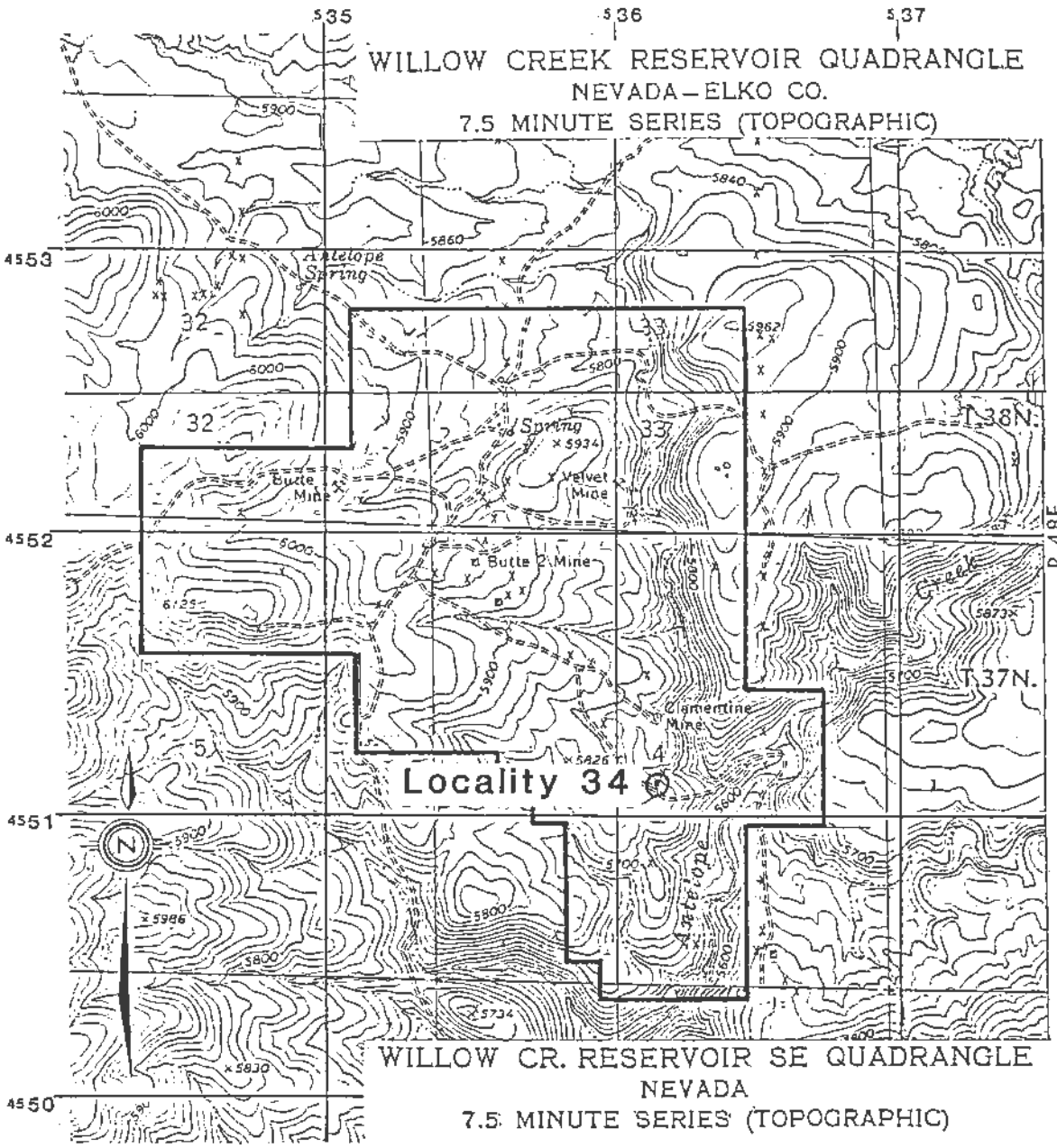
Topographic Data: Edge of flat bench on rimrock overlooking confluence of Velvet and Little Antelope canyons.

Quarry Data: No on-site source.

Description: Discrete flaking station (feature 67-14) on top of outcrop of poor quality opalite outcrop. A moderate density of white opalite debitage with a few flakes of pink and yellow; no bifaces associated.

Site Condition: Adjacent historic mining trench and road.

Remarks: Need to clarify historic and/or recent effects.



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September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 35 Type: Quarry Pit Complex

UTM: 536040E/4551060N

Size: 90m NS/30m EW Max. Area (m^2): 2,700

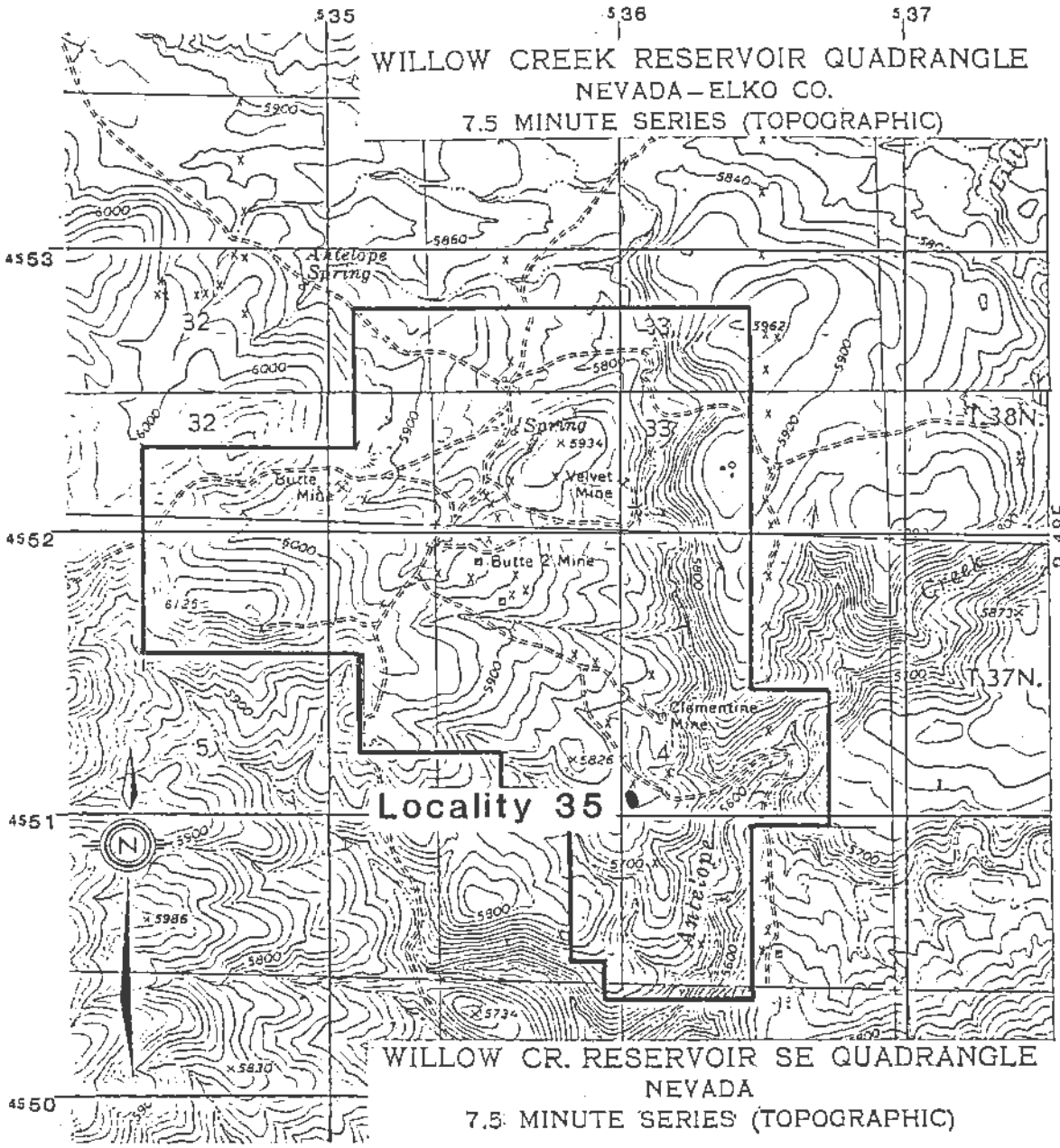
Topographic Data: Located on top and moderately sloping (9%), southeast-facing edges of wide colluvial bench. Bedrock outcrops as low ledge at bench rim.

Quarry Data: Silicified opalite cobbles in colluvium intensively quarried; bedrock outcrop is not suitable for toolstone.

Description: Quarry pit complex (features 64-8, 64-9) and battered (weathered) bedrock ledge (65-14). Pits were excavated into colluvium at bench rim. Very dense flake accumulations surrounding pit complexes. Similar to nearby Locality 36, but not such high quality raw material. Rhyolite hammerstones, conspicuous primary reduction, small cores.

Site Condition: No conspicuous disturbance noted.

Remarks: Typical of intensive quarry pit complexes where knappable cobble-sized opalite is available under shallow colluvial cap. Not as remarkable as many other similar localities because toolstone quality is only so-so to good (compare Localities 36, 48, and 188).



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September 1987

SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 36 Type: Large Quarry Pit Complex/ Reduction Station Complex

UTM: 535940E/4550940N

Size: 180m NS/ 120m EW Max. Area (m^2): 21,600

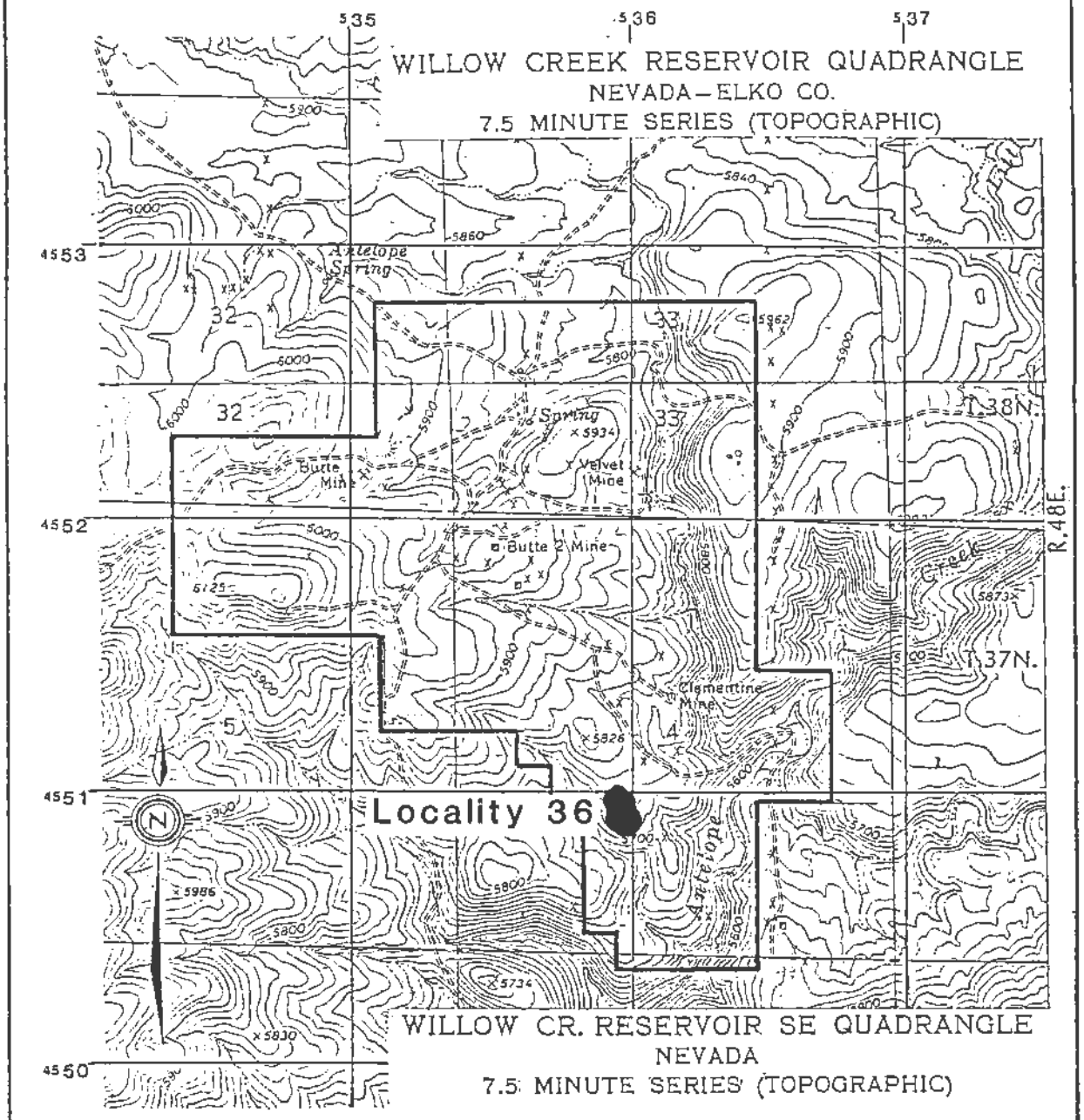
Topographic Data: Located on the top and along moderately sloping (9%) western edges of a southeast-trending ridge.

Quarry Data: Colluvial mantle covers ridge; opalite cobbles were quarried from colluvium and pits were dug into opalite talus. Good quality toolstone.

Description: Large quarry pit complex (more than 55 pits total) with series of small, shallow coalescing pits as well as quite large, deep excavations (see features 60-3, 60-4, 60-5, 61-4). Also includes two discrete (nearby) flaking stations (features 61-3, 62-7).

Site Condition: Road through center of site; some historic excavation. In general, little disturbed.

Remarks: A good example of its kind, that is, pits excavated into cobble talus and colluvium.



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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 37 Type: Small Reduction Station

UTM: 535960E/4551120N

Size: 2m N/4m EW Max. Area (m^2): 10

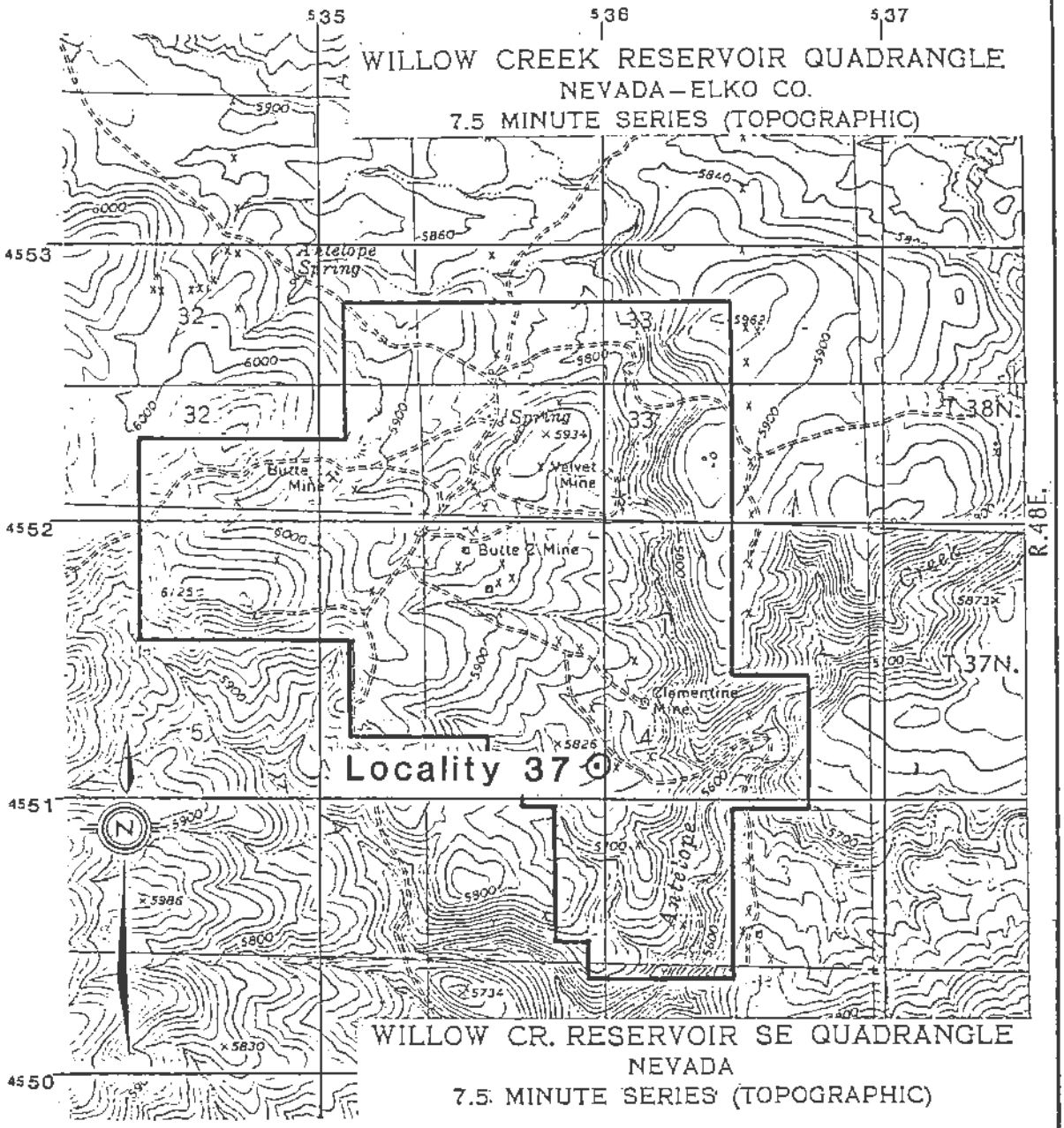
Topographic Data: Edge of a small flat on ridge, south-facing.

Quarry Data: No on-site opalite source.

Description: Discrete reduction station with core fragments, shatter, and ca. 500 biface thinning flakes (feature 62-6).

Site Condition: Excellent.

Remarks: Discrete, contained, likely limited use, may have reduced 4-5 bifaces.



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1 KILOMETER

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DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Pink Pits

Locality No.: 38 (the Pink Pits) Type: Isolated Quarry Pit

UTM: 536020E/4551260N

Size: 3m x 3m (50cm deep) Max. Area (m^2): 15

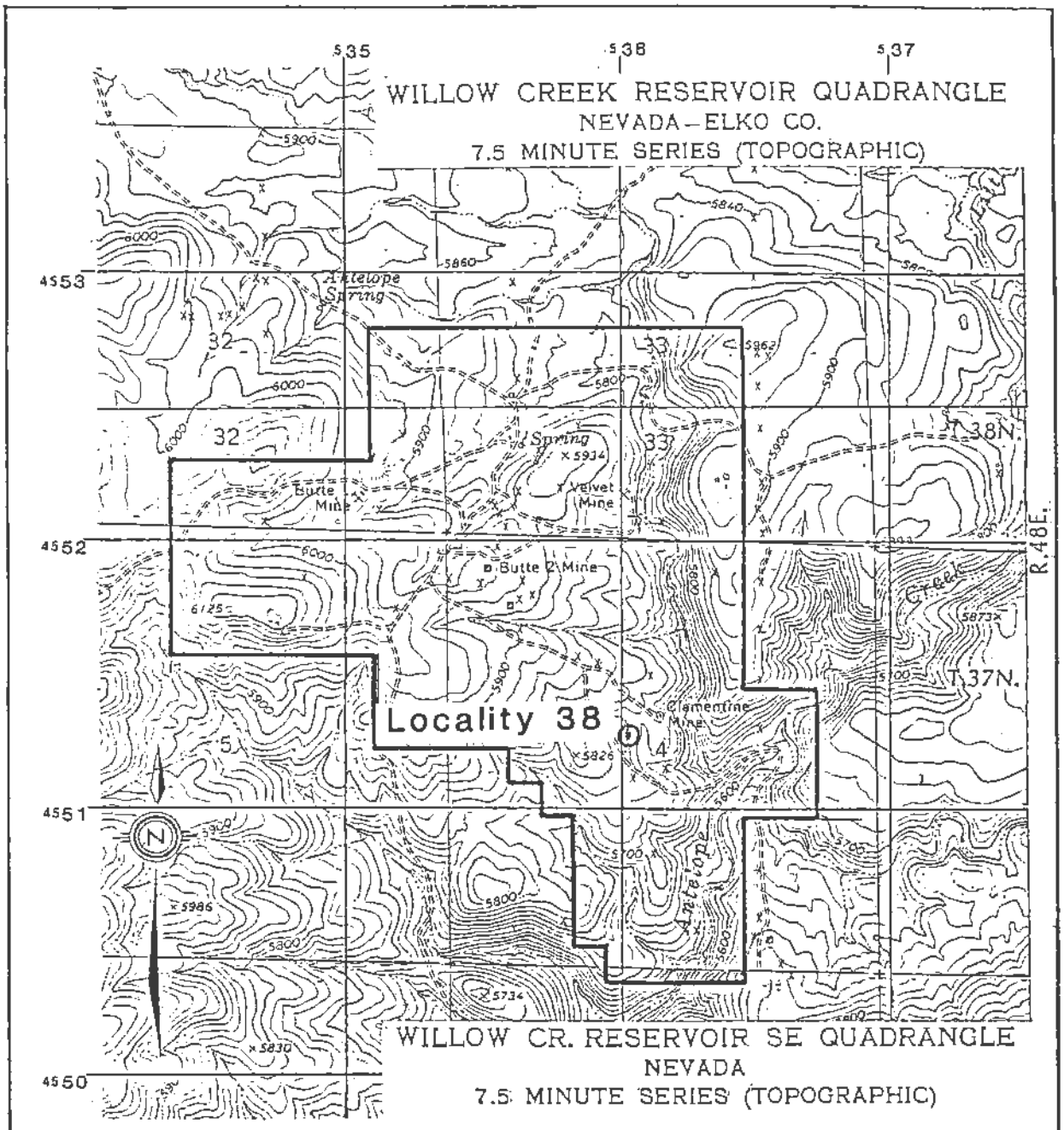
Topographic Data: Small flat on gently sloping, southeast-trending ridge.

Quarry Data: Cobbles in colluvium; salmon colored.

Description: Isolated quarry pit (Feature 63-5) into colluvium; moderate density flake scatter with a few bifaces and many large biface thinning flakes. Purple debitage and a possible metate fragment were also observed here.

Site Condition: Excellent.

Remarks: Feature is an interesting research locality due to distinctive salmon-colored opalite; sharp feature boundaries; contained in space. (See similar salmon pink opalite at nearby localities 39 and 48).



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SCALE 1:24000

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1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Pink Pits

Locality No.: 39 Type: Quarry Pit Complex

UTM: 535940E/4551180N

Size: 200m / 120m Max. Area (m^2): 24,000

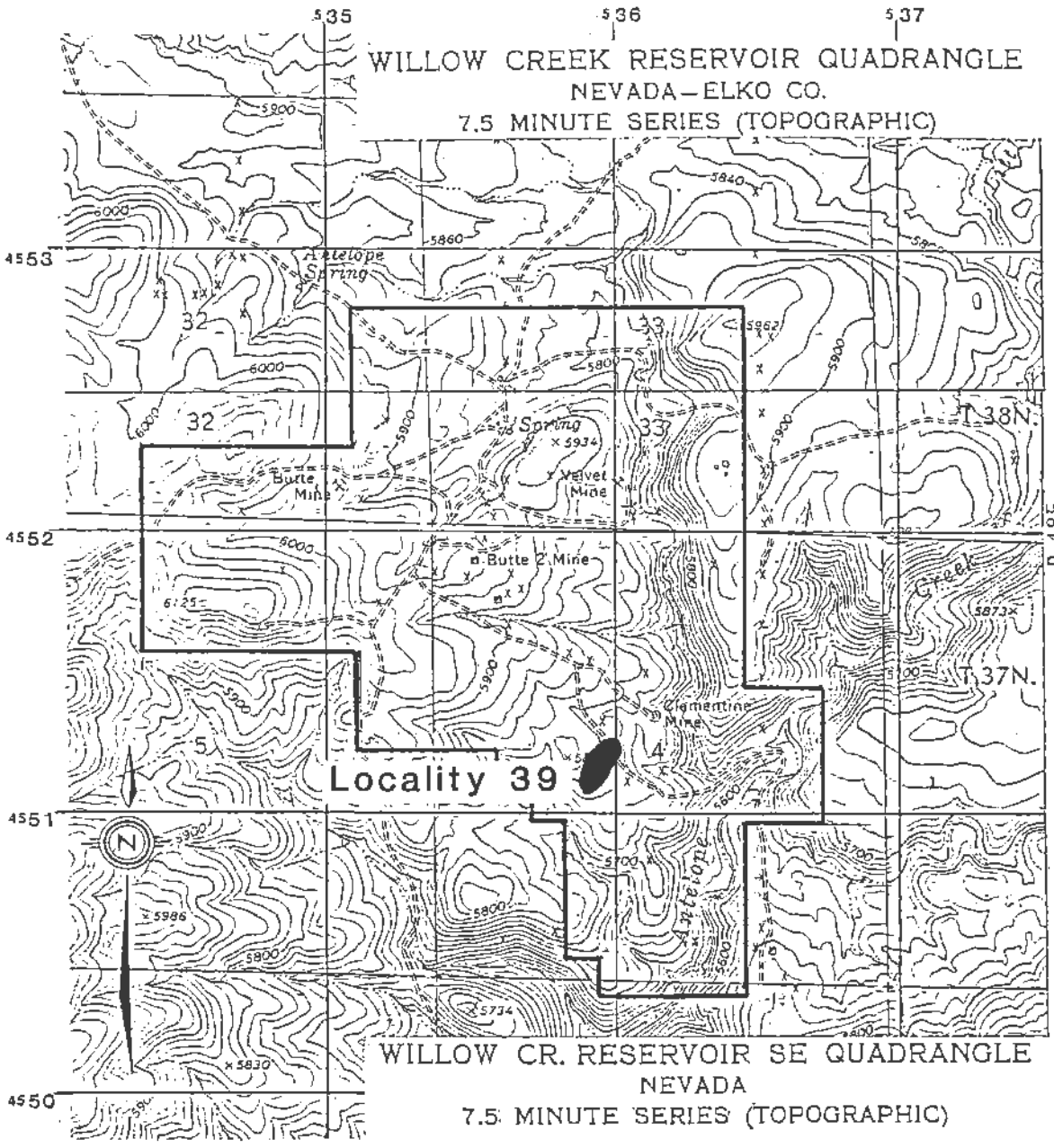
Topographic Data: Top and gentle slopes (5%) of southeast-trending ridge.

Quarry Data: Thin mantle of colluvium covers bedrock on top and western slopes; bedrock exposed at surface on eastern slopes. Pink to buff colored opalite similar to (but lighter in color) localities 38 and 48. Good quality material.

Description: A series of shallow pits were excavated through thin colluvium to expose good quality opalite near the top of the flat (feature 59-12); an isolated pit (feature 59-11) was excavated along the contact between exposed bedrock and colluvium. Poor quality boulders and cobbles where bedrock exposed (see feature 58-9), but light to moderate density cultural scatter over entire site area.

Site Condition: Some minor historic disturbance (adjacent road).

Remarks: Similar in color to pink opalite at localities 38 (The Pink Pit) and 48. Differences in toolstone quality at these localities may be reflected in amount of energy (cubic meters of earth removed as reflected in size and depth of pits) expended in excavating raw material. (Note small shallow pits at 39 versus large deep pits at 48).



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1 KILOMETER

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DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: North Boundary Ravine

Locality No.: 40 (Boundary Shelter) Type: Rockshelter (Residential ?)/ Quarry Pit

UTM: 535820E/4551160N

Size: 40m NS/45m EW Max. Area (m^2): 1,800

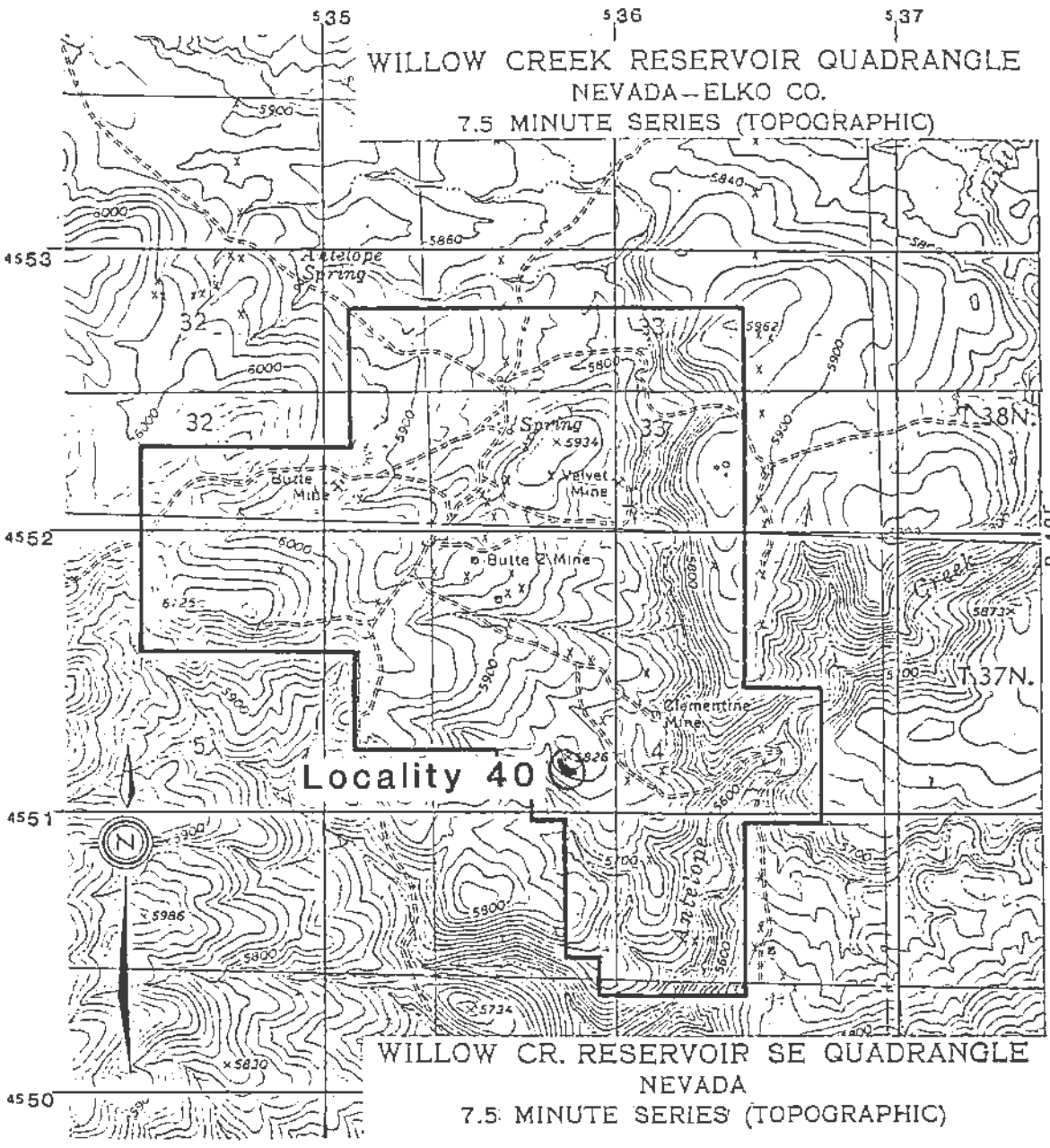
Topographic Data: Small two meter high bedrock outcrop overlooking confluence of two ephemeral drainages; facing southwest.

Quarry Data: Banded white and grey chert quarried from colluvium at base outcrop.

Description: Bedrock outcrop with many small shelters and alcoves. Soil around outcrops is grey in color. One shelter is filled with soil and flakes; extends under rock 3 or 4 meters. May be a residential locality (feature 56-3). Numerous small scatters on top and around base of outcrop (see also Locality 41). Rosegate projectile point collected.

Site Condition: Undisturbed.

Remarks: Deeply filled shelter should be explored by excavation. Flaking stations may be related to nearby quarry pit complex (Locality 42).



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1 MILE

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1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: North Boundary Ravine

Locality No.: 41 Type: Isolated Quarry Pit/ Reduction Station

UTM: 535800E/4551180N

Size: 60m NS/ 30mEW Max. Area (m^2): 1,800

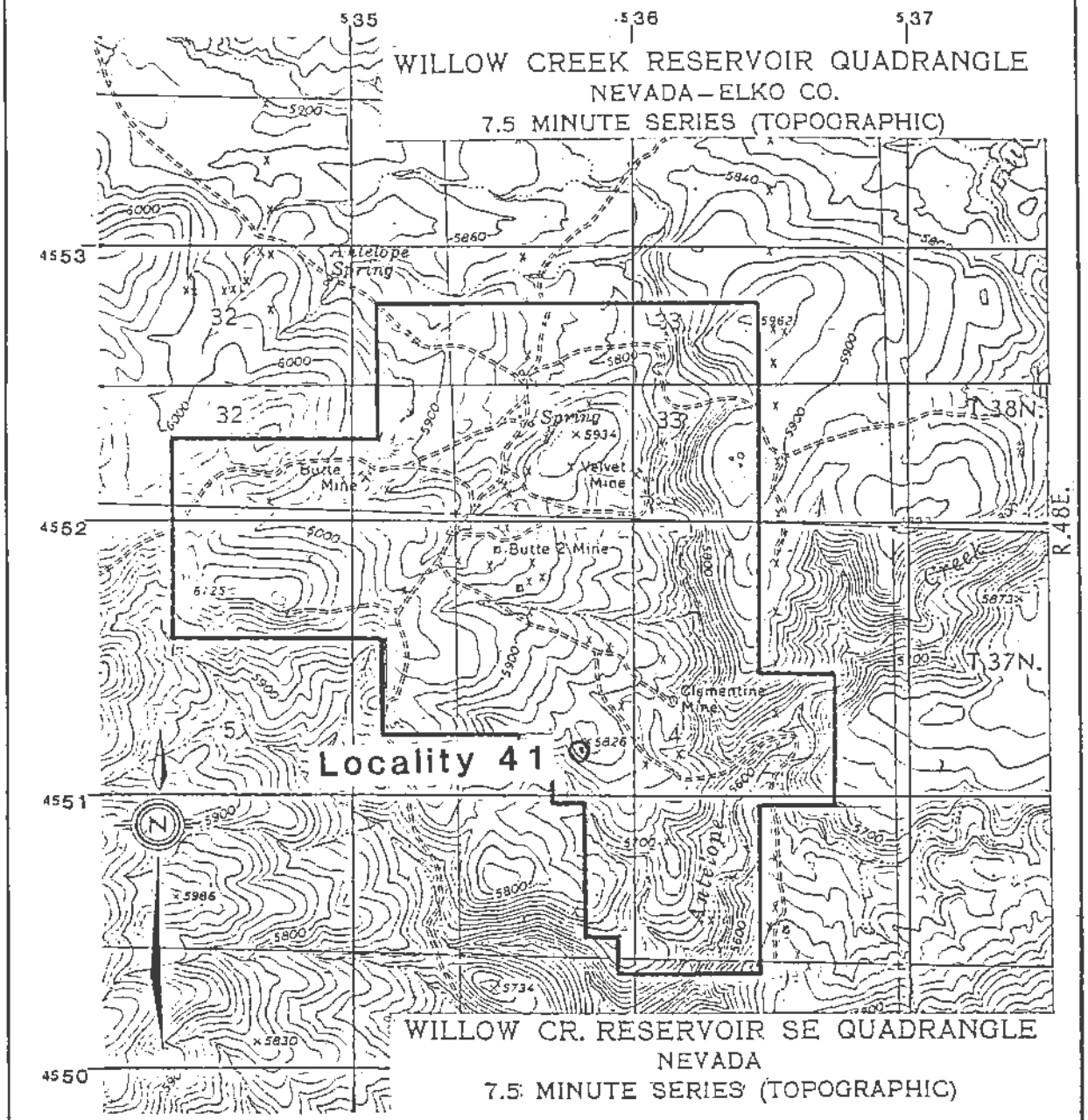
Topographic Data: Base of 2 meter high bedrock outcrop overlooking an ephemeral drainage; facing west.

Quarry Data: Apparently poor quality chert boulders excavated from colluvium at base bedrock outcrop.

Description: Isolated quarry pit and diffuse flake scatter on top and base of bedrock outcrop (no features designated).

Site Condition: Undisturbed.

Remarks: Establish relationship to site 101 (feature 57-5), a similar nearby isolated pit. Locality 41 is part of the same outcrop formation as Locality 40.



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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: North Boundary Ravine

Locality No.: 42 Type: Quarry Pit Complex

UTM: 535720E/4551220N

Size: 35m NS/ 60mEW Max. Area (m^2): 2,100

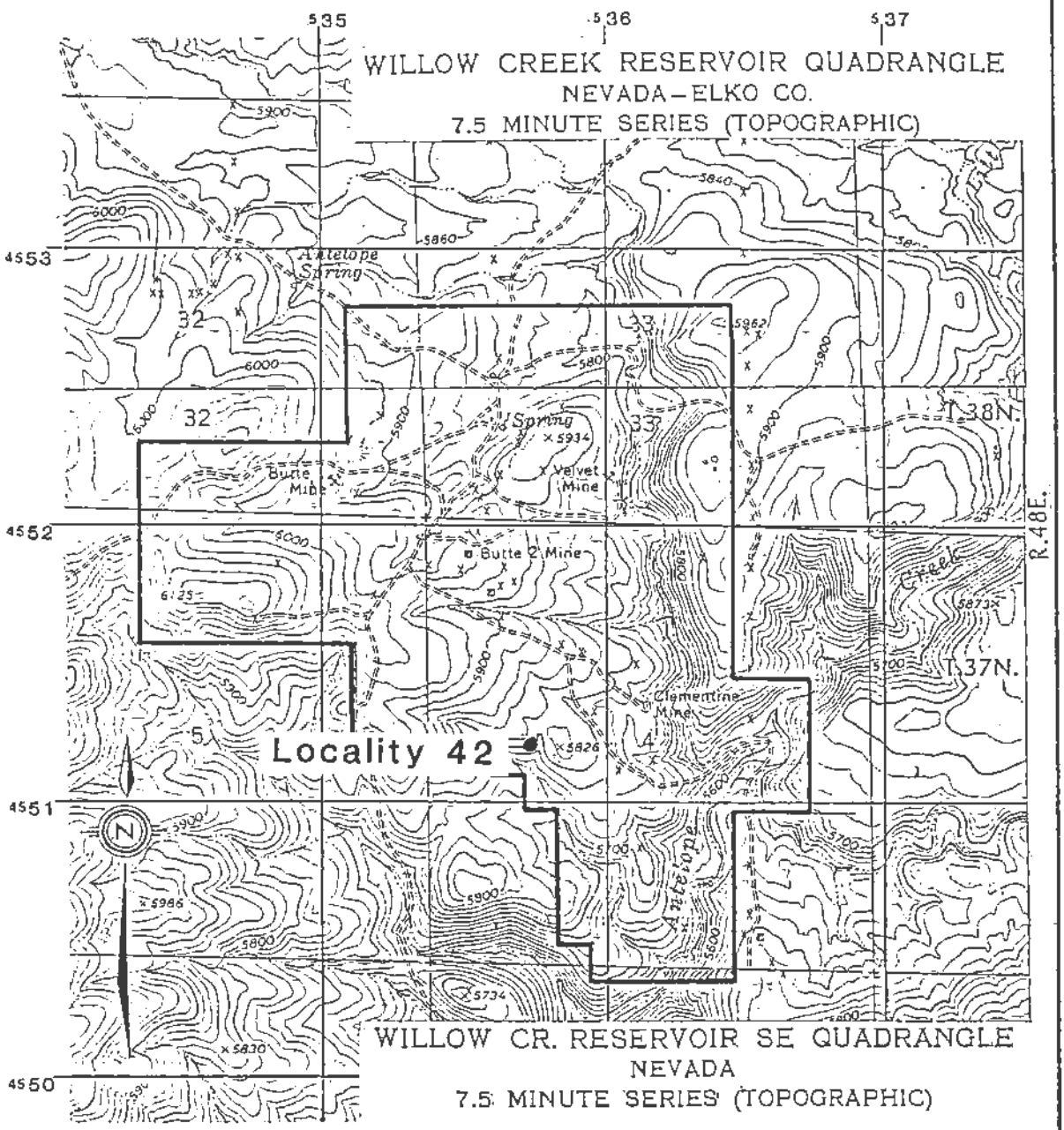
Topographic Data: Bedrock outcrop near base of ephemeral drainage; facing southeast.

Quarry Data: High quality banded opaque grey/white chert quarried from colluvium at base outcrop; exposed bedrock is poor quality.

Description: Intensive quarry comprised of four pits into colluvium below a bedrock outcrop (features 54-14 and 54-15), one of which is very deep. Slope beneath outcrop has been extensively modified. Basalt hammerstones and flakes are numerous. Cobbles fill the downslope pits and cobble patches fill the intervening space.

Site Condition: Pristine.

Remarks: Very interesting locality with high research potential. It is relatively small and spatially discrete; a good example of reduction associated with a bedrock ledge; numerous basalt hammerstones; a major candidate for testing. (see also possible relationships to nearby shelter and flaking stations at Locality 40).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 43 Type: Large Quarry Pit Complex

UTM: 535580 E / 4551260 N

Size: 60m NS/ 120m EW Max. Area (m^2): 7,200

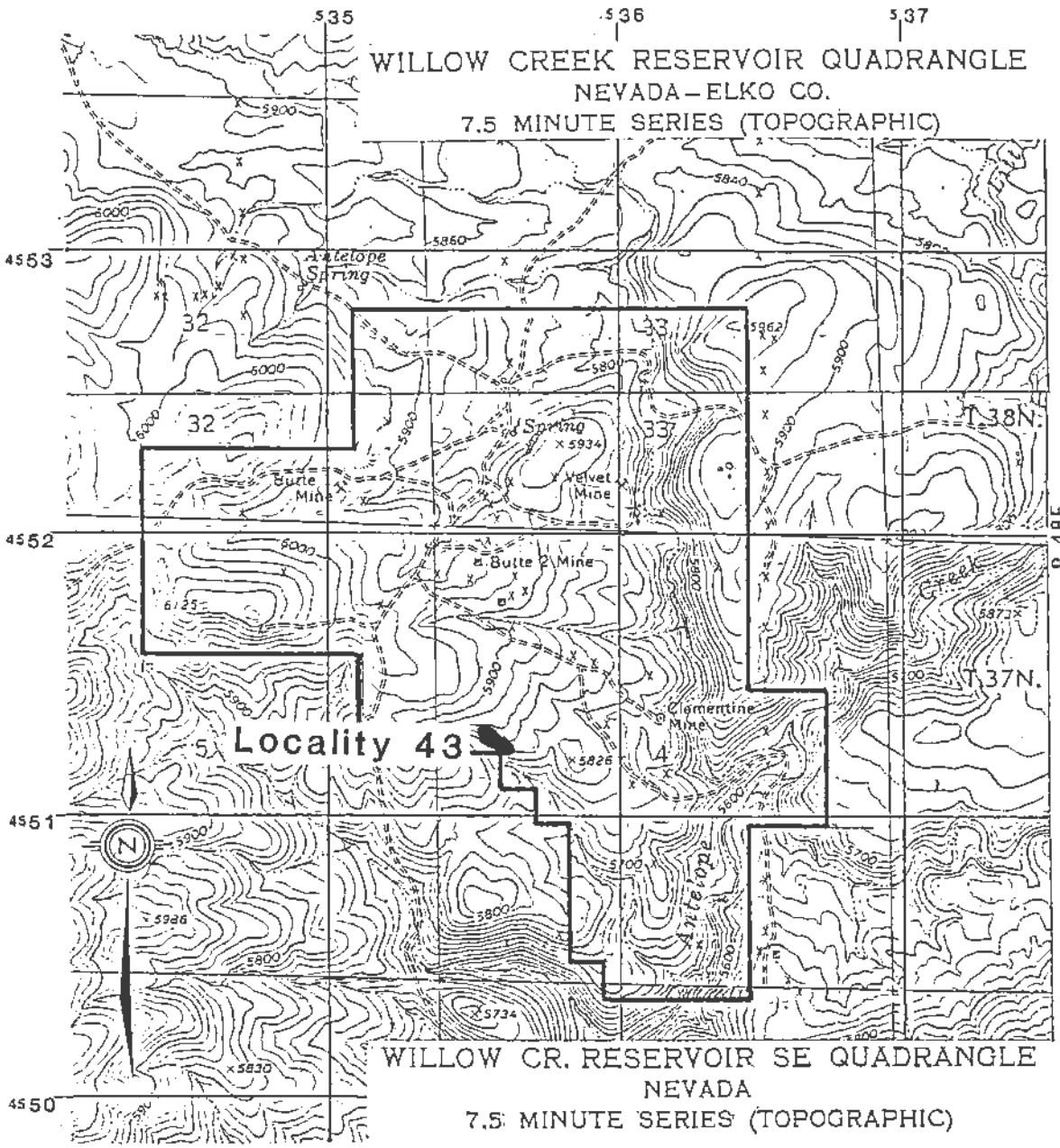
Topographic Data: Located on narrow bench on strongly sloping (20%) colluvial slope overlooking ephemeral drainage; facing south.

Quarry Data: Bedrock forms a narrow bench and break in slope under a thin layer of colluvium; cobbles extracted from numerous pits excavated into the colluvium. Medium quality white to grey toolstone (opaque to slightly translucent); lots of vugs and chalky inclusions. (Narrow ledge of bedrock exposed at east and west perimeters site at ground surface, but this poor quality material was not quarried for toolstone).

Description: Large, complex site with two distinct pit complexes (features 48-5 and 49-5) (composed of more than 20 separate pits). Basalt cobbles, flakes and spalls are common across the site. Locality may reflect prehistoric quarry selection criteria, i.e., a minimal bedrock exposure along break in slope signals zone where good quality toolstone cobbles are buried under thin layer of colluvium.

Site Condition: Old road along south edge site, but features essentially undisturbed.

Remarks: Spatially related to localities 42, 41, and 40; all located along southfacing colluvial slope; all apparently focused on same geologic formation (thinly mantled bedrock); all are undisturbed by historic or recent exploration features.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 44 Type: Large Quarry Pit Complex

UTM: 535460E/4551480N

Size: 300m NS/ 150m EW Max. Area (m^2): 45,000

Topographic Data: On top ridge and along south- and east-facing slopes (5% to 10%).

Quarry Data: Cobbles in colluvium; surface boulders and cobble talus. Variable quality; white to tan.

Description: A large, complex quarry locality evidencing several different toolstone extraction strategies. On top of the ridge, opalite cobbles form thick talus "stripes"; numerous prehistoric pits were excavated into the talus (features 45-5, 44-2, 44-3, 43-2). High density accumulation of reduction debris is associated with talus pit features. On the east, bedrock is thinly mantled by colluvium and the slope is covered by poor quality boulders and cobbles; several shallow pits (features 46-7, 46-6A) were excavated here and are surrounded by a moderate to light density flake scatter. Subsequently, several historic trenches were excavated along the edges of the talus, and into the cobble field, exposing thinly mantled bedrock on the east and thick colluvial mantle on west. In one historic trench on the west, sidewalls indicate at least 2 meters of colluvium comprised of debitage, tuff chunks, and soil.

Site Condition: Extensive historic trenching.

Remarks: Good place to investigate several research problems relating to toolstone quality and associated procurement methods in colluvium, talus, and exposed bedrock. Historic trenches provide vertical exposures for understanding geomorphic processes.

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Red Hill Ridge

Locality No.: 45 Type: Quarry Pit Complex

UTM: 535320 E/4551260 N

Size: 45m NS/60m EW Max. Area (m^2): 2,700

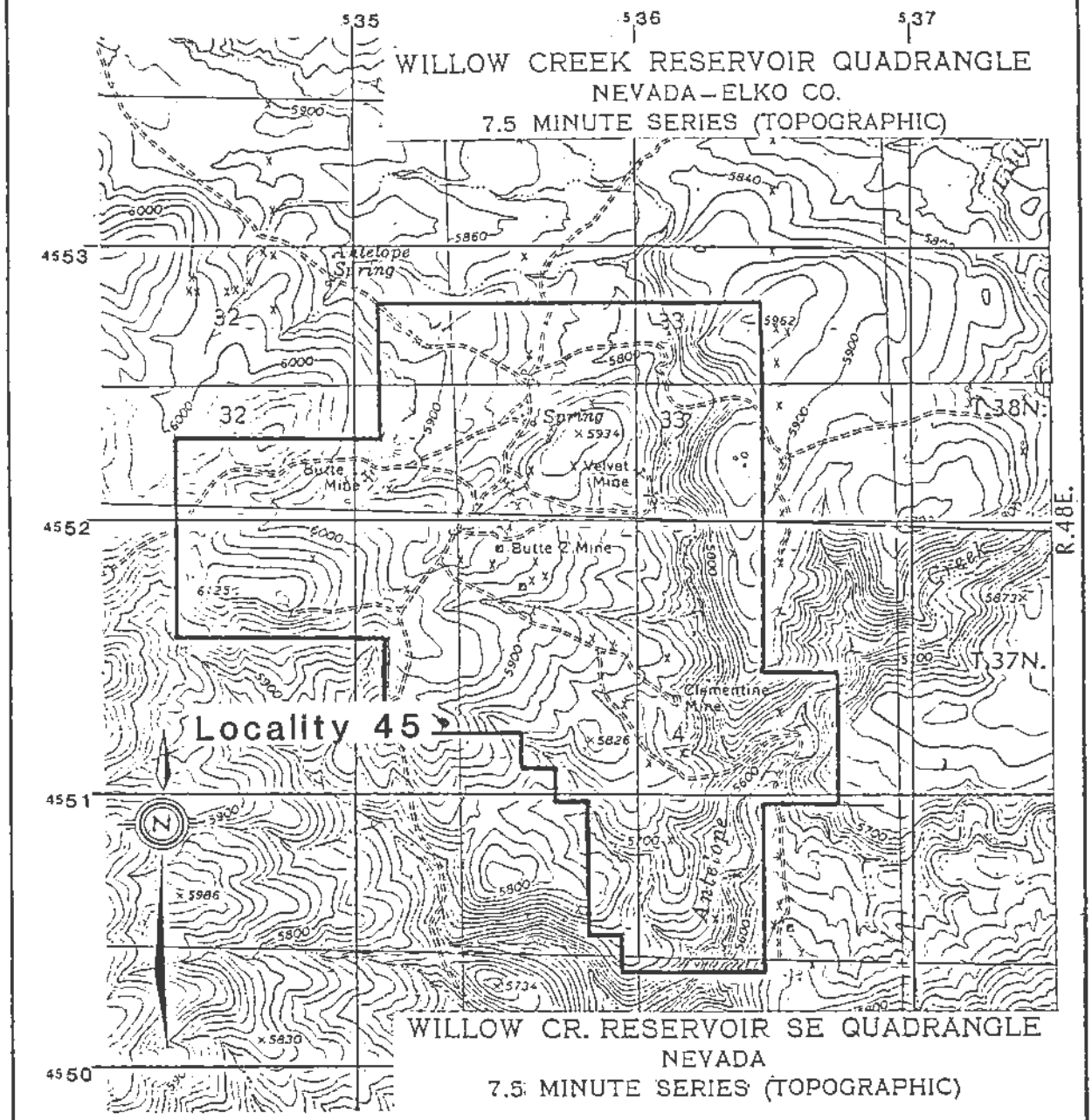
Topographic Data: Flat bench at edge of knoll, east-facing.

Quarry Data: Toolstone quarried from shallow pits into colluvium; poor quality boulders outcrop on surface.

Description: Two small (2m diameter), shallow (20 cm deep) pits in vicinity poor quality boulder outcrop (feature 39-14); primary and secondary reduction flakes; lots of shatter; no bifaces. Nearby feature 40-8 is a large pit (4m x 3m) with poor quality reduction flakes (chalcedony-like inclusions). Light to moderate density flake scatter surrounds pits.

Site Condition: Undisturbed.

Remarks: Seems to be example of small quarry where poor quality materials where reduced (perhaps pits reflect exploratory prospects).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Red Hill Ridge

Locality No.: 46 Type: Reduction Station Complex

UTM: 535440E/4551240N

Size: 20m NS/30m EW Max. Area (m^2): 600

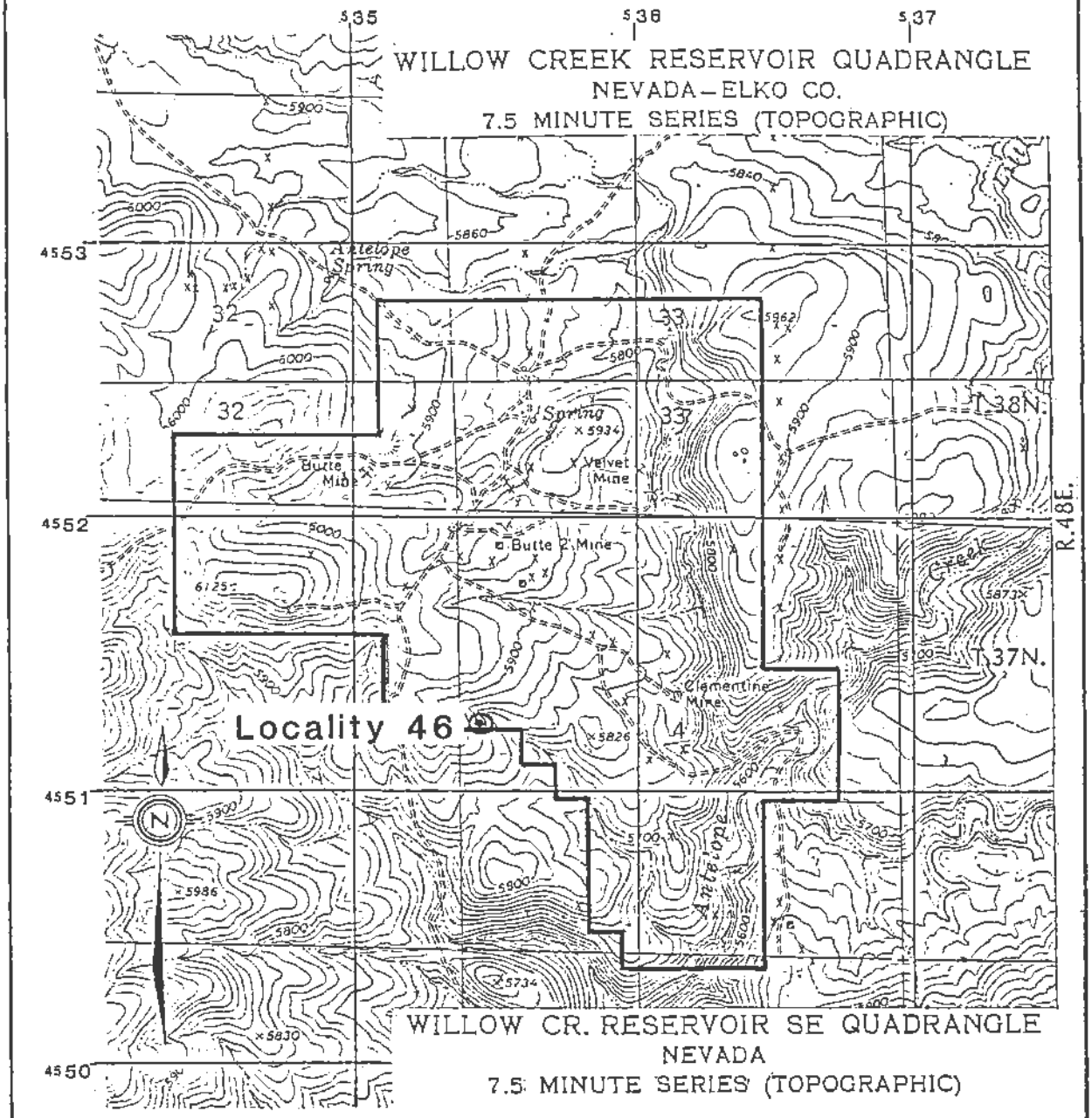
Topographic Data: Moderately steep (16%), north-facing colluvial slope overlooking ephemeral drainage.

Quarry Data: No on-site opalite source.

Description: Small reduction area consisting of moderate density debitage with several bifaces and a few basalt cobbles and flakes (feature 45-6); inferred overlapping reduction stations.

Site Condition: Undisturbed.

Remarks: Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Red Hill Ridge

Locality No.: 47 Type: Quarry Pit Complex

UTM: 535660E/4551440N

Size: pits = 40m x45m Max. Area (m^2): 8,100

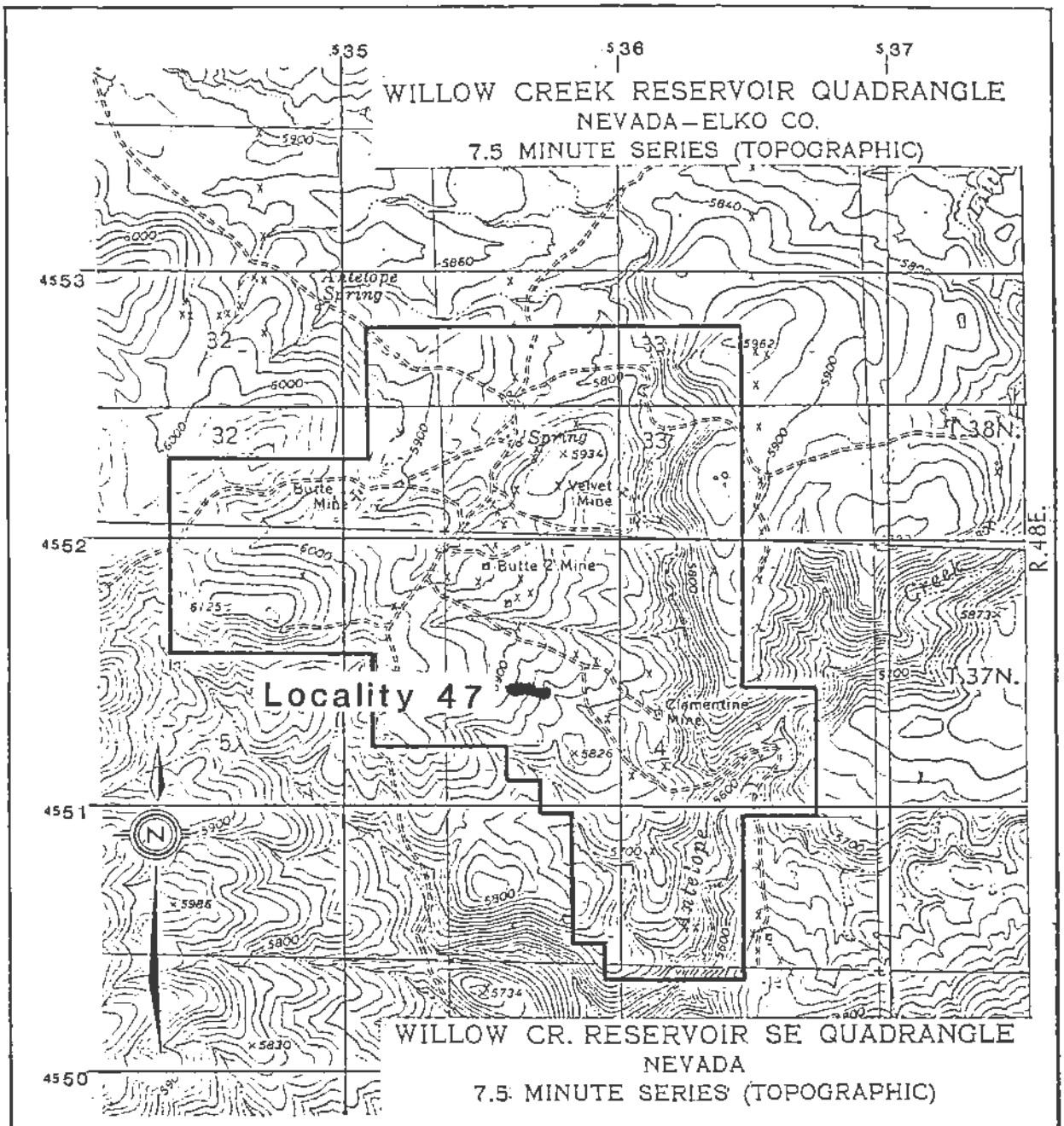
Topographic Data: On moderate to strongly sloping (8%-12%) cobble field, near small bedrock ledge, east-facing.

Quarry Data: Narrow bedrock ledge exposed along slope contour is poor quality material; high quality opalite (cream to tan) excavated from shallow pits through thin layer of colluvium over bedrock.

Description: Small pit complex (3 pits) in large moderate density scatter along low bedrock exposure (feature 50-7). Some assaying of surface cobbles, but most reduction reflects excavated pit materials (i.e., weathered subsurface bedrock). Hammerstones are restricted in location; occur in association with only one of the three pits.

Site Condition: Undisturbed.

Remarks: Structure of pits, restricted association of hammerstones, relationships between natural cobbles, material quality, and flake size suggests high research potential.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Pink Pits

Locality No.: 48 Type: Quarry Pit Complex

UTM: 535920E/4551280N

Size: 30m x 30m Max. Area (m^2): 900

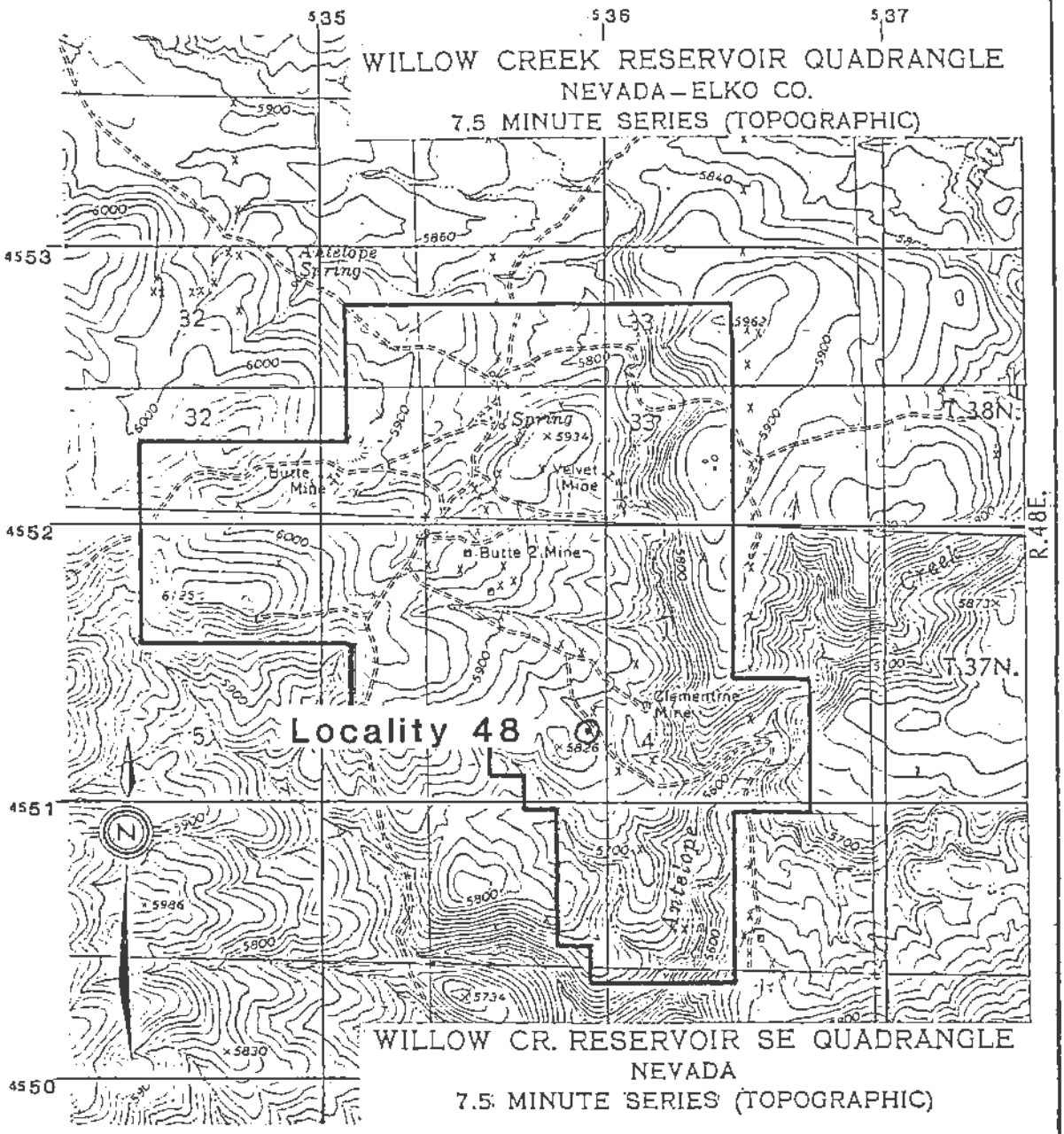
Topographic Data: Colluvial slope below shallow bedrock outcrop, strongly sloping (10%), facing north.

Quarry Data: Boulders in colluvium; salmon and buff colored; good quality.

Description: Small pit complex of 7 large (5 m diameter) and deep (50 cm) pits (feature 59-4). Pits are filled with cores, cobbles, and bifaces; debitage flakes are quite large (10-11 cm); all rhyolite hammerstones (no basalt).

Site Condition: Undisturbed.

Remarks: May be part of same pink colored outcrop as at localities 39 and 38. Very contained spatially, but very intensive quarrying indicated.



WILLOW CREEK RESERVOIR QUADRANGLE
NEVADA—ELKO CO.
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WILLOW CR. RESERVOIR SE QUADRANGLE
NEVADA
7.5 MINUTE SERIES (TOPOGRAPHIC)

INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 49

Type: Lithic Scatter (Undetermined Type)

UTM: 536200E/4551300N

Size: 15m NS/35m

Max. Area (m^2): 525

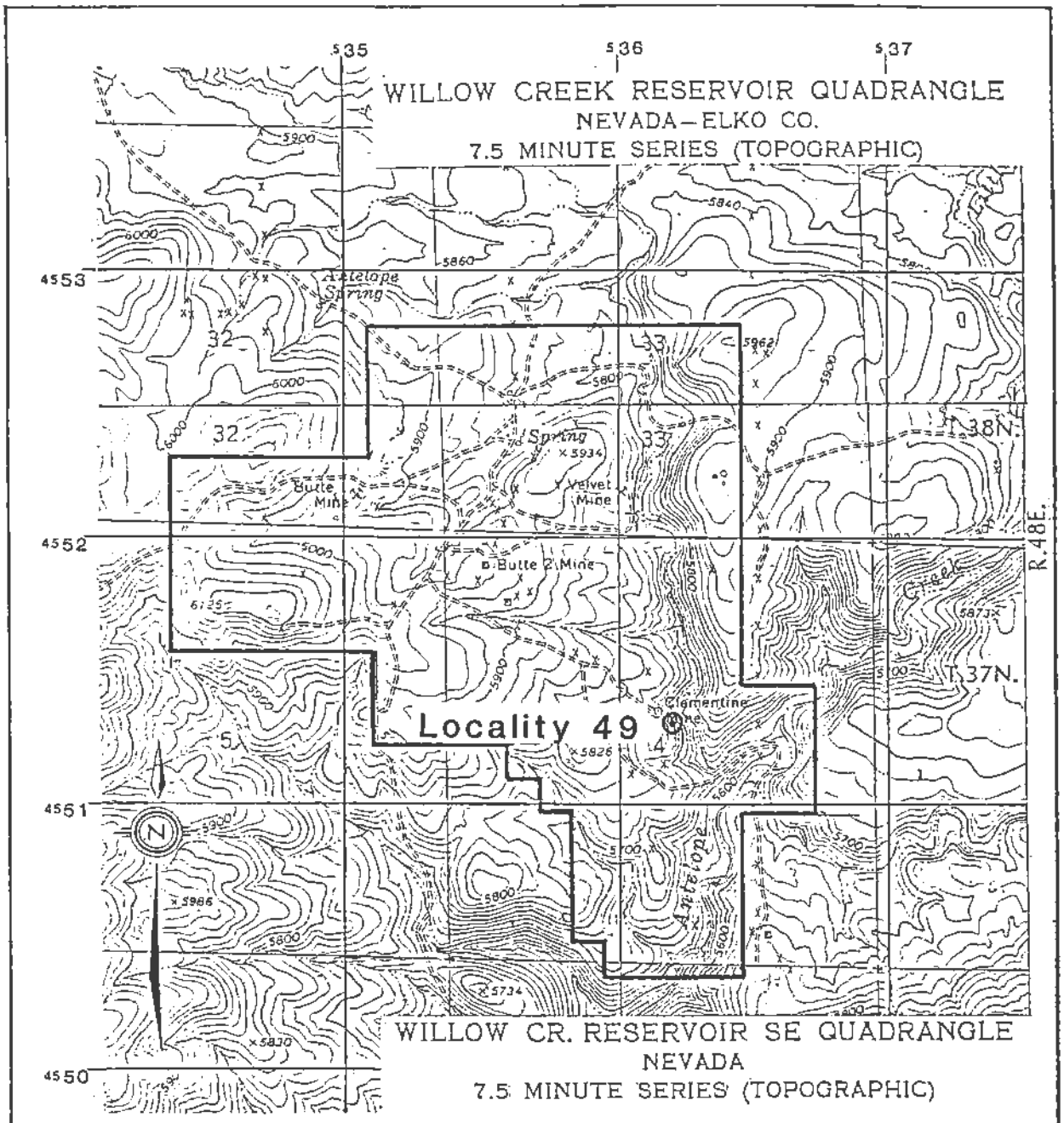
Topographic Data: Small flat and steep (40%) slope on upper western edge Velvet Canyon.

Quarry Data: No on-site opalite source indicated.

Description: Moderate density flake scatter with bifaces and reduction debris (feature 68-9). Scatter originates on flat knoll top.

Site Condition: Movement along slope; adjacent to intensive historic Clementine disturbance.

Remarks: May be related to localities 50, 51, and 99.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 50 Type: Small Outcrop-Assay Quarry

UTM: 536220E/4551260N

Size: 10m x 6m Max. Area (m^2): 60

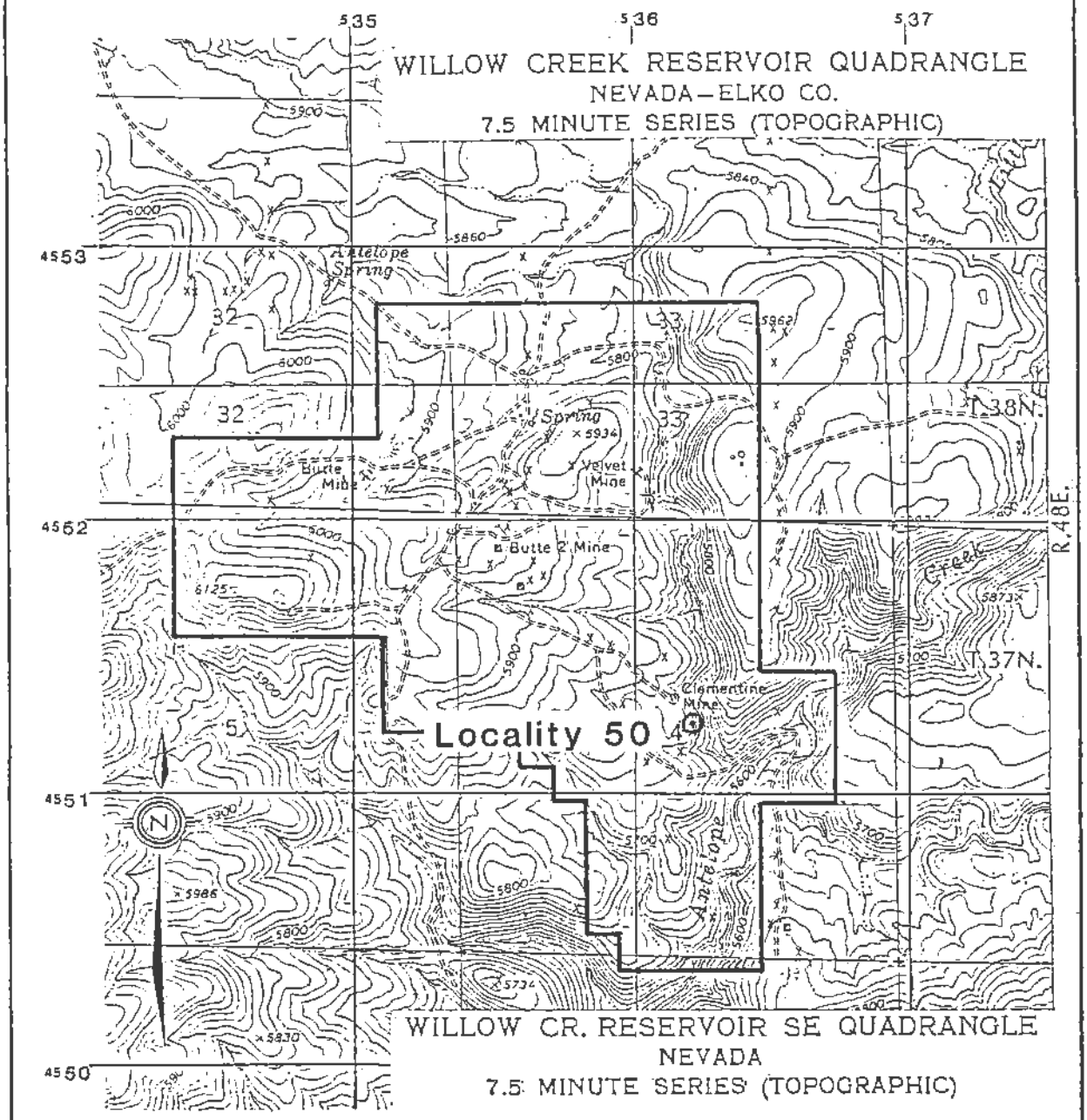
Topographic Data: Upper edge steep slope on west side Velvet Canyon.

Quarry Data: Poor quality boulder outcrop.

Description: Small outcrop quarry/assay station (feature 69-17). Abundant primary flakes and shatter; several cores and bifaces.

Site Condition: Undisturbed but adjacent historic Clementine Mine.

Remarks: Possibly related to localities 49, 51, and 99.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 51 Type: Rockshelter (Reduction Station)

UTM: 536220E/4551320N

Size: alcove=3m x 1.5m x 1m Max. Area (m^2): 75

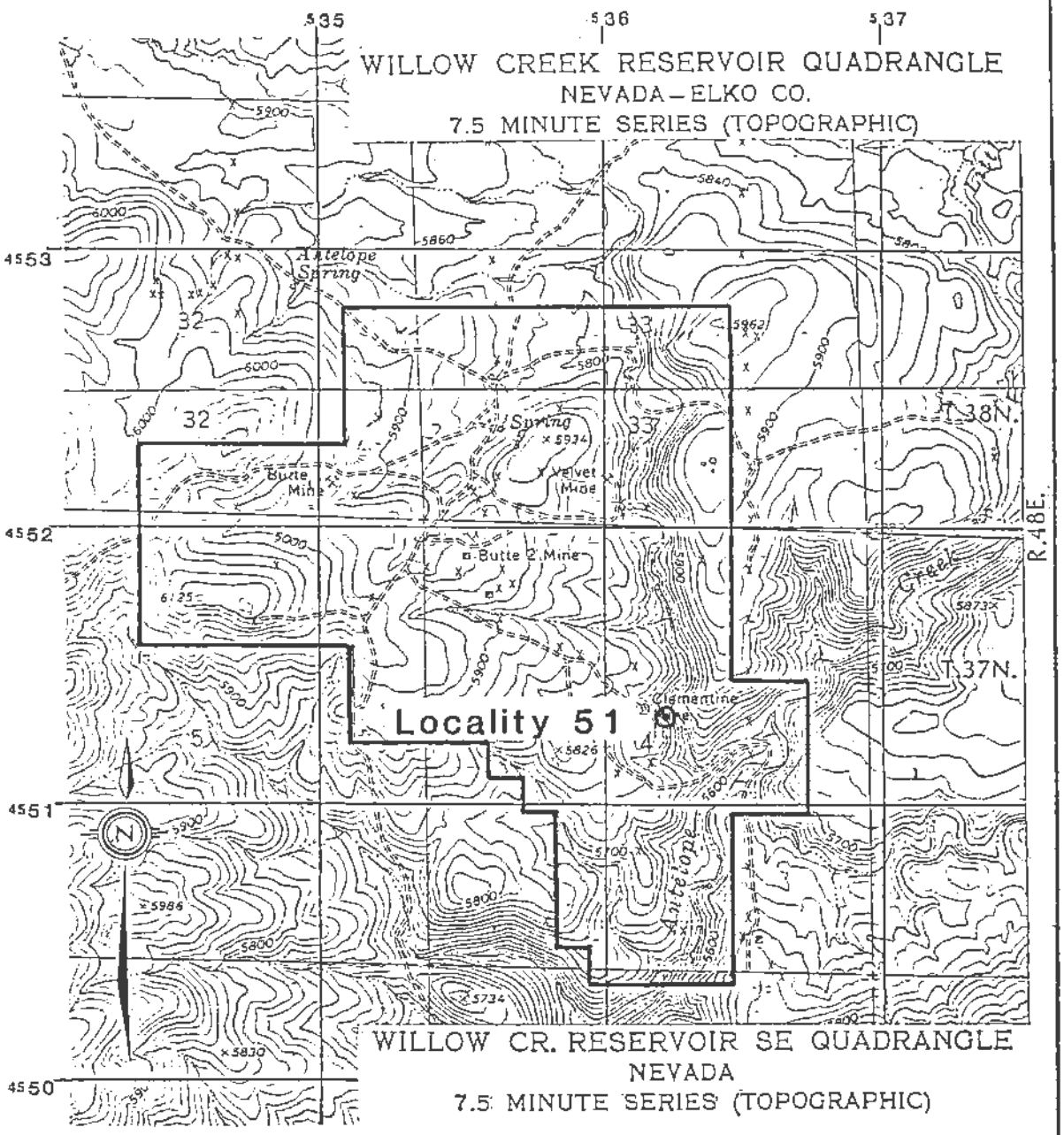
Topographic Data: In rimrock on steep slope (40%), west edge Velvet Canyon.

Quarry Data: No on-site source.

Description: Scatter of primary and secondary debitage associated with small shelter (feature 69-18); slightly pronounced apron.

Site Condition: Undisturbed, except for movement on slope below shelter.

Remarks: May be associated with localities 49, 50, and 99.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 52 Type: Rockshelter (Undetermined Type)

UTM: 536280E/4551360N

Size: shelter=7m wide/3-6m deep Max. Area (m^2): 75

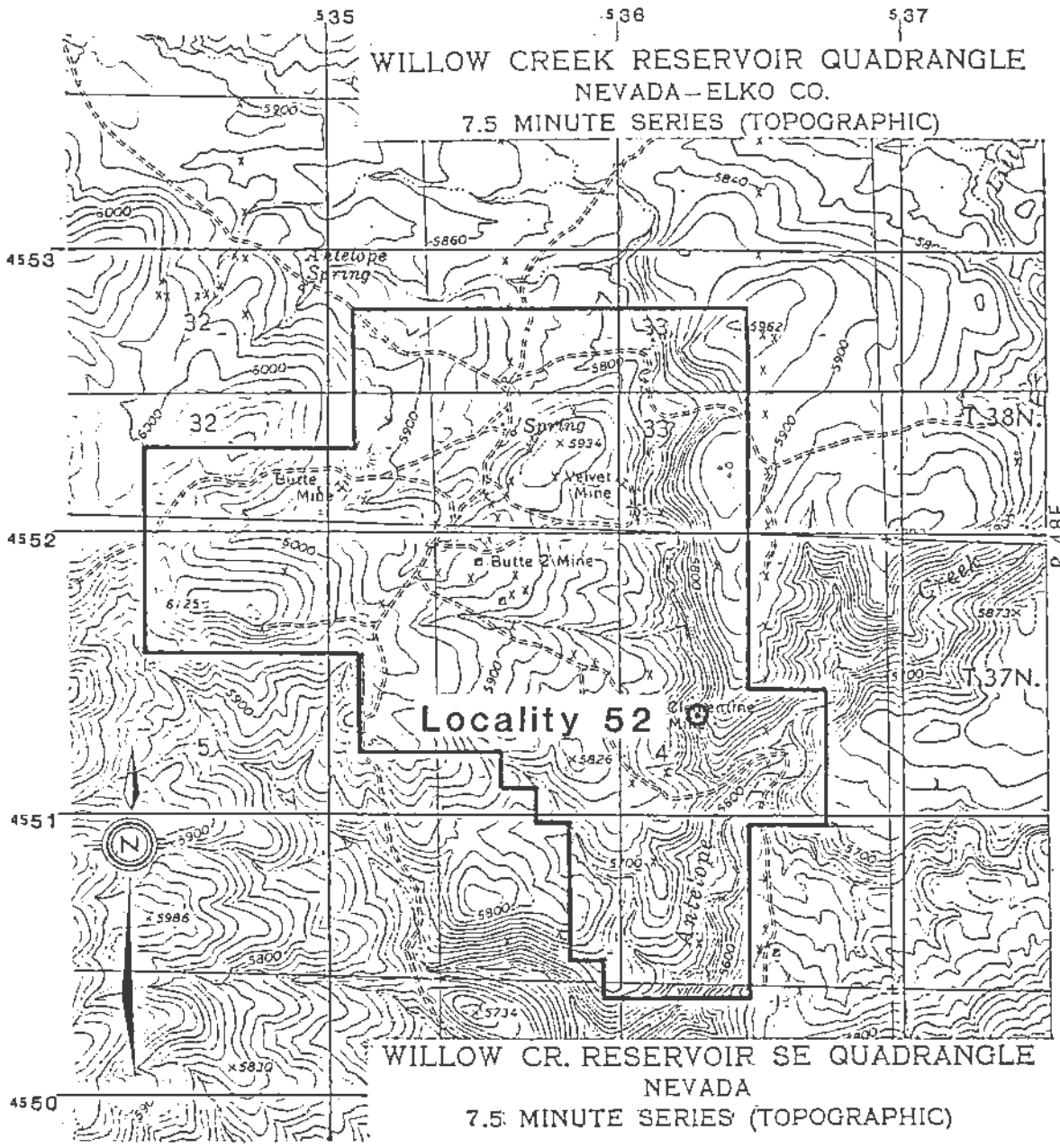
Topographic Data: Base of outcrop, west-facing slope, lower portion Velvet Canyon.

Quarry Data: No on-site opalite source.

Description: Flake scatter in fair-sized shelter and along apron slope (feature 71-4); some potential for depth.

Site Condition: Undisturbed.

Remarks: Needs further assessment by testing.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Southern Owl Ridge

Locality No.: 53 Type: Small Reduction Station

UTM: 536400E/4551320N

Size: 5m x 5m Max. Area (m^2): 25

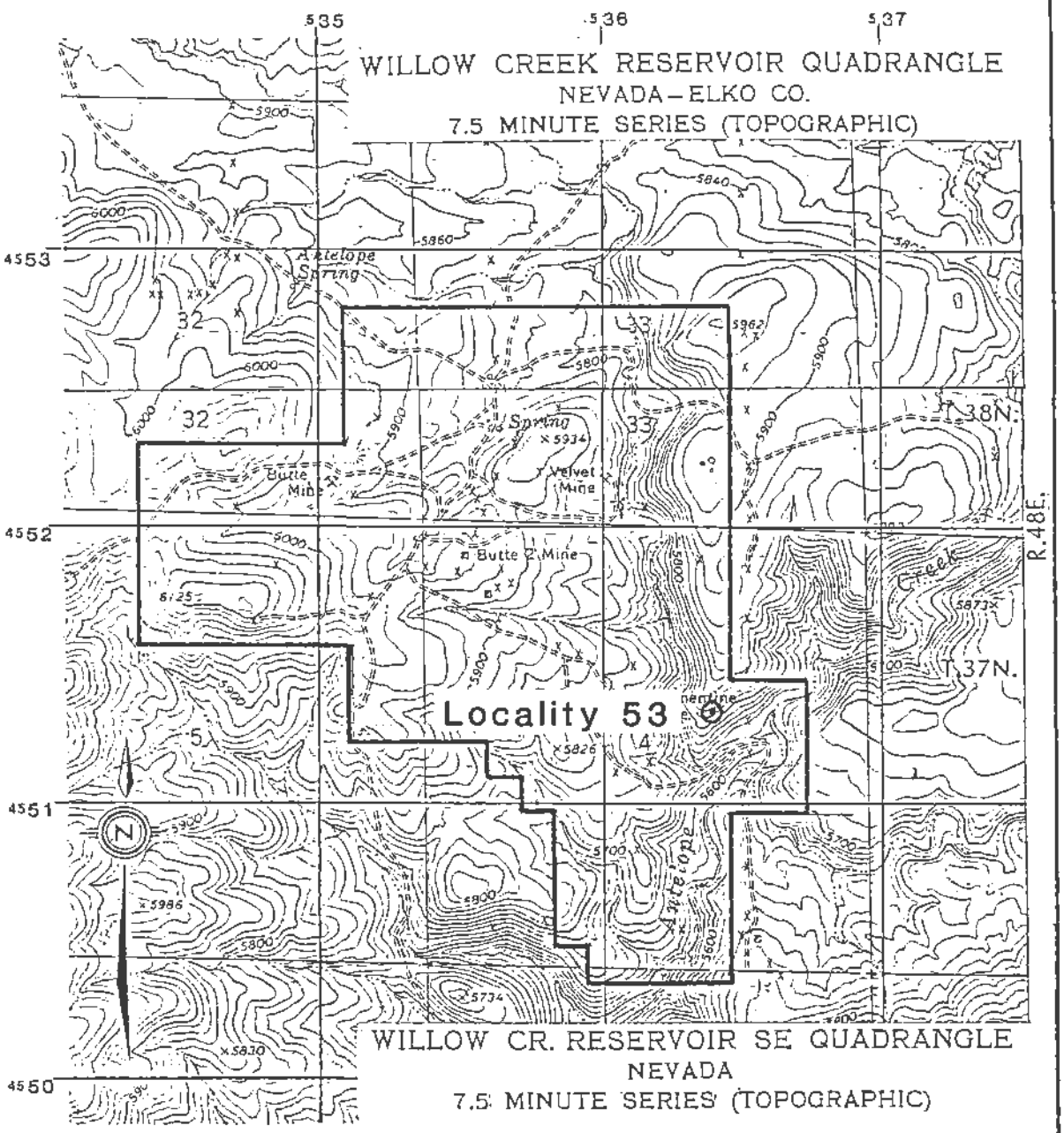
Topographic Data: On moderately steep (25%) colluvial slope, facing south.

Quarry Data: Poor quality cobbles on surface, but most are not useable for toolstone.

Description: Discrete flake scatter and one biface (feature 75-E3).

Site Condition: Undisturbed but for some movement along slope.

Remarks: Several similar stations (see localities 54, 55) were recorded on this slope above intensive ledge quarry (locality 30).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Southern Owl Ridge

Locality No: 54 Type: Small Reduction Station

UTM: 536360E/4551420N

Size: 15m x 15m Max. Area (m^2): 225

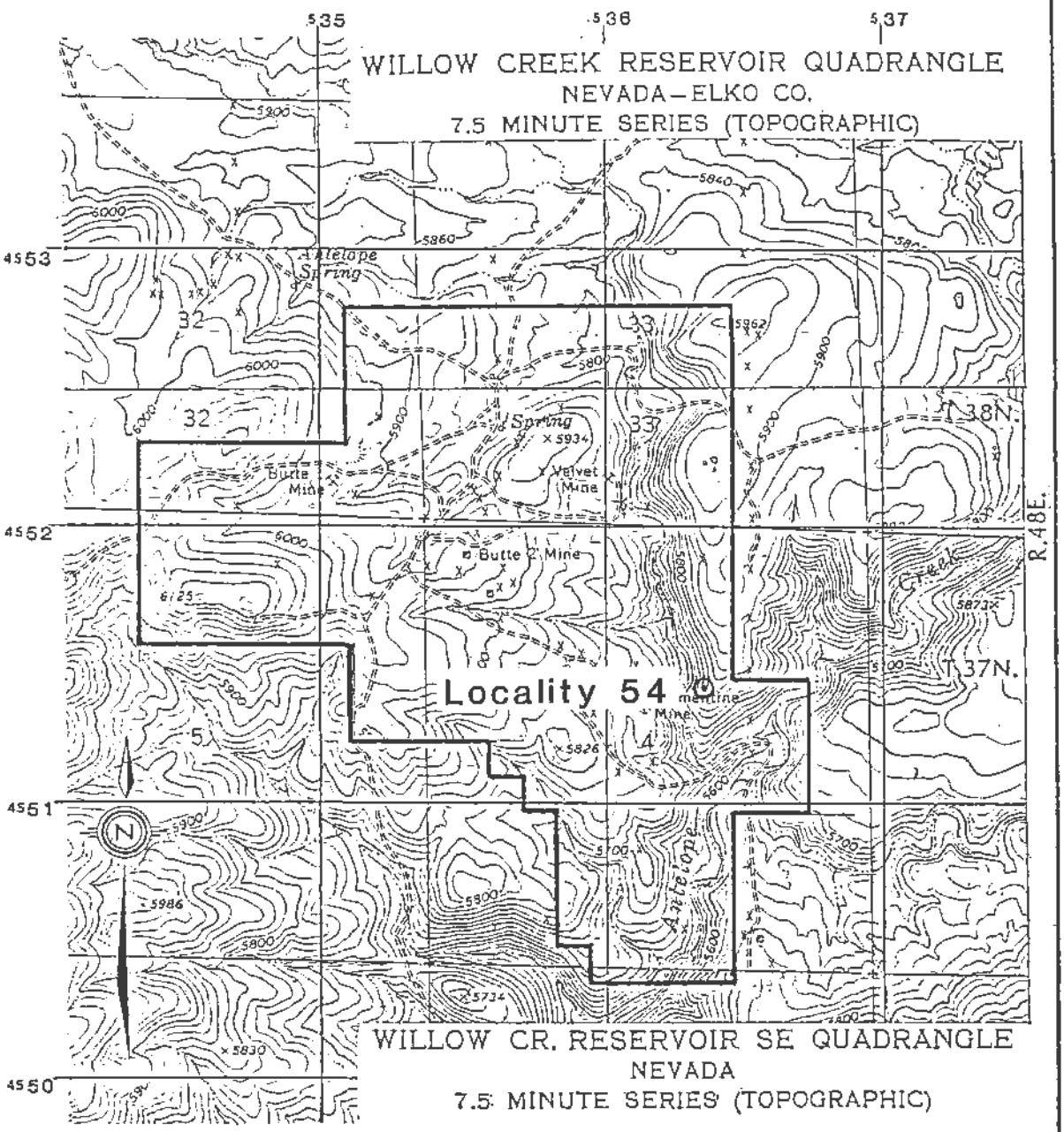
Topographic Data: On moderately steep (25%) colluvial slope, facing south.

Quarry Data: No on-site toolstone source.

Description: Two discrete flake scatters; each consists of secondary flakes with a few cores and bifaces (feature 74-E4).

Site Condition: Undisturbed except for natural movement on slope.

Remarks: Similar to localities 53 and 55; apparently reflect reduction of cores from Locality 30 near base of slope.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Southern Owl Ridge

Locality No.: 55 Type: Small Reduction Station

UTM: 536360E/4551520N

Size: 5m EW/ 2m NS Max. Area (m^2): 10

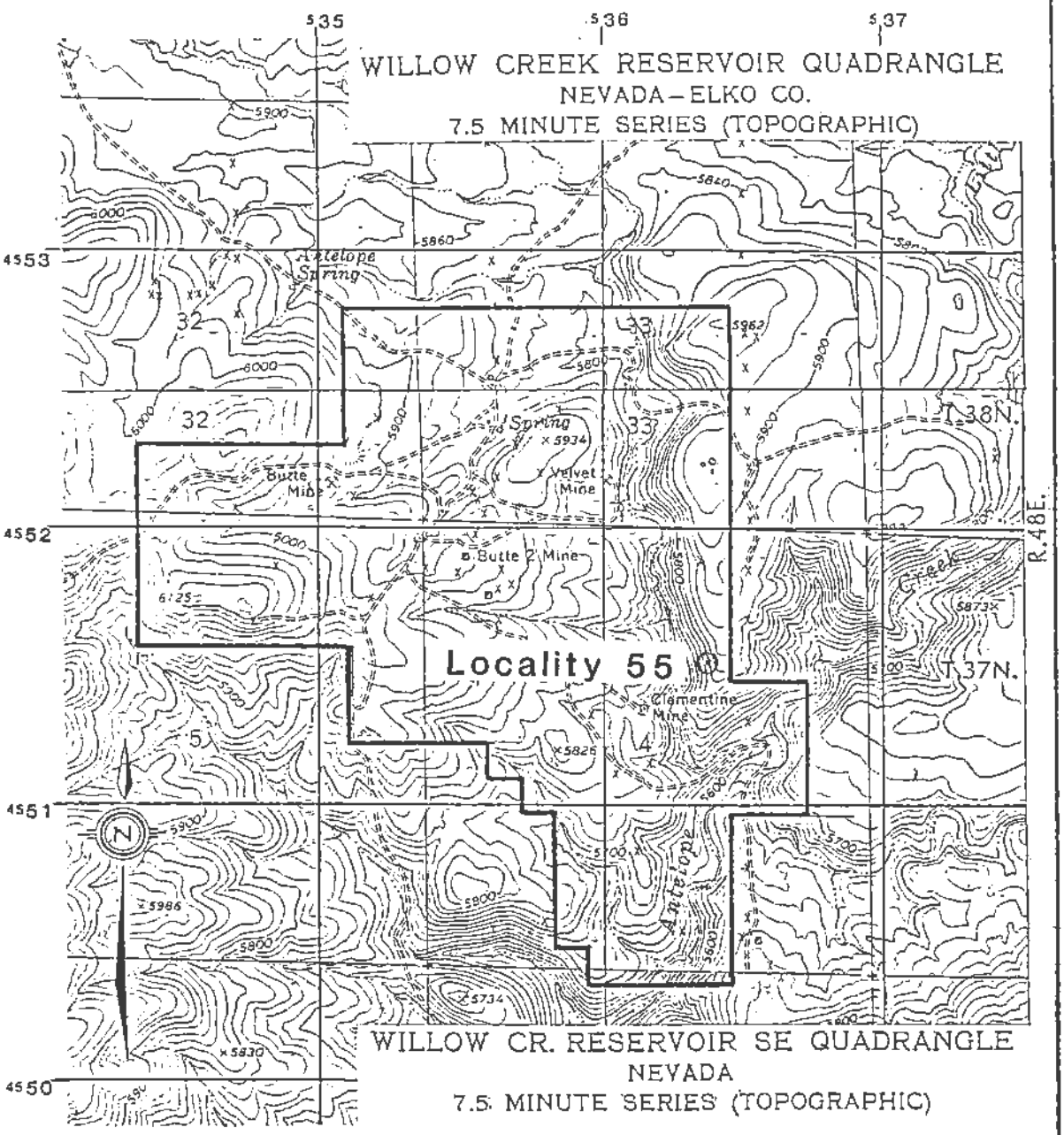
Topographic Data: West edge volcanic bedrock ledge on steep (35%) slope, facing southwest.

Quarry Data: No on-site opalite source.

Description: Small flaking station with one biface and about 200 secondary flakes (feature 75-E3).

Site Condition: Undisturbed.

Remarks: Numerous other similar localities recorded at base of this volcanic outcrop along upper edge ridge.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 56 Type: Outcrop Quarry Complex

UTM: 536280E/455/460N

Size: 60m NS/40m EW Max. Area (m^2): 2,400

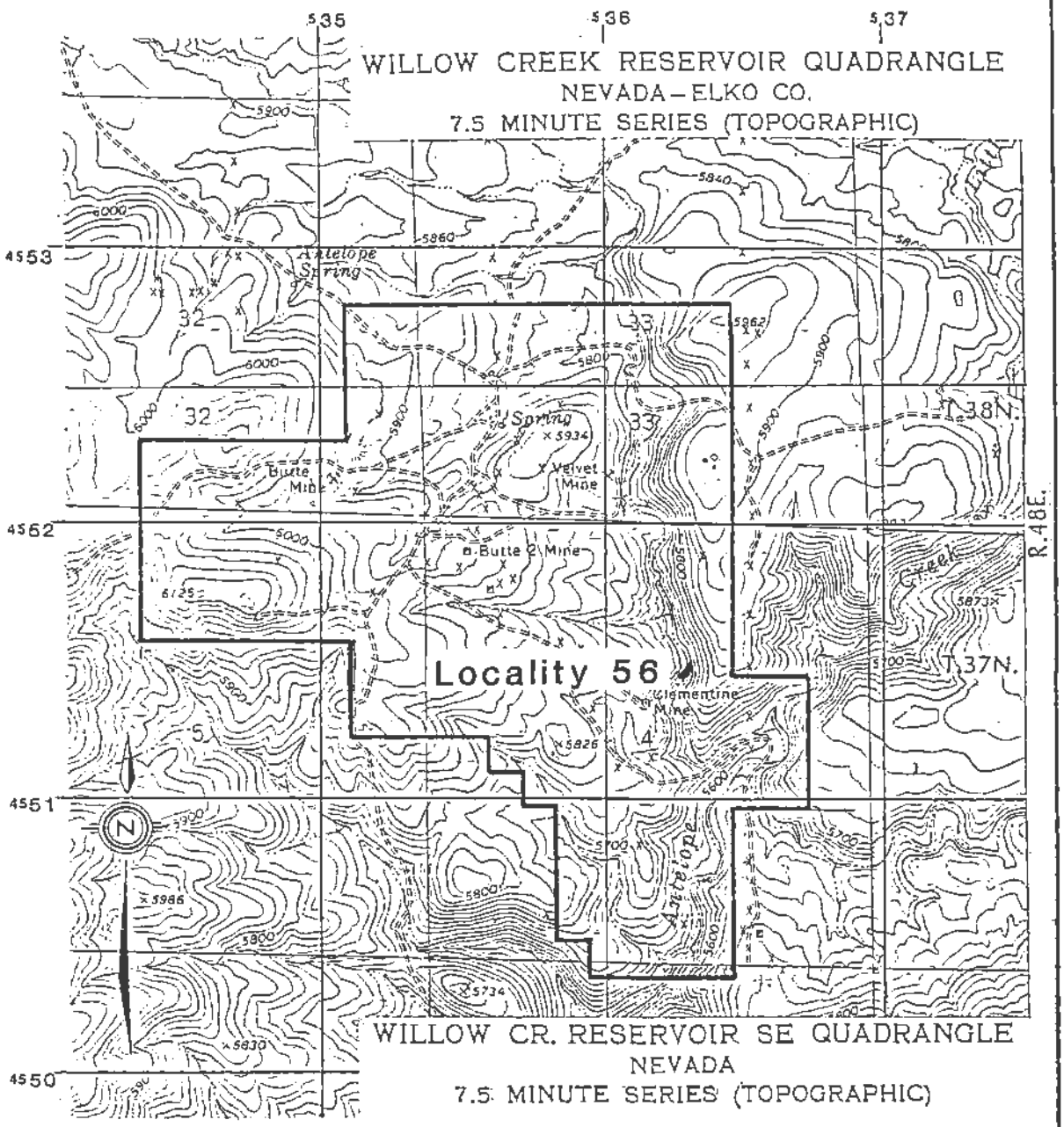
Topographic Data: Outcrop in base of Velvet Canyon.

Quarry Data: Intensive reduction bedrock outcrop.

Description: Intensive quarrying along bedrock ledge exposure (features 72-2 and 71-3). Numerous bifaces and moderate density flake scatter.

Site Condition: Undisturbed except for natural movement on slope and erosion in drainage.

Remarks: Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 57 (Clementine Shelter) Type: Rockshelter (Residential)

UTM: 536220E/4551440N

Size: shelter=6m wide/1.5m high/3m deep Max. Area (m^2): 200

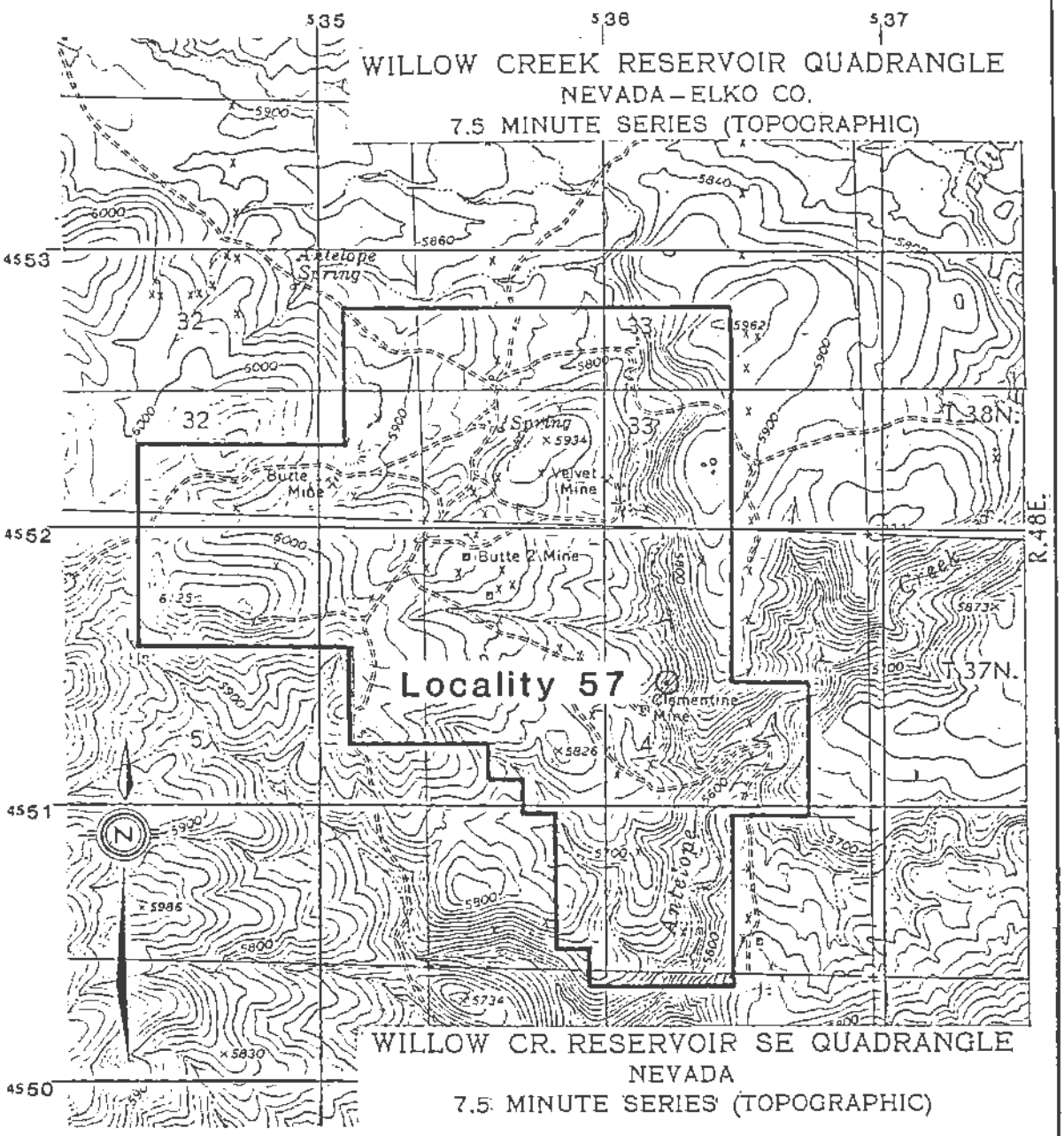
Topographic Data: In outcrop on west slope of Velvet Canyon.

Quarry Data: No on-site opalite source.

Description: Small shelter with well developed refuse berm on apron (feature 69-10). Grey soil suggests possible charcoal or midden accumulation. Small amounts of groundstone and burned rocks suggest habitation; however, most conspicuous use of shelter is reflected in large accumulation of bifaces and secondary flakes on apron slope.

Site Condition: Fair. A pile of backdirt and flakes in front of shelter is likely a result of vandalism (see also Stan Jaynes for recent evidence of same). Much of subsurface and apron deposit, however, may remain intact.

Remarks: Significant research potential; sensitive due to its high visibility.



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Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 58 Type: Adit/Small Outcrop Quarry

UTM: 536200E/4551420N

Size: adit=5m x 2.5m Max. Area (m^2): 25

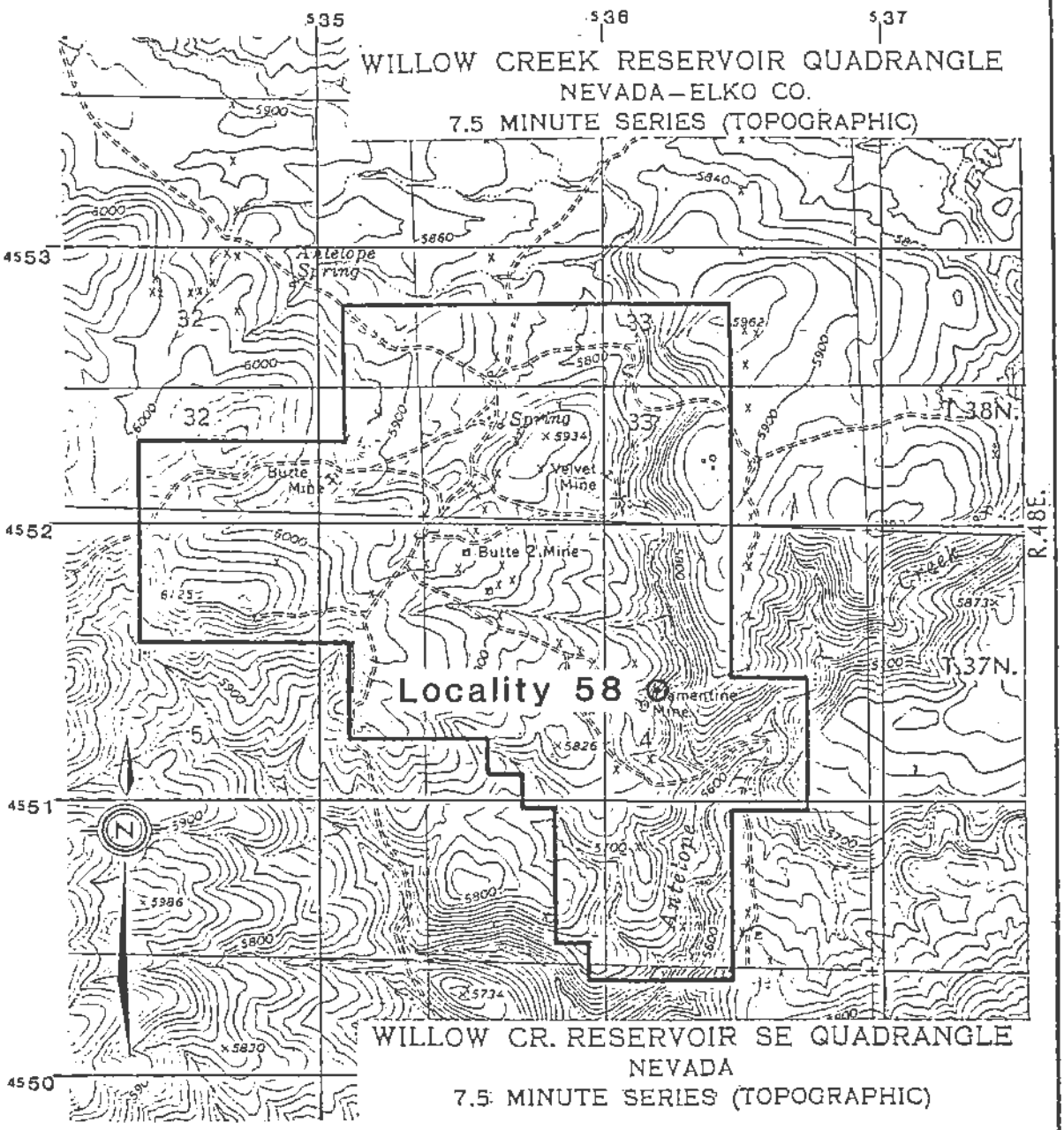
Topographic Data: Outcrop on very steep (50%) slope, west side of Velvet Canyon.

Quarry Data: Variable quality outcrop on-site.

Description: Possible prehistoric adit with associated primary reduction debitage and biface thinning flakes.

Site Condition: Apparently undisturbed.

Remarks: Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 59 Type: Small Outcrop Quarry

UTM: 536160E/4551400N

Size: 25m x 20m Max. Area (m^2): 500

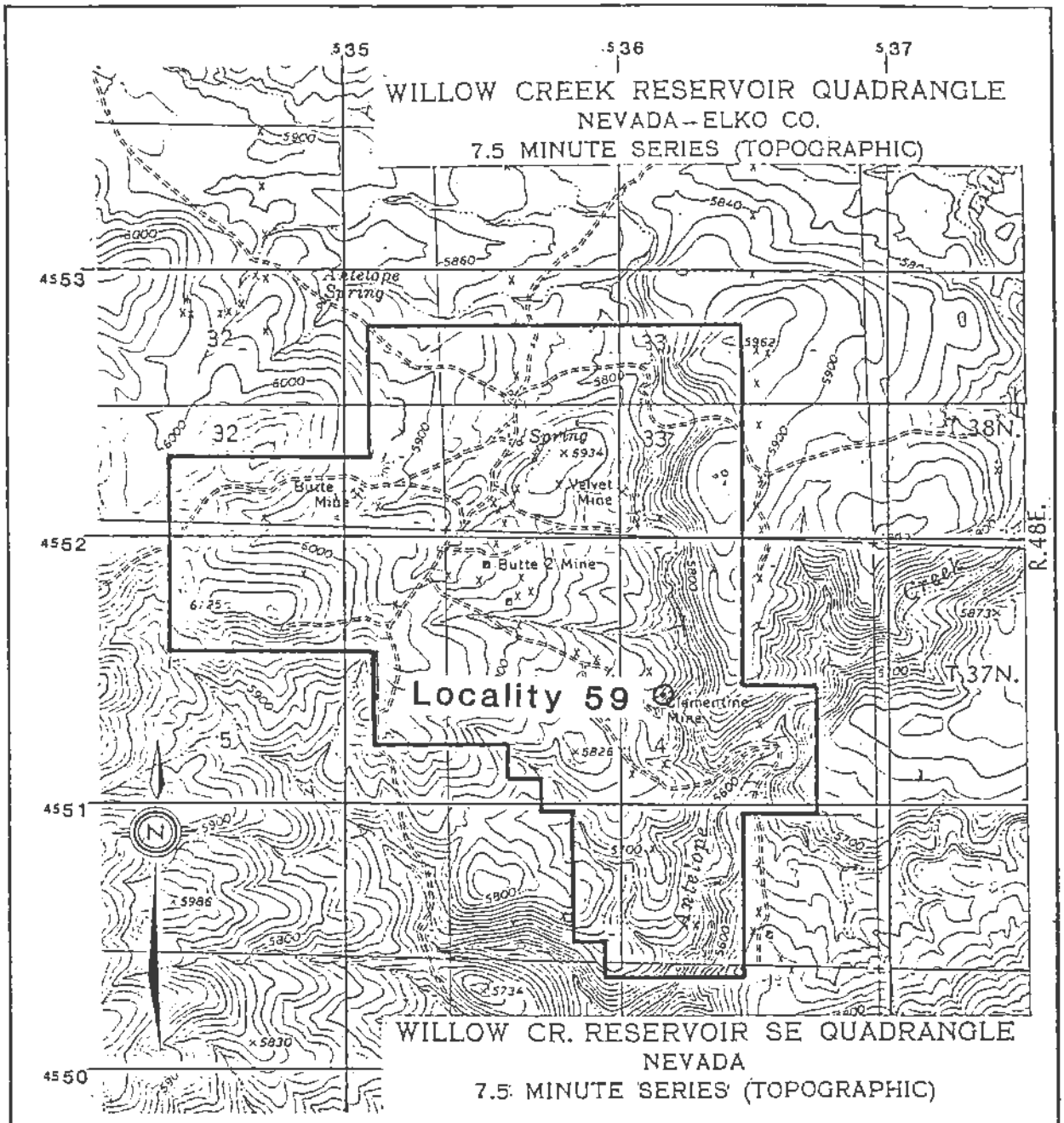
Topographic Data: Bedrock outcrop overlooking steep slope on west edge Velvet Canyon.

Quarry Data: Variable quality opalite available in boulder outcrops on site.

Description: Both primary and secondary debitage and a few bifaces associated with small alcoves (and some variable quality toolstone sources) (feature 69-9).

Site Condition: Apparently undisturbed; close to historic Clementine Mine.

Remarks: Need to assess on-site opalite source in relation to reduction debris (are they truly related or is association merely fortuitous?).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 60 Type: Quarry Pit Complex

UTM: 536200E/4551560N

Size: 30m NS /75m EW Max. Area (m^2): 2,250

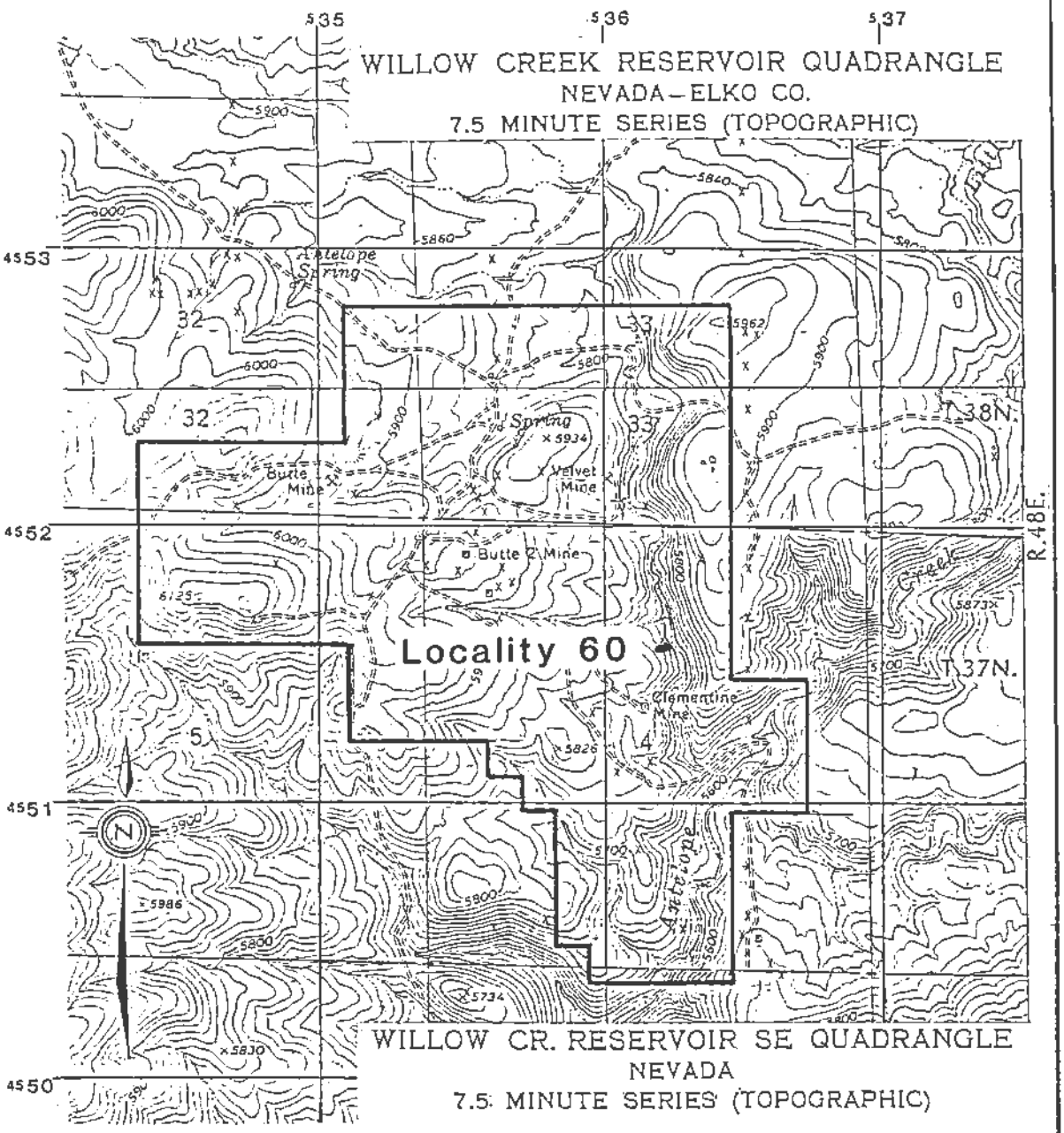
Topographic Data: Moderately steep (25%) colluvial slope below bedrock outcrop, lower west side of Velvet Canyon.

Quarry Data: Boulders of opaque grey-white opalite; ranges from medium to poor quality toolstone. Some material mined from colluvium at base of slope; also some evidence of mining bedrock outcrop.

Description: Two quarry pit complexes (features 69-7, 69-8, and 68-12) in moderate density flake scatter.

Site Condition: Adjacent to historic Clementine Mine disturbance; historic pit on site and nearby road disturbance.

Remarks: Historic impacts may obscure prehistoric patterns.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 61 Type: Small Outcrop Quarry/Adit?

UTM: 536200E/4551600N

Size: 3m x 3m Max. Area (m^2): 9

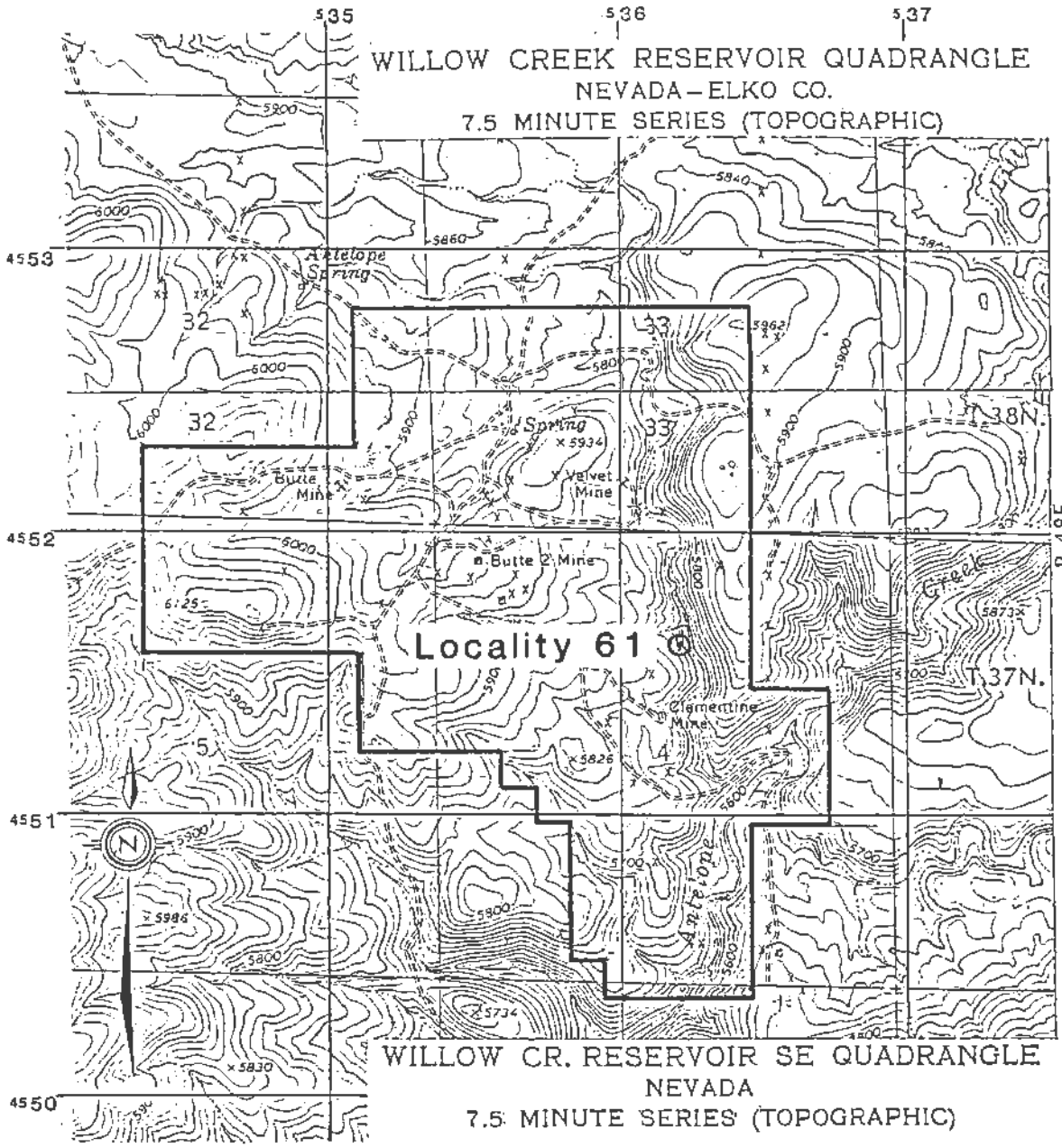
Topographic Data: In bedrock on steep (40%) slope, lower west side of Velvet Canyon.

Quarry Data: Bedrock outcrop.

Description: Small scatter of primary debitage associated with possible prehistoric adit in opalite outcrop (feature 69-5).

Site Condition: Adit may be historic modification of prehistoric quarry feature.

Remarks: Verify source of debitage relative to outcrop and adit.



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Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Sagehen Ridge

Locality No.: 62 Type: Quarry Pit Complex

UTM: 536100E/4551540N

Size: 100m NS/ 35m EW Max. Area (m^2): 3,500

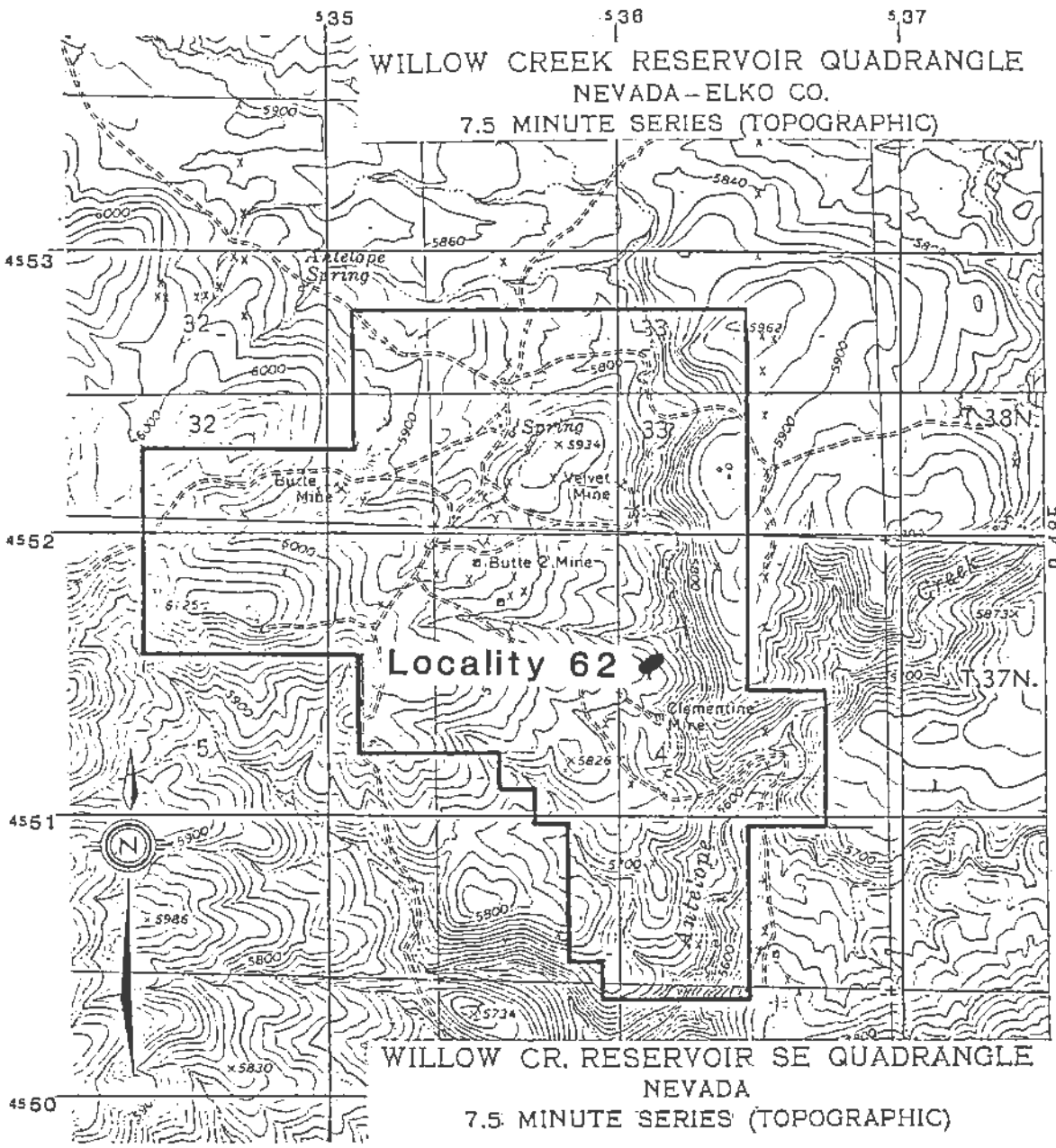
Topographic Data: Colluvial slope overlooking Velvet Canyon, upper west side.

Quarry Data: Grey-buff opaque opalite, good quality, in boulders in colluvium.

Description: Two prehistoric pit complexes (features 66-17, 64-7) and discrete reduction station (66-16) surrounded by moderate density flake scatter. (Several historic pits overlay prehistoric quarry activities).

Site Condition: Seriously disturbed by historic mining and exploration associated with Clementine Mine.

Remarks: Historic disturbance may obscure structural relationships.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Sagehen Ridge

Locality No.: 63 Type: Quarry Pit Complex

UTM: 535760E/4551640N

Size: 45m NS/ 100m EW Max. Area (m^2): 4,500

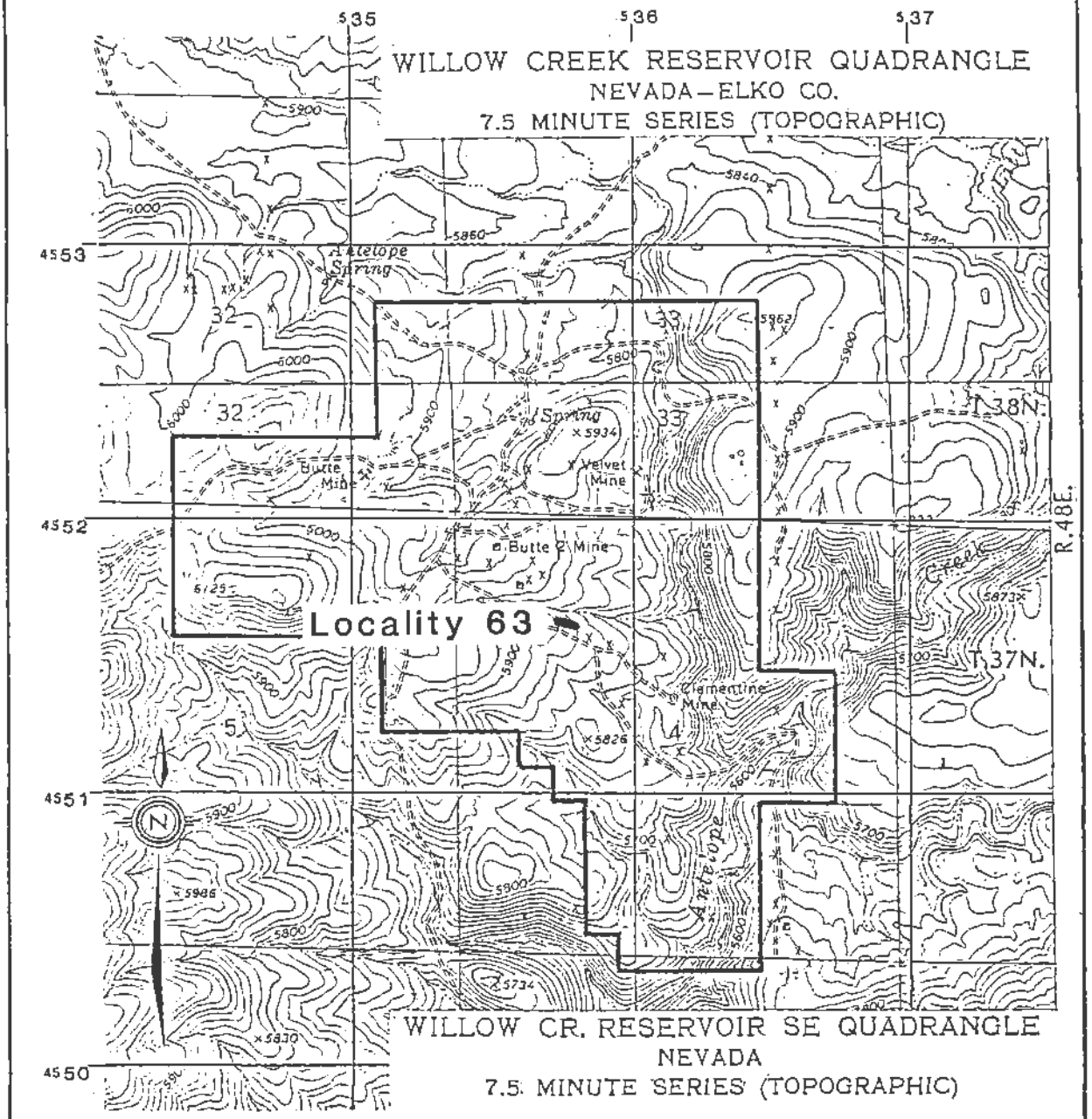
Topographic Data: Top of gently sloping (5%), southeast-trending ridge.

Quarry Data: Bedrock is near surface under thin mantle of colluvium; some boulder outcrop exposures. Cobbles and boulders were quarried from colluvium overlying bedrock. Material is variable quality, poor to good, mottled and banded opaque grey and white. Poor quality material is vuggy, fractured, heterogeneous.

Description: Complex of widely scattered pits (53-6, 54-13, 56-2) in a cobble and boulder field characterized by a moderate density of flake debitage and angular shatter. Basalt hammerstone and flakes recorded in Feature 56-2.

Site Condition: Good. Adjacent to road, but no obvious historic disturbance.

Remarks: Good example of hypothesized exploration technique whereby surface boulders/cobbles identify potential source of toolstone in colluvial mantle; surface cobbles are assayed; cobbles in colluvium are quarried with small shallow pits. Paucity of pit features likely related to overall poor to medium quality of toolstone.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

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1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 64

Type: Isolated Quarry Pit/ Outcrop Quarry

UTM: 535640E/4551580N

Size: 15m x 15m

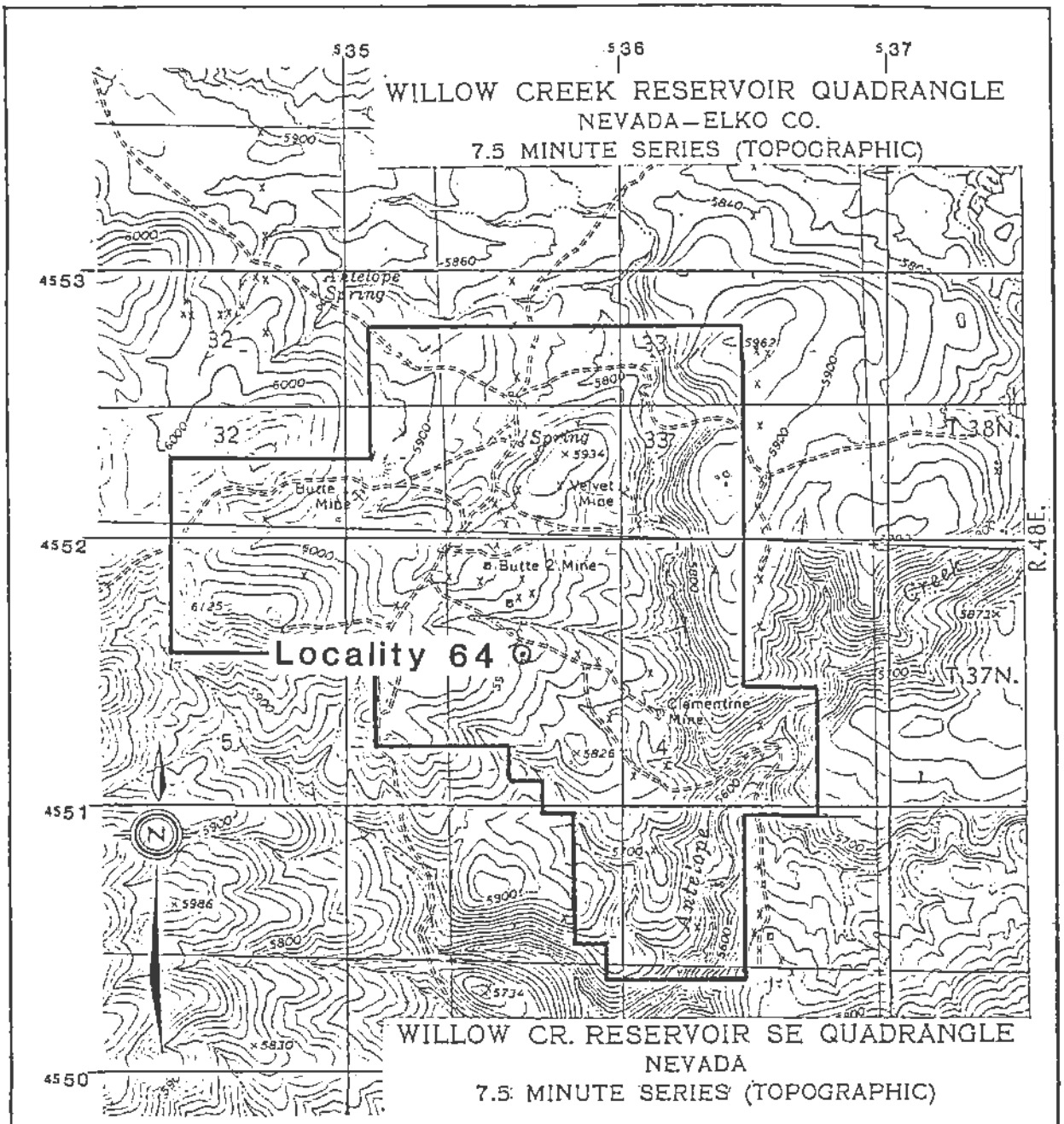
Max. Area (m^2): 225

Topographic Data: Bedrock outcrop on gently sloping (5%), southeast trending ridge. Quarry Data: Colluvium associated with bedrock outcrop; material medium to poor quality, vuggy, variegated white and grey to grey green.

Description: Isolated quarry pit (feature 51-5) near upper edge bedrock outcrop. Pit is 5.5m x 4m in area and 60cm deep; a baseball-sized rhyolite hammerstone, rounded from use battering, found downslope from pit. Moderate density scatter is restricted to small zone surrounding pit; previous moderate density estimates is actually non-cultural angular shatter associated with decomposed bedrock and a talus strip running upslope to the road.

Site Condition: Undisturbed.

Remarks: Possible relationships to similar opalite formation at site 63.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

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1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Crabtree Ridge

Locality No.: 65 Type: Quarry Pit Complex/ Ledge Outcrop

UTM: 535740E/4551720

Size: 120m NS/ 200m EW Max. Area (m^2): 24,000

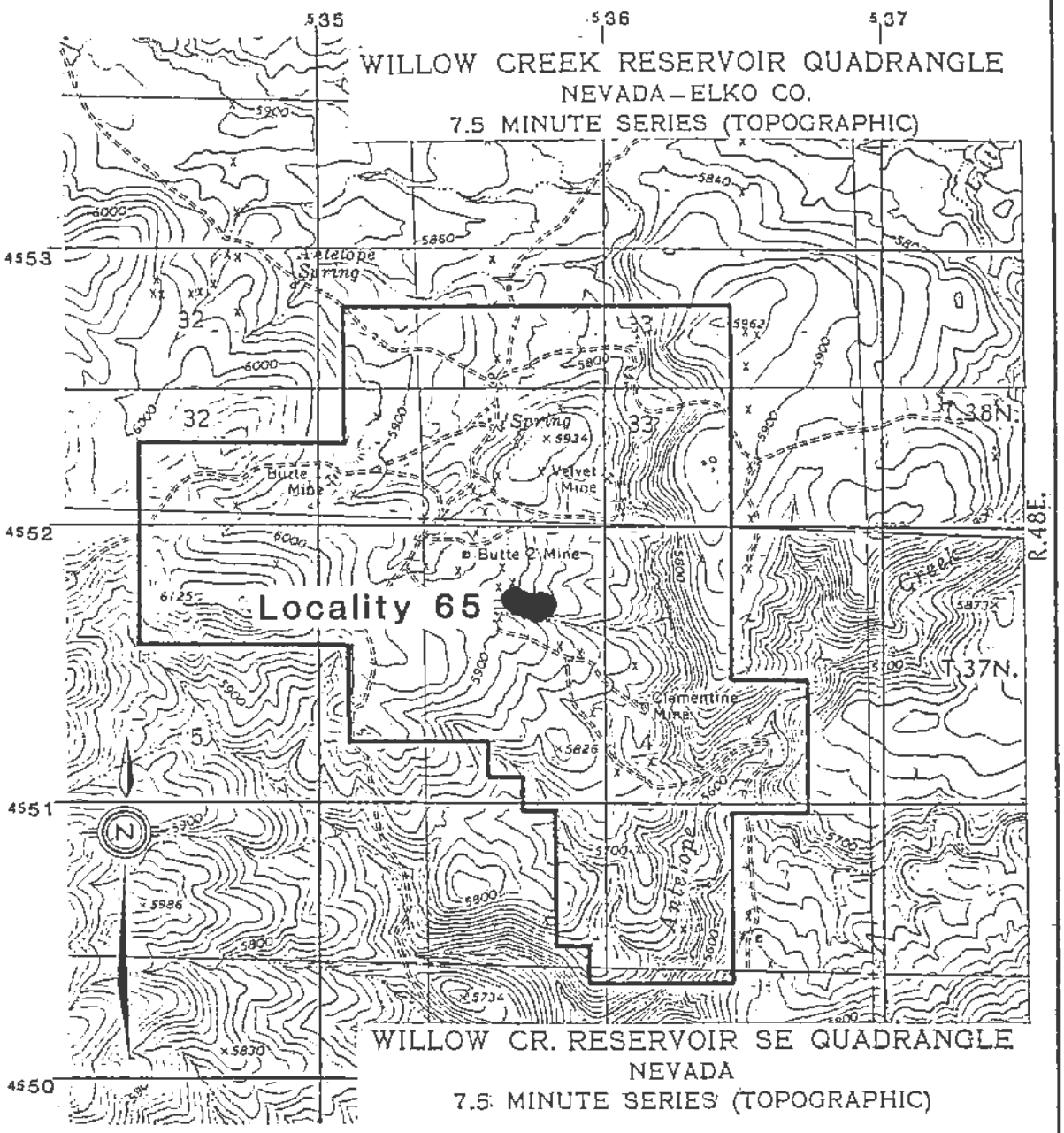
Topographic Data: Top and south-facing slopes of long, gently (5%) sloping ridge. Bedrock ledge exposed along south edge ridge; thin mantle of colluvium overlies terraced bedrock on ridge top.

Quarry Data: Three meter high bedrock ledge exposed by stream cut (ephemeral drainage) on south side low ridge; on top of ridge, terraced bedrock is exposed at surface or is covered with thin mantle of colluvium. Opalite is grey-white banded or mottled opaque, generally good quality.

Description: Large complex of several different pit complexes, all united by a continuous moderate density flake scatter. Pits along ridge top excavated into shallow colluvium (or where bedrock is exposed) includes Feature 51-6 (5 pit complex), Feature 54-10 (complex of 14 pits), and Feature 54-11 (complex of 5 pits). Also includes a shallow pit complex along sloping terraced bedrock (Feature 54-12) and a small quarried bedrock ledge (55-1). Basalt hammerstones and spalls are common; basalt debitage noted in recorded feature 54-11.

Site Condition: Very good. Historic Butte II mining disturbance impinges on north edge locality, but does not extend into mapped locality.

Remarks: Part of nearly continuous series of pit quarries along same formation (see localities 67, 68, and 69). Very interesting example of intensive prehistoric quarrying in the center of the district; significant because of its high integrity while located midway between historic Butte II, Clementine and Velvet mines.



INTERMOUNTAIN RESEARCH PROJECT 611

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September 1987

SCALE 1:24000

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1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 66 Type: Quarry Pit Complex

UTM: 536180E/4551480N

Size: 60m NS/30m EW Max. Area (m^2): 1,800

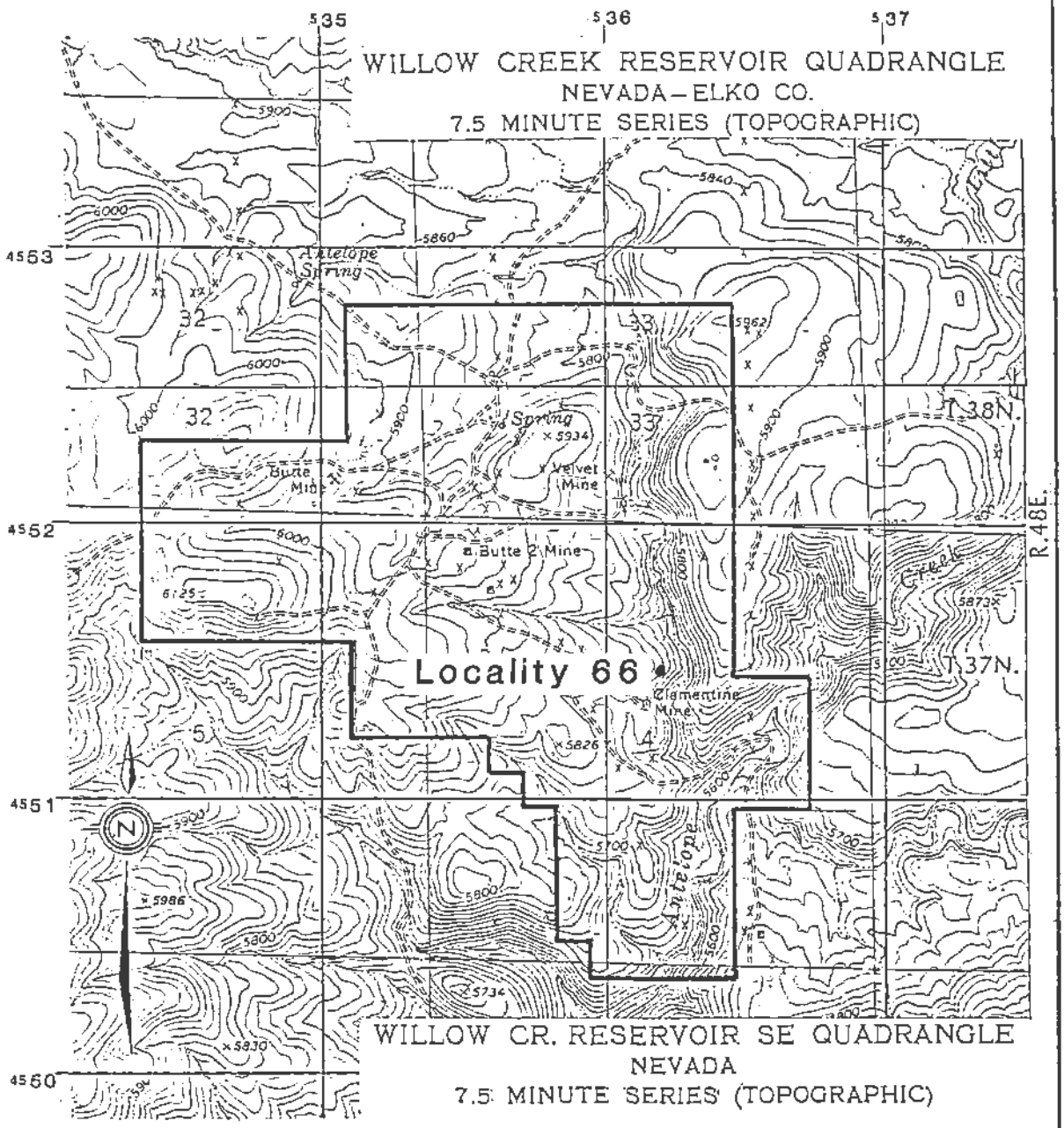
Topographic Data: On rimrock, west side of Velvet Canyon.

Quarry Data: Variable quality bedrock outcrop.

Description: A moderate density flake scatter is located on the top of an outcrop; numerous incipient pits were excavated into the thin colluvium at edges of the outcrop. Rockshelter at base of outcrop is designated separately as Locality 80.

Site Condition: Undisturbed.

Remarks: Rockshelter should be assessed by test excavation.



INTERMOUNTAIN RESEARCH PROJECT 611

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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Crabtree Ridge

Locality No.: 67

Type: Quarry Pit Complex/ Ledge Outcrop

UTM: 535780E/4551700N

Size: 30m NS/ 45mEW

Max. Area (m^2): 1,350

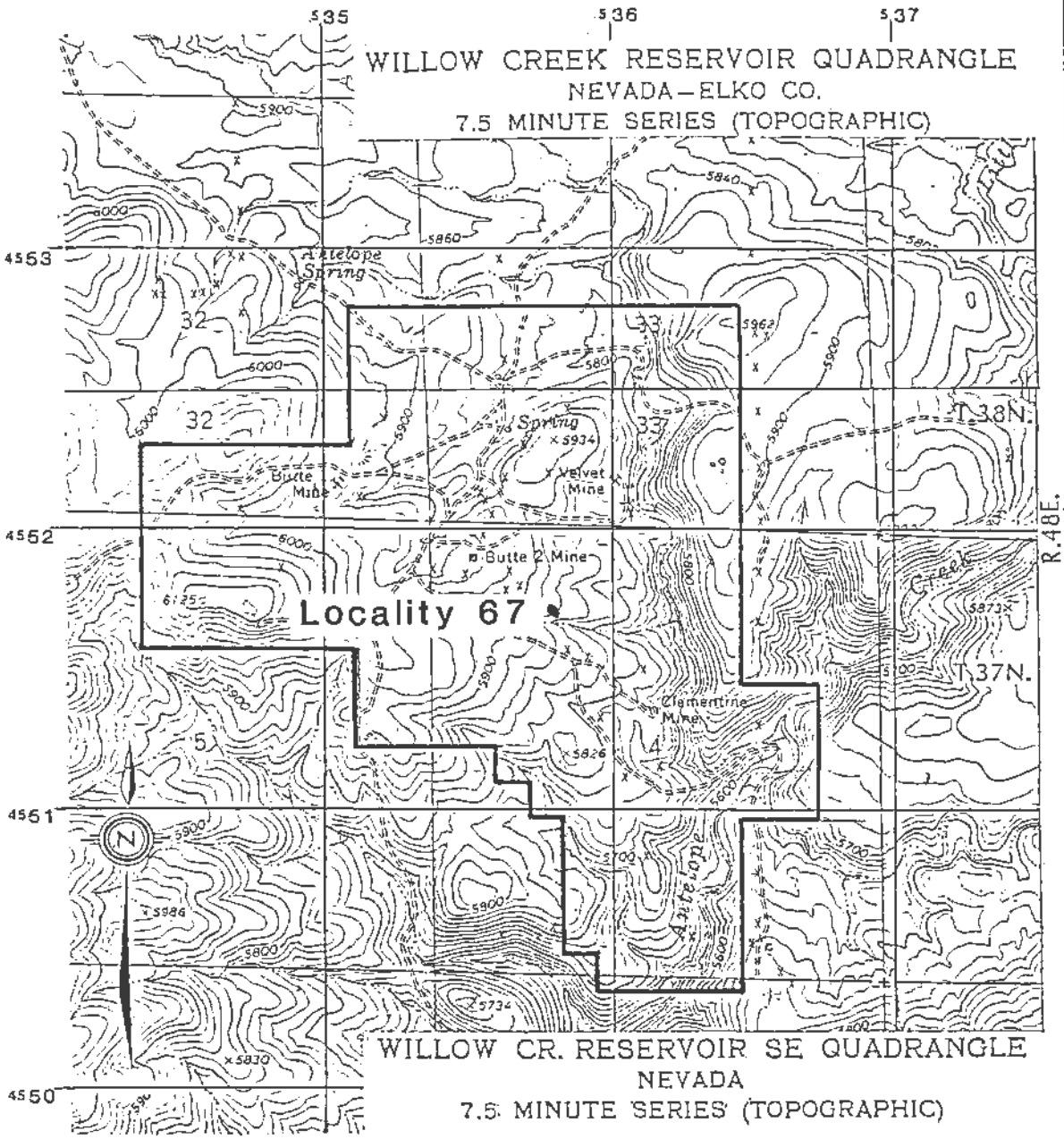
Topographic Data: Top and south-facing slopes of long, gently (5%) sloping ridge. Bedrock ledge exposed along south edge ridge; thin mantle colluvium overlies bedrock on ridge top.

Quarry Data: Boulders in colluvium, possibly bedrock, used as quarry source. Opalite is medium to good quality; color ranges from cream to salmon. Waste rock is poor quality opalite.

Description: Small complex of 7 quarry pits in shallow colluvium overlying bedrock on ridge slope. Part of same complex as localities 65, 68, and 69. Hammerstones are all rhyolite, likely from Velvet Canyon.

Site Condition: Very good.

Remarks: Part of significant complex designated localities 65-69 (see remarks for Locality 65). An area of Big Sagebrush near pit features (57-7) indicates deeper soil (possible subsurface cultural deposit); associated moderate density flake scatter may reflect reduction of transported materials.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Crabtree Ridge

Locality No.: 68 Type: Outcrop Quarry Complex

UTM: 535900E/4551700N

Size: 30m NS/ 75m EW Max. Area (m^2): 2,250

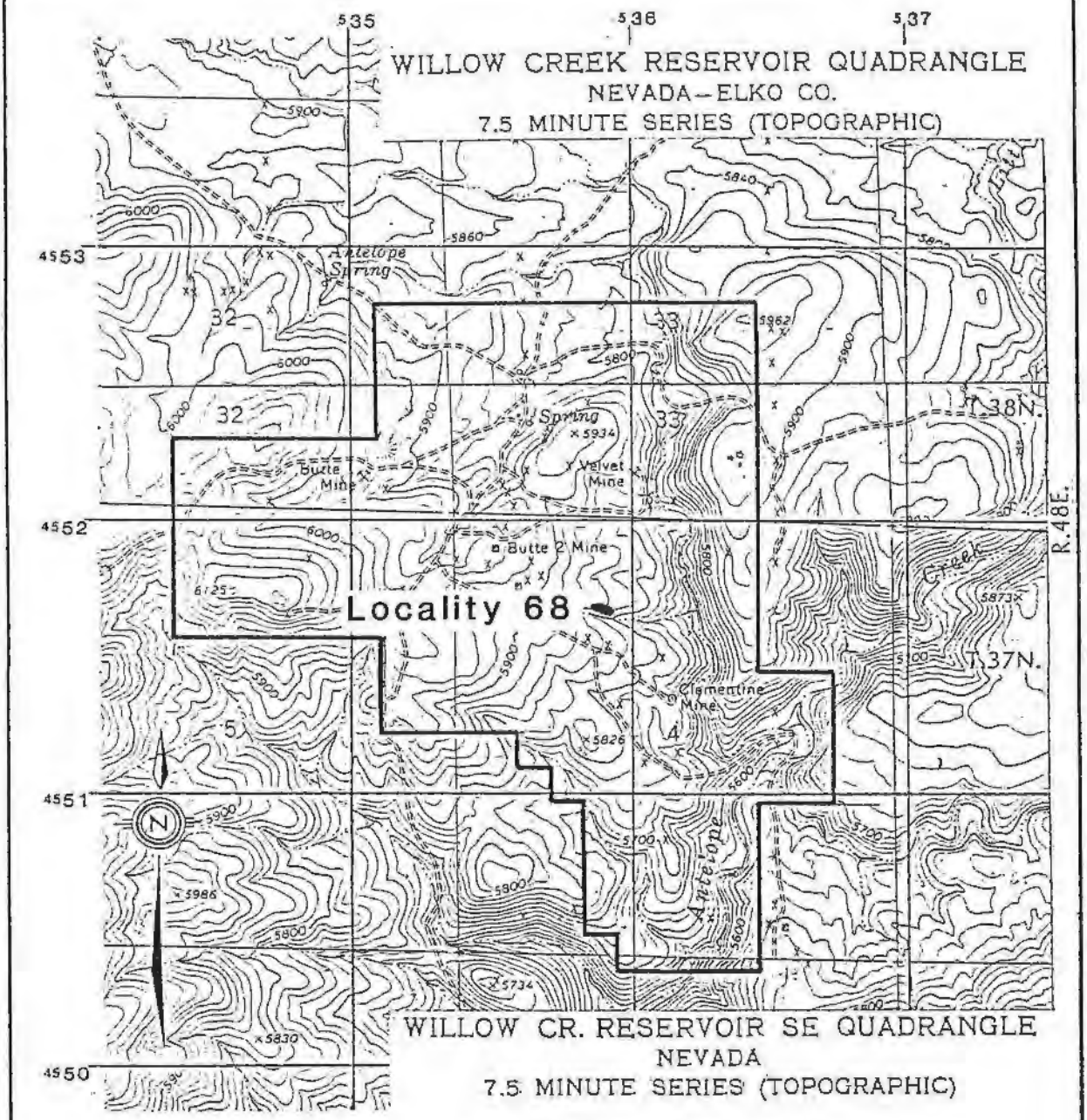
Topographic Data: Two-meter high outcrop along south edge ridge near base of ephemeral drainage.

Quarry Data: Opalite ledge outcrop is white opaque opalite of good quality, but face of formation is weathered and cracked.

Description: Bedrock ledge outcrop with batttered surfaces (feature 60-1), a prehistoric adit (1.5m wide and 1 m deep) and adjacent pit into colluvium at base outcrop (adit and pit = feature 58-6). A (rare) tabular groundstone artifact was located at the edge of the pit.

Site Condition: Good; apparently undisturbed.

Remarks: Unique adit/pit/groundstone association. Some possibility of depth. Part of significant 65-69 complex.



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Crabtree Ridge

Locality No.: 69 Type: Outcrop Quarry Complex

UTM: 536000E/4551660N

Size: 30m NS/ 30m EW Max. Area (m^2): 900

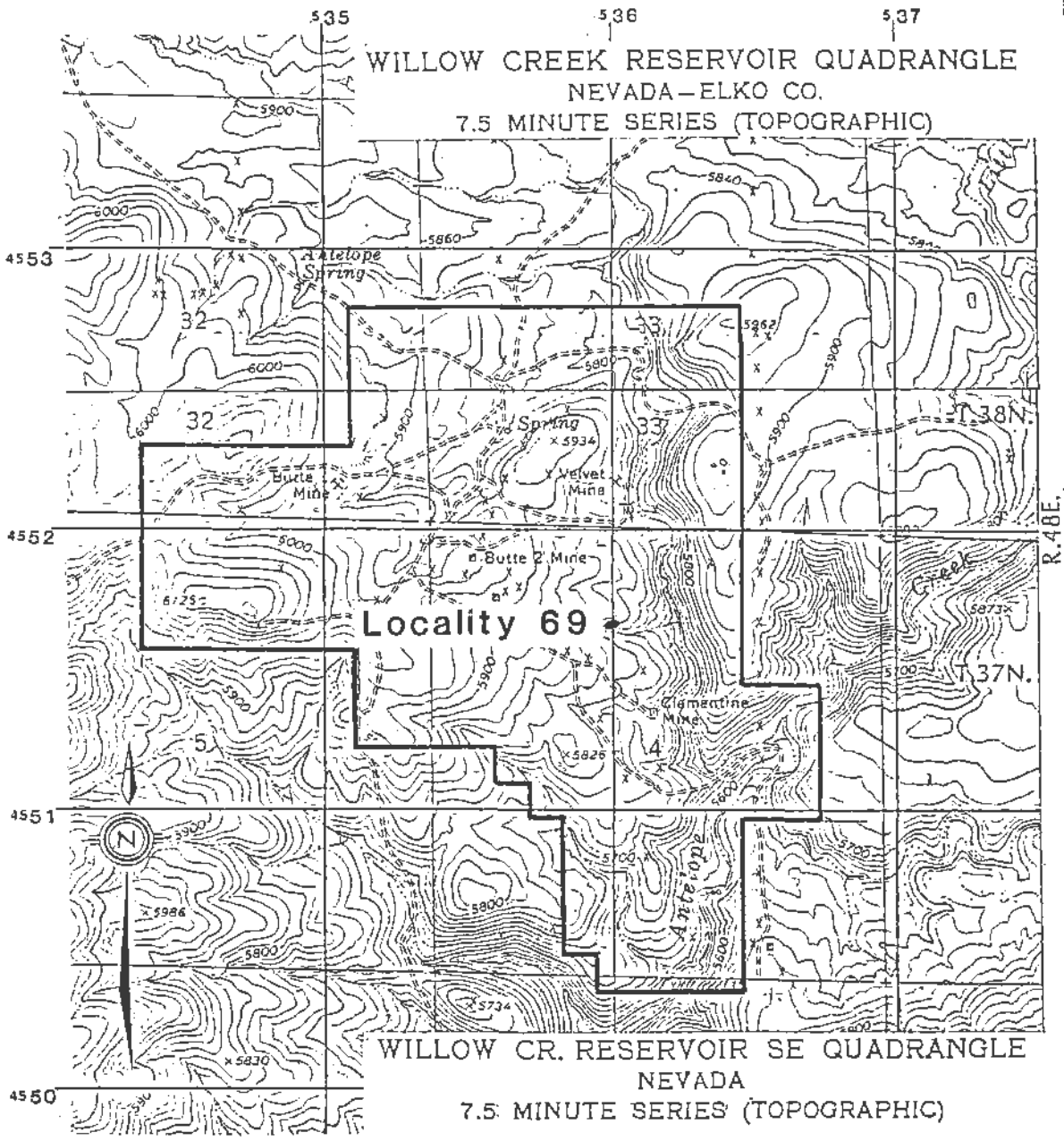
Topographic Data: Bedrock ledge outcrop on moderately steep (25%), south-facing slope at edge ephemeral drainage.

Quarry Data: Opalite extracted from colluvium and bedrock at base of outcrop; poor to medium quality material; white to cream with inclusions, some white is streaked with red.

Description: A deep pit (feature 62-5) was excavated through colluvium accumulated at base bedrock outcrop and into the underlying bedrock (center pit is 1..5 m below berm). The pit is filled with rubble and could easily be deeper; good candidate for prehistoric vertical shaft. Thick debitage accumulation around deep pit is about 10 m in diameter.

Site Condition: Apparently undisturbed.

Remarks: Possible vertical shaft is rather unique prehistoric feature. Locality is component of the significant 65-69 complex.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 70 Type: Small Outcrop-Assay Quarry

UTM: 536200E/4551700N

Size: 30m x 20m Max. Area (m^2): 600

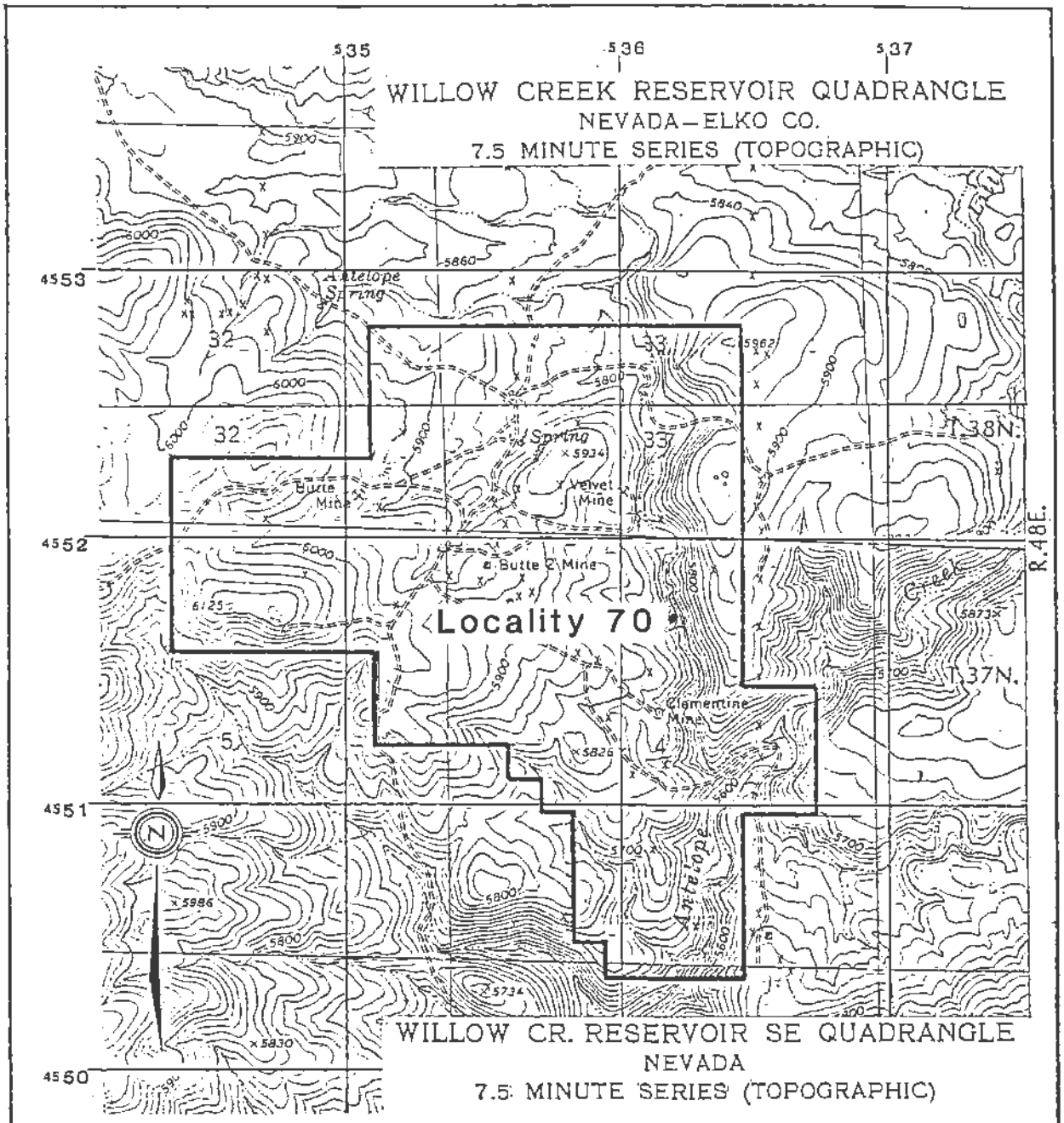
Topographic Data: Moderately steep (20%) slope, west side Velvet Canyon, near base of drainage.

Quarry Data: Bedrock outcrop exposed in canyon wall.

Description: Small outcrop quarry (feature 69-4) with light to moderate scatter of assay flakes, primary reduction debitage and a few bifaces.

Site Condition: Apparently undisturbed.

Remarks: Location not verified by transit map.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 71 Type: Small Outcrop-Assay Quarry

UTM: 536140E/4551740N

Size: 10m x 20m Max. Area (m^2): 200

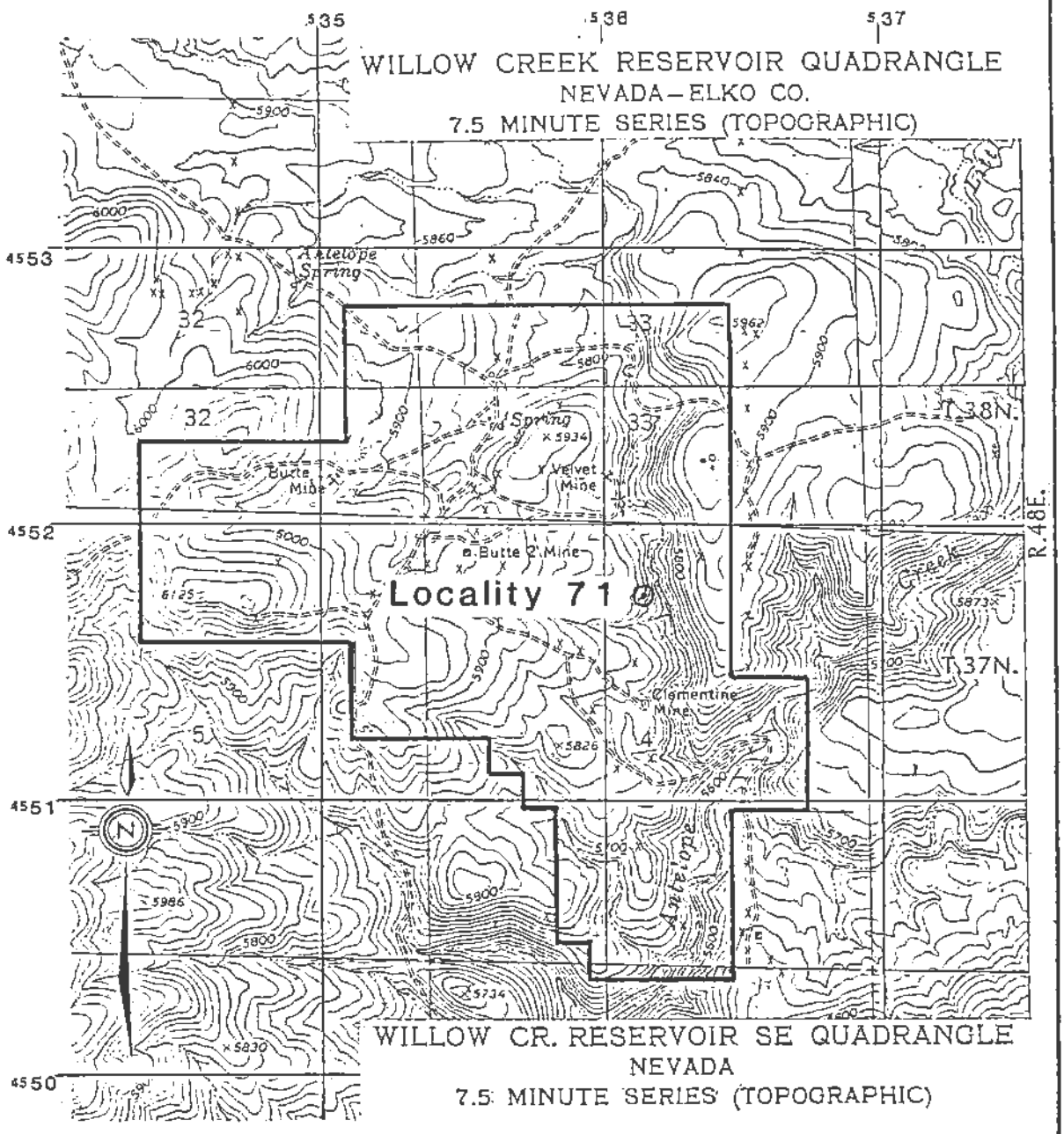
Topographic Data: In bedrock on moderately steep (20%) slope, west side of Velvet Canyon.

Quarry Data: Bedrock outcrop source.

Description: Small, isolated bedrock outcrop quarry with three incipient pit features (feature 67-3). Numerous cores and assayed cobbles in moderate density flake scatter.

Site Condition: Apparently undisturbed.

Remarks: Location not verified with transit map due to difficult terrain.



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SCALE 1:24000

1 0 1 MILE

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 72 Type: Rockshelter (Residential ?)

UTM: 536120E/4551760N

Size: shelter=6m wide, 2m high, 2m deep Max. Area (m^2): 150

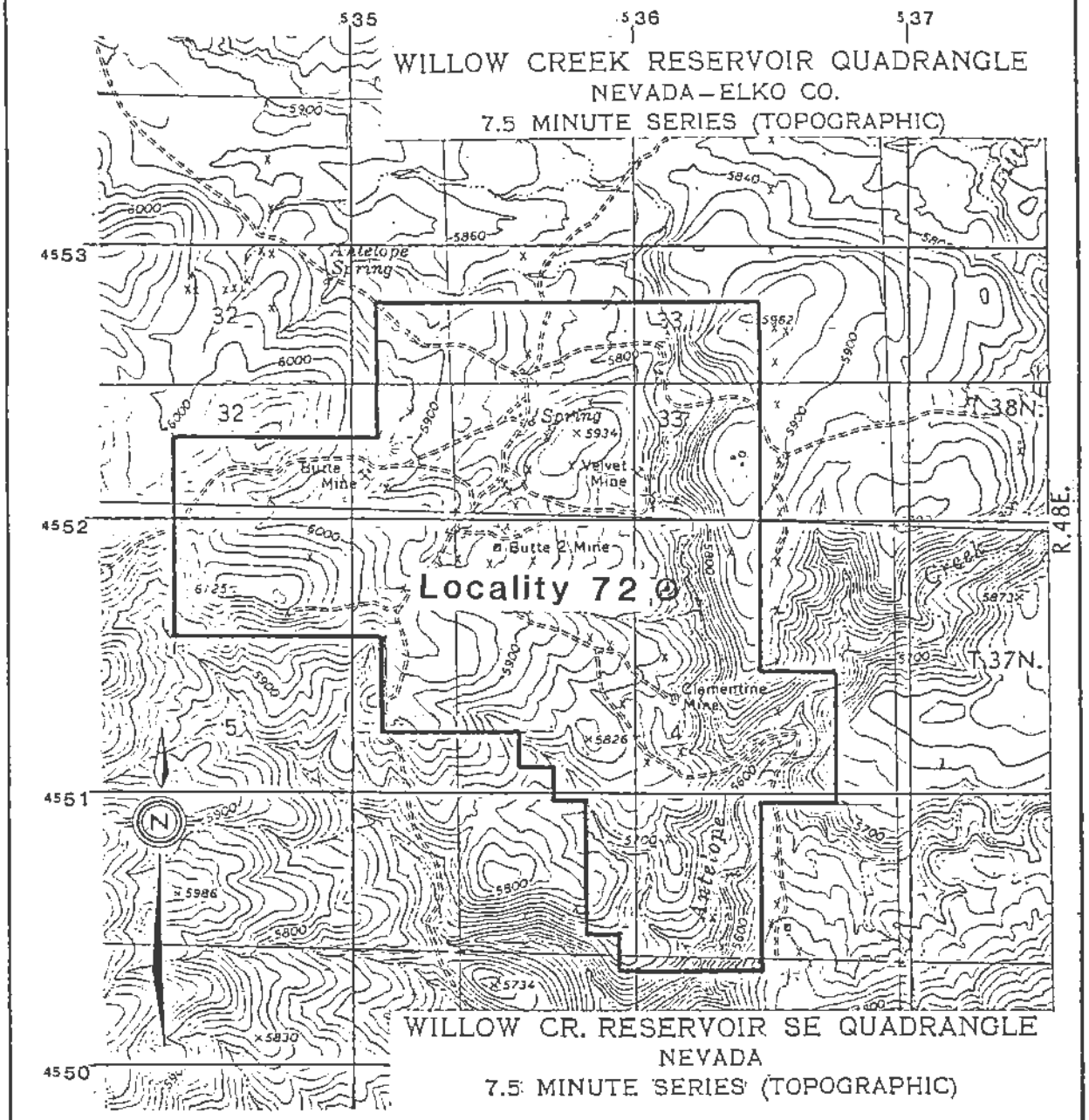
Topographic Data: In rimrock on upper western edge of Velvet Canyon, east facing.

Quarry Data: No on-site source, but hypothesized relationship to quarry pits at Locality 75.

Description: Rockshelter (feature 66-9) is similar to Clementine Shelter in the kinds of artifacts present, especially the abundance of bifaces, and its potential for undisturbed subsurface deposits. Thick accumulation of variable colored opalite debitage on platform and berm in front of alcove, one patch of debitage is yellow opalite similar to material from locality 103. A metate is cached in shelter; Elko projectile point collected from bedrock shelf downslope from shelter.

Site Condition: Undisturbed.

Remarks: Highlighted for data recovery; significant as biface production location and as potential residential site.



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September 1987

SCALE 1:24000

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7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 73 Type: Rockshelter/ (Reduction Station)

UTM: 536100E/4551780N

Size: shelter=2m wide/1m high/2m deep Max. Area (m^2): 75

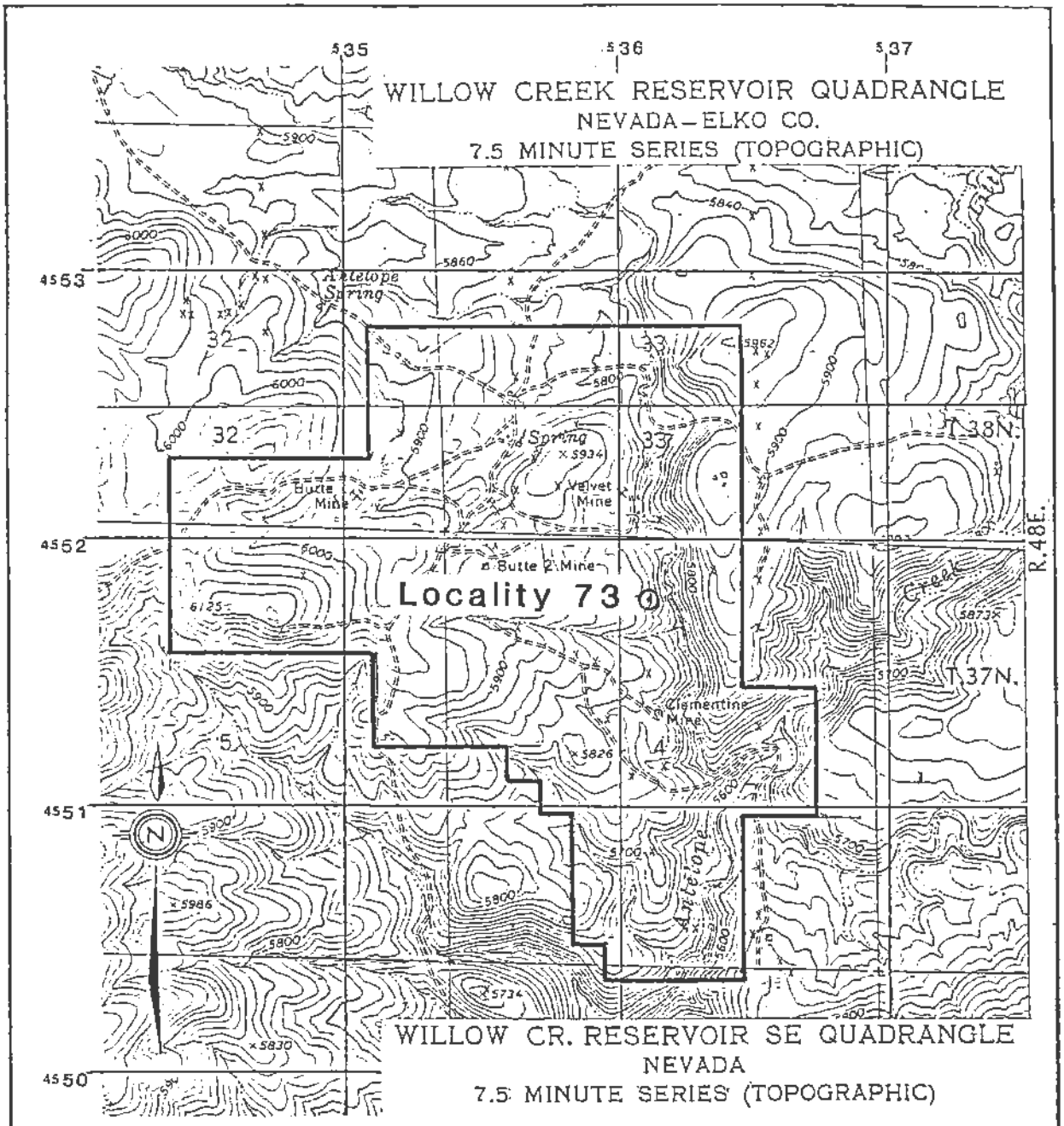
Topographic Data: Located in rimrock on upper western edge Velvet Canyon, southeast facing.

Quarry Data: No on-site quarry source; hypothesized relationship to Locality 75 quarry pits.

Description: Small alcove with limited artifact associations and apparent bedrock floor (feature 66-8). About 300 secondary flakes and one biface (all of white chert) are scattered at edge shelter (and downslope).

Site Condition: Undisturbed.

Remarks: Artifacts suggest discrete biface thinning station. Located in same formation and near Locality 72. Opalite may be derived from Locality 75.



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SCALE 1:24000

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1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 74 Type: Reduction Station Complex

UTM: 536080E/4551760N

Size: 30m x 20m Max. Area (m^2): 600

Topographic Data: Top and upper edges irregular bedrock outcrop formation in rimrock at upper western edge Velvet Canyon.

Quarry Data: No on-site source, but hypothesized relationships to Locality 75 quarry pits.

Description: Several small, discrete (5m diameter) flaking stations characterized by 100-500 core or biface thinning flakes (feature 65-8).

Site Condition: Undisturbed.

Remarks: Located near Locality 75 quarry pits and presumed to be related. Good research potential in association with localities 72, 73, 75, and 76.

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 75 Type: Quarry Pit Complex

UTM: 536080E/4551800N

Size: 45m NS/ 60m EW Max. Area (m^2): 2,700

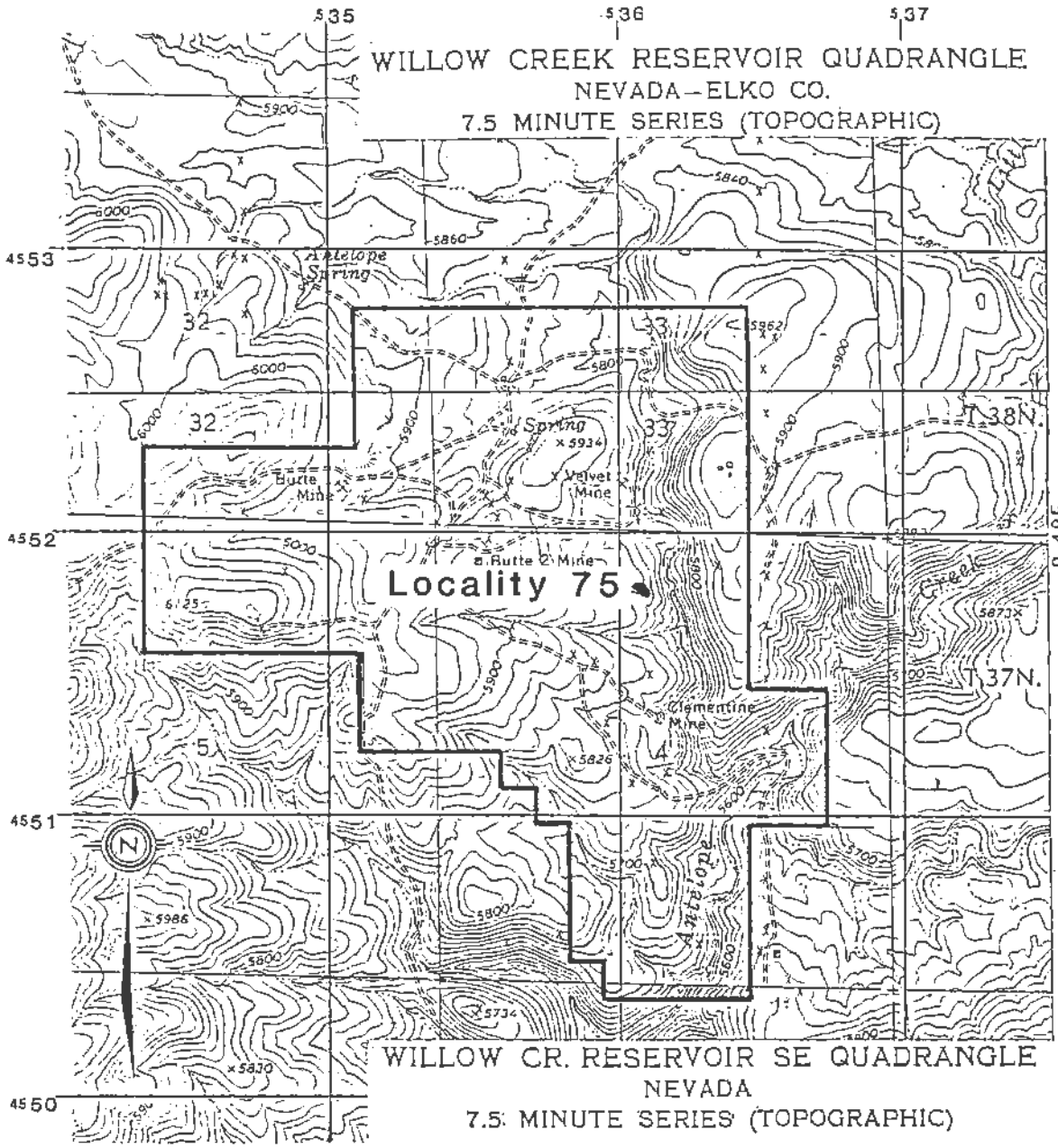
Topographic Data: Top of small saddle and moderately steep (15%) colluvial slopes of adjacent ridge; at edge rimrock, upper western edges Velvet Canyon.

Quarry Data: Cobbles in colluvium; good quality material; ranges from white to mottled grey with embedded quartz crystals.

Description: Two distinct quarry pit complexes. Feature 64-5 consists of three shallow contiguous pits on a saddle; this source is hypothesized to be related to reduction stations at localities 72-74, 76. An undesignated pit complex, with several deep excavations (and possible historic overlay), is located on the colluvial slope to the north.

Site Condition: Undisturbed.

Remarks: Pit complex feature 64-5 is hypothesized source for reduction stations at localities 73, 74, and 76 as well as possible residential locality 72.



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SCALE 1:24000

1 MILE

7000 FEET

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 76 Type: Rockshelter (Reduction Station)

UTM: 536080E/4551820N

Size: 3m x 15m Max. Area (m^2): 45

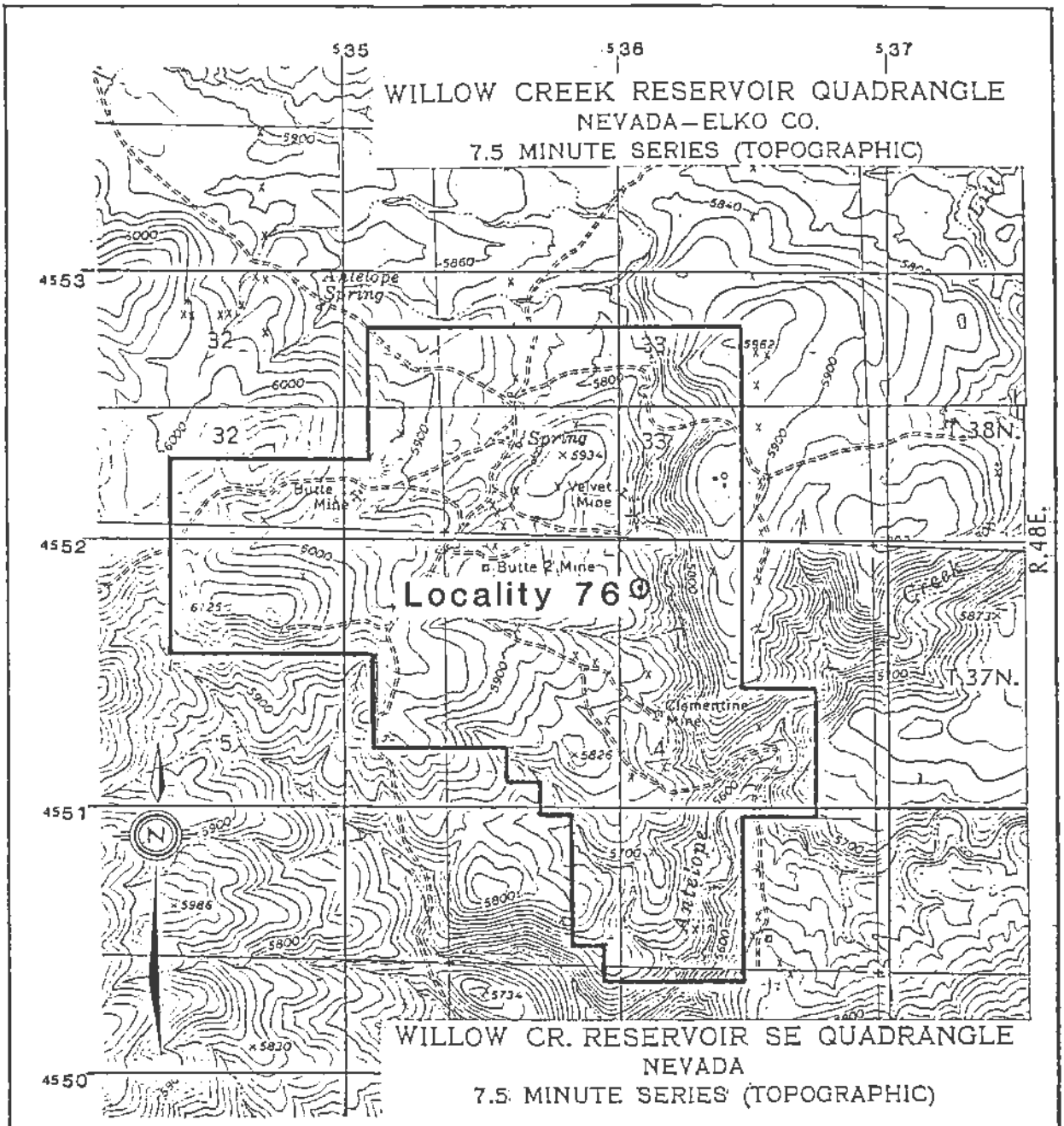
Topographic Data: Rimrock at upper western edge Velvet Canyon.

Quarry Data: No on-site source (see Locality 75).

Description: Reduction station in front of small overhang (feature 65-9). One biface and small scatter debitage associated. No potential for depth indicated.

Site Condition: Edge cut by historic ditch.

Remarks: May be associated with Locality 75 quarry pits (see also localities 72-74.



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SCALE 1:24000

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1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Rainbow Ridge

Locality No.: 77

Type: Quarry Pit Complex (Colluvium)

UTM: 535880E/4551840N

Size: 40m x 75m

Max. Area (m^2): 3,000

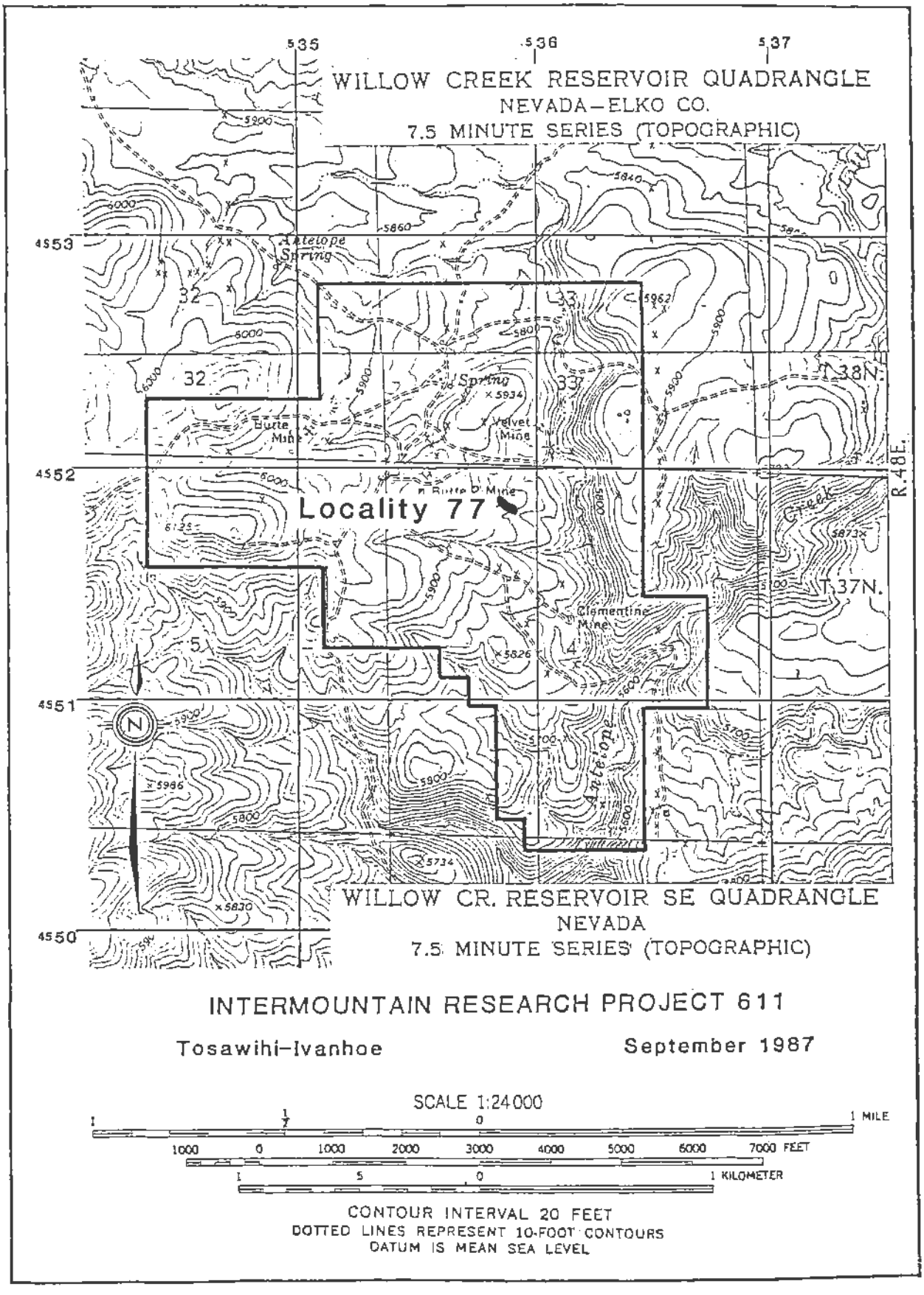
Topographic Data: Top and south edge of gently sloping (5%) colluvial ridge (east facing).

Quarry Data: Purely colluvial deposit with relatively deep soil; cream colored cobbles (as well as other colors); good quality material but high waste to opalite ratio.

Description: Small quarry pit complex comprised of 5 large, contiguous pits (feature 58-7). Large size (3m x 5m) of pits is in strong contrast to small amounts of debitage present in each.

Site Condition: Prehistoric pits may have been enhanced by historic excavations, but if so, this was not obvious.

Remarks: Need to consider the economics of prehistoric quarrying here in light of the high waste ratio, deep excavations, small amount of opalite debitage. Consider methods to segregate possible historic effects.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butte No. 2 Group

Locality No.: 78 Type: Quarry Pit Complex

UTM: 535720E/4551820N

Size: 75m NS/ 30m EW Max. Area (m^2): 2,250

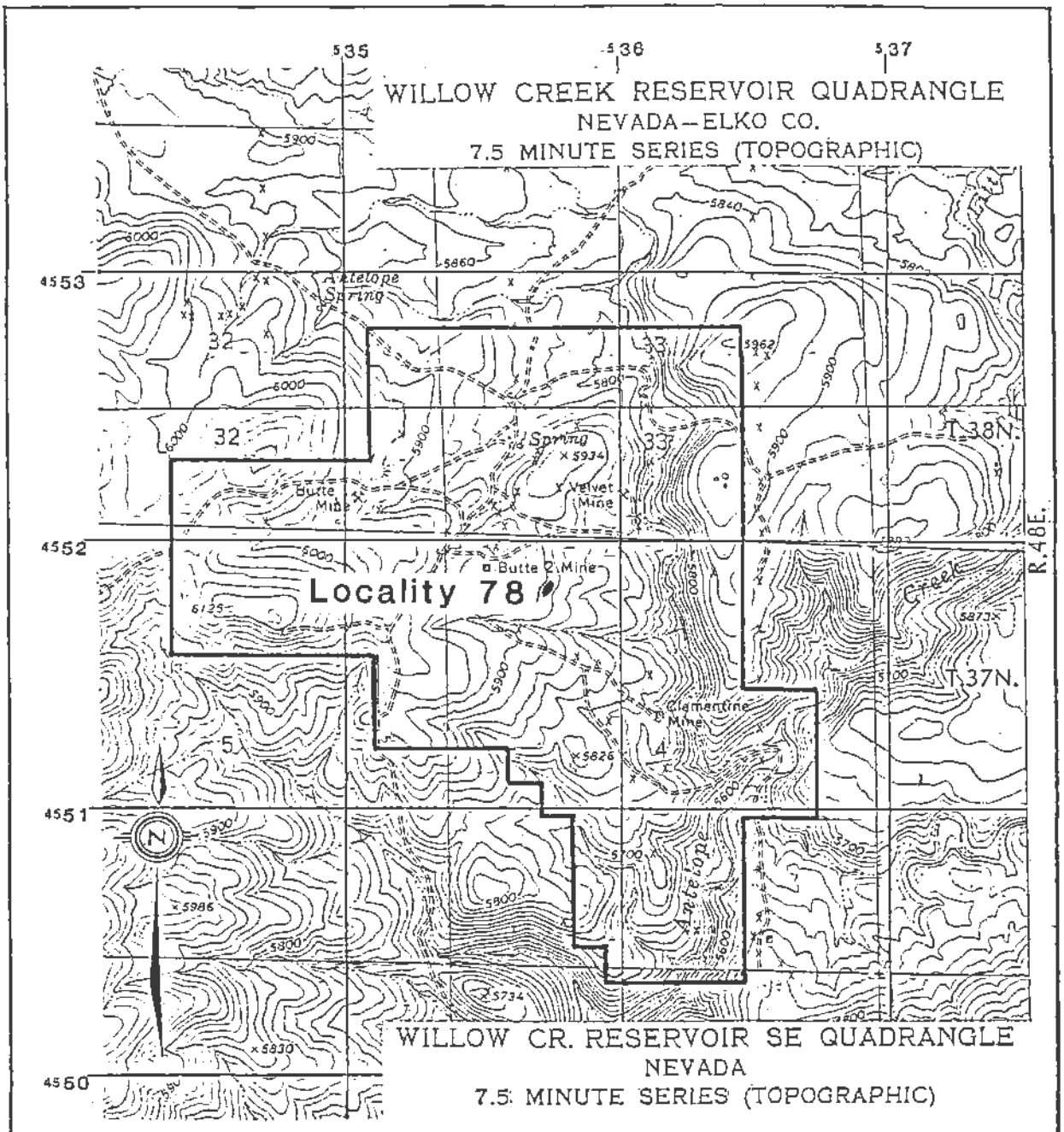
Topographic Data: East-facing ridge slope, strongly sloping (10%).

Quarry Data: Quarried opalite occurs as boulders in shallow colluvium over bedrock. A boulder outcrop and talus stripe occur on north edge locality (likely initial assay area). Material is good quality, opaque, cream-colored chert, weathering to tan.

Description: Small complex of 5 contiguous shallow pits (feature 54-9) were excavated through thin colluvium to extract cobbles and boulders over weathered bedrock. A separate quarry pit (feature 53-4) is located to the south of the small complex. On the north surface exposures of shallow bedrock, a cobble talus stripe, and scattered boulders (feature 54-8) evidences primarily assay flakes and shatter.

Site Condition: Adjacent to extensive disturbance from Butte No. 2 Mine (on west), but locality as mapped is essentially undisturbed.

Remarks: Typical of several localities where bedrock is near surface; small outcrops evidence assay materials and pits are located where a thin layer of colluvium covers better opalite source.



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butte No. 2 Group

Locality No.: 79 (Butte No. 2 Group) Type: Quarry Pit Complex

UTM: 535740E/4551880N

Size: 60m NS/ 150m EW Max. Area (m^2): 9,000

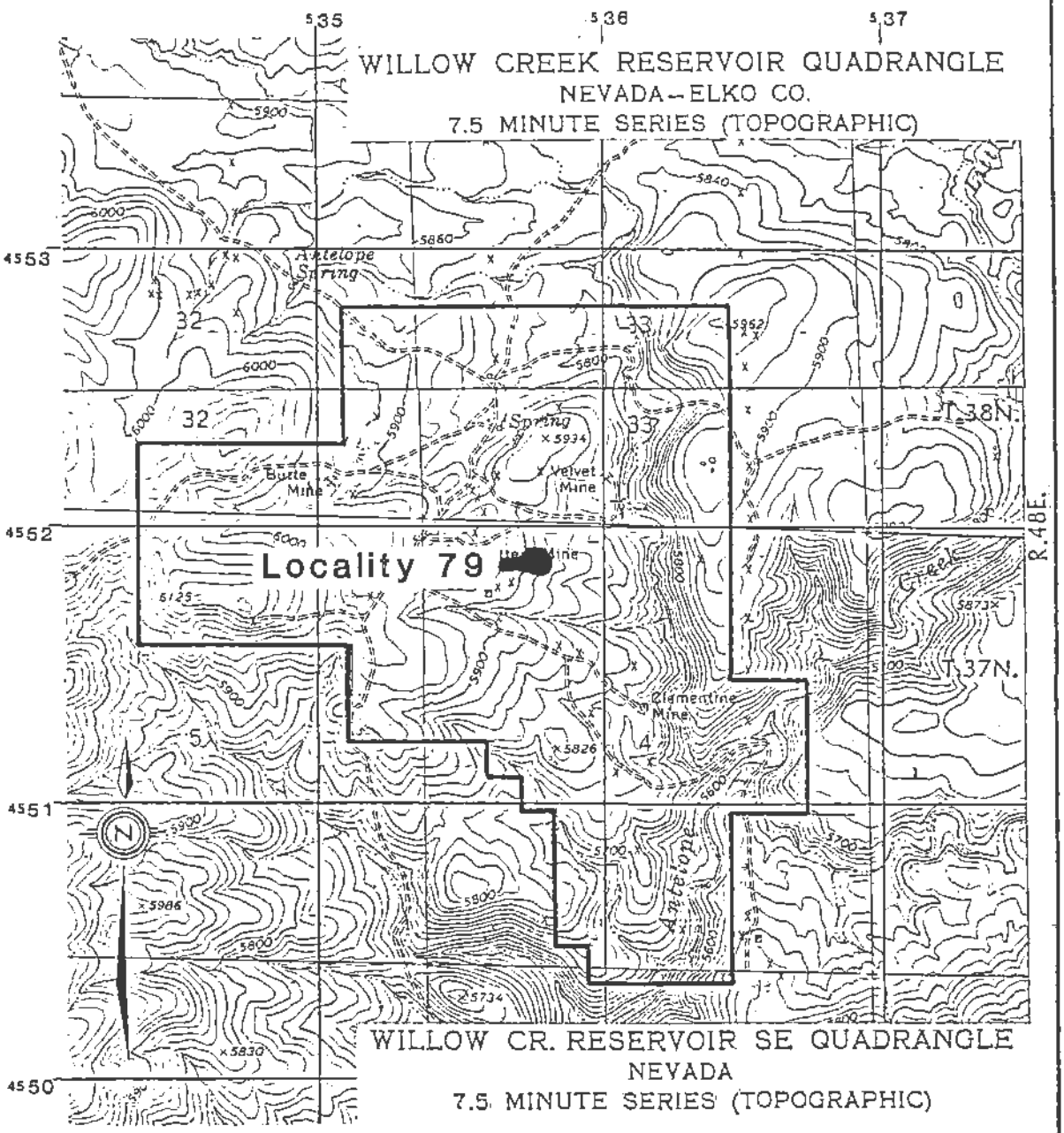
Topographic Data: Flat bench with grassy mound near low bedrock exposure on strongly sloping (10%), east-facing slope.

Quarry Data: Cobbles from near-surface bedrock as well as from 2m deep soil lobe. Material quality variable, from poor to good.

Description: Quarry pit complex consisting of two different kinds of features. Bedrock outcrops at ground surface on the (southwestern) upper slopes. Here, cobbles were quarried from a series of shallow pits excavated into weathered bedrock (features 51-1, 52-1). On the north edge of the bedrock, lower on the slope, a lobe of fine-grained sediments (supporting a healthy stand of bunchgrasses) evidence several large, deep pits (feature 54-7). The grassy mound is probably groundwater controlled (perhaps an old spring); pits were excavated through the soil to the underlying colluvium and bedrock. Lots of soil in relationship to debitage and waste rock.

Site Condition: Adjacent intensive historic Butte No. 2 mining disturbance; site as mapped is not visibly disturbed.

Remarks: The deep soil in grassy mound (feature 54-7) is similar to features noted at the north end of the district (Quhilliebillie zone). In most grassy mounds, "flakes" are components of the soil matrix, but quarry features (pits) are not. This raises the issue of the large deep pits in Locality 79; perhaps these features are not prehistoric excavations (why the low debitage and waste rock to soil ratio?). Of more interest may be the nature of the soil feature, its formation, and the incorporation of cultural debitage to depth.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No: 80 Type: Rockshelter (Undetermined Type)

UTM: 536180E/4551440N

Size: 2m wide /3m deep Max. Area (m^2): 15

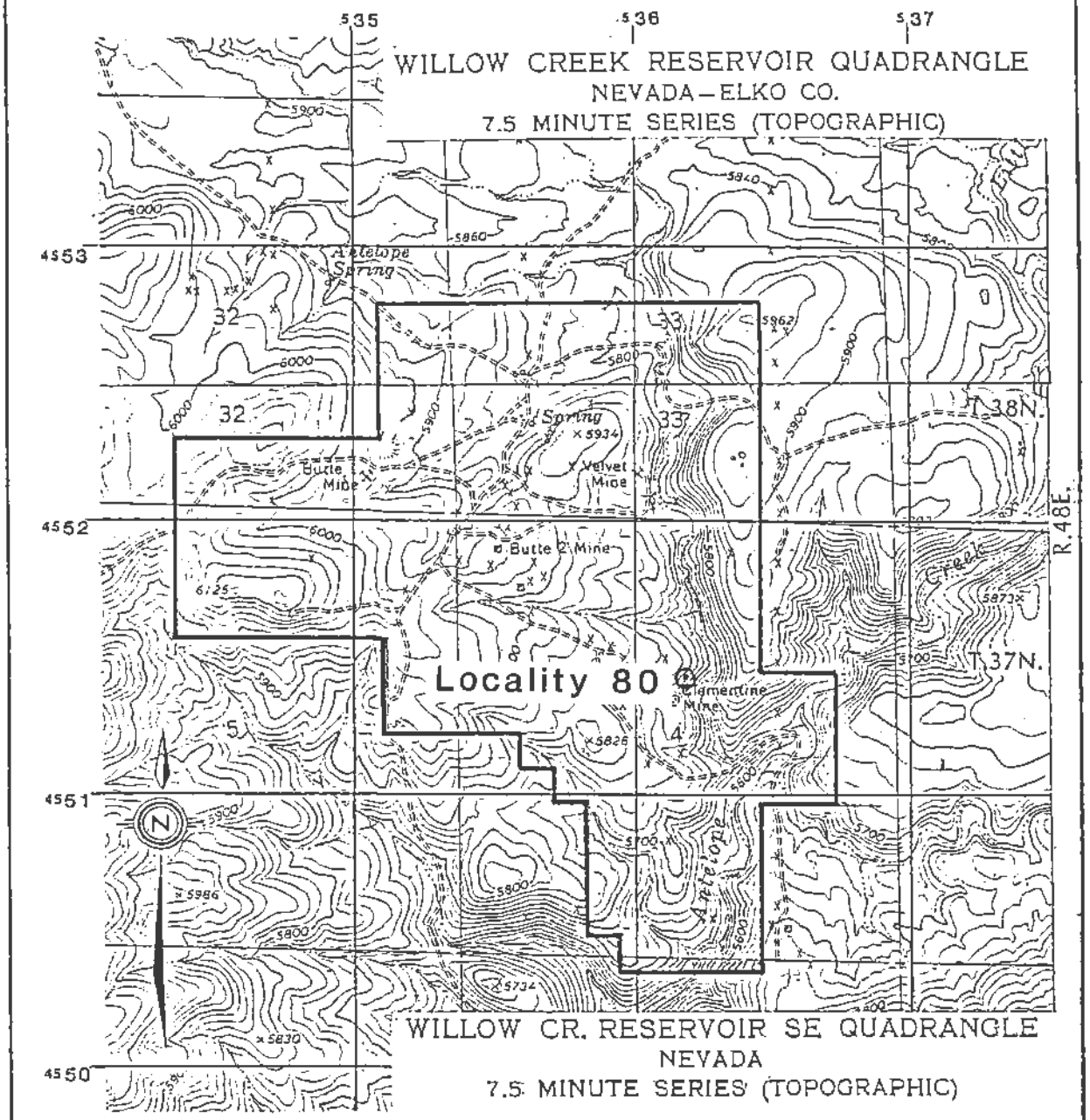
Topographic Data: On rimrock, west side of Velvet Canyon.

Quarry Data: Variable quality bedrock outcrop.

Description: Rockshelter (feature 69-A) filled with soil and flakes at base rimrock.

Site Condition: Undisturbed.

Remarks: Rockshelter should be assessed by test excavation.



INTERMOUNTAIN RESEARCH PROJECT 611

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CONTOUR INTERVAL 20 FEET
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DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bordes Ridge

Locality No.: 81 Type: Quarry Pit Complex

UTM: 535840E/4551840N

Size: 75m NS/ 45m EW Max. Area (m^2): 3,375

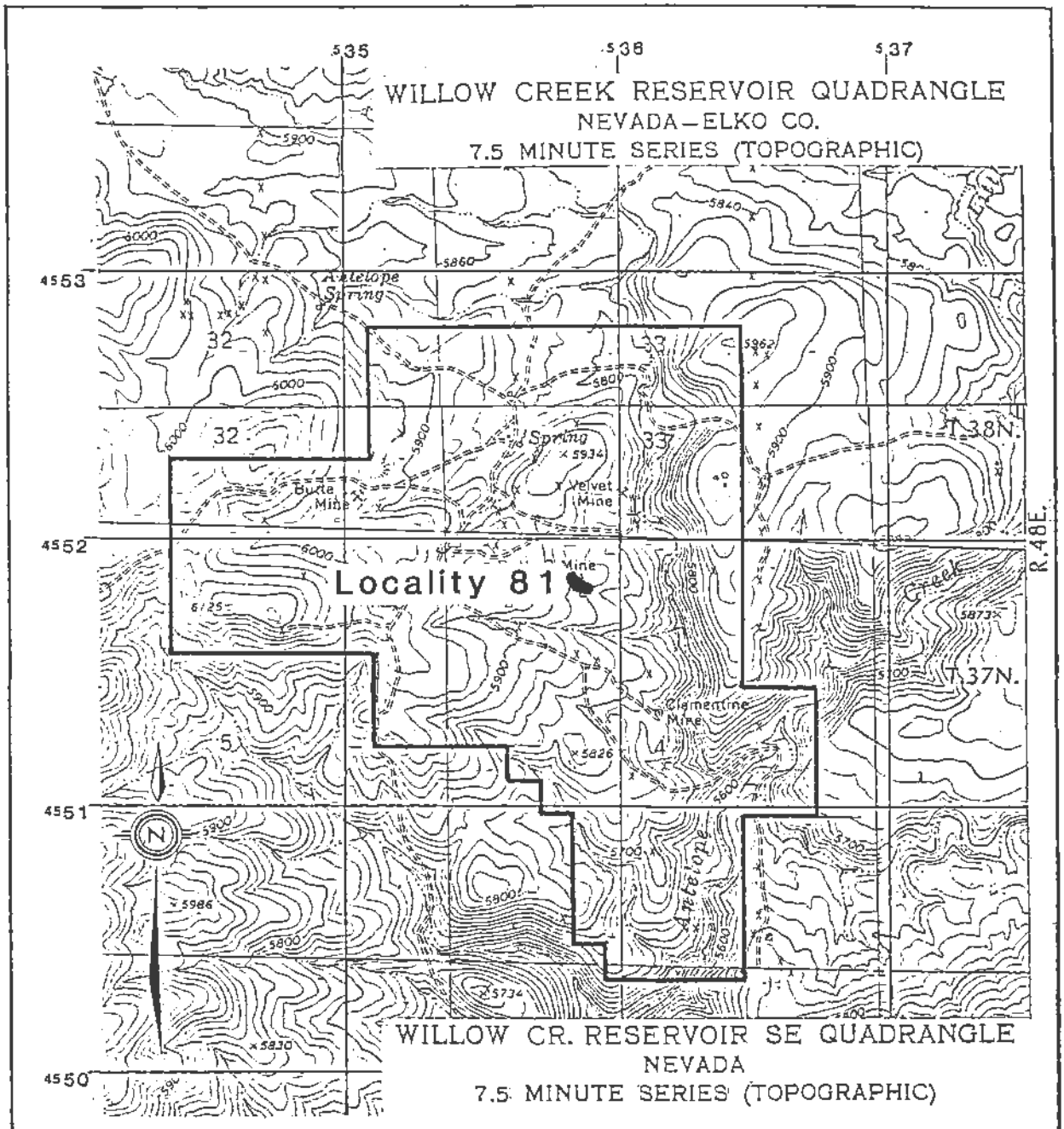
Topographic Data: Small bench at break in slope on ridge slope (15%), east-facing.

Quarry Data: Edge of near-surface bedrock defines break in slope; pits excavated through thin colluvium overlying bedrock. Exposed opalite in pits is white-grey with red streaks. Surrounding debitage highly variable in color.

Description: Small pit complex (feature 59-8) in shallow colluvium over bedrock on ridge slope. Battered bedrock is exposed in the pit bottom and on uphill slope. Colors exposed in quarry pits (grey-white with red streaks) is quite different from the wide range of colors (brown, purple, pink) noted in debitage surrounding pit features (similar to Locality 103 quarry source).

Site Condition: Undisturbed.

Remarks: Opalite in quarry pits is similar in color to that at nearby Locality 86. Brown-purple-pink debitage similar to that from multicolored quarry pits at Locality 103.



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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 82 Type: Quarry Pit Complex

UTM: 536100 E/4552000 N

Size: 90m NS/ 230m EW Max. Area (m^2): 20,700

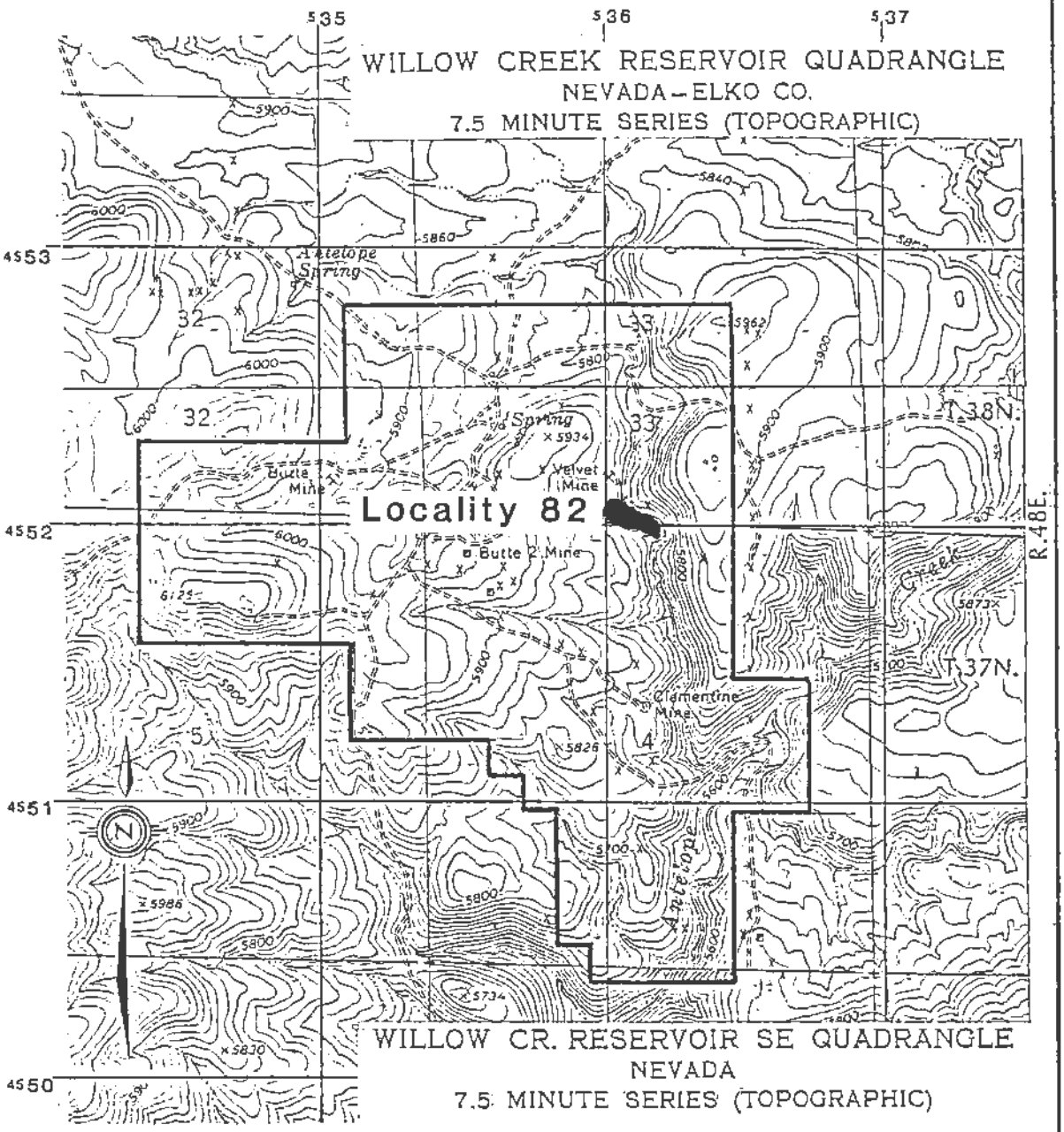
Topographic Data: Strongly sloping (12-15%), east-facing colluvial slope with bedrock outcrop on upper west edge and very steep rimrock on north edge; formation extends from base of Velvet Canyon to rimrock 20m (in elevation) above drainage.

Quarry Data: Extensive quarrying of boulders in colluvium at base of bedrock exposures as well as into thicker colluvium on lower slope.

Description: Intensive pit and outcrop quarry with six large pits (feature 68-7, 66-10, 66-11) excavated into deep colluvium near base of slope, and myriad shallow pits on upper slopes where bedrock is at or near surface. One fair-sized pit (feature 67-9a) was excavated into the base of an exposed bedrock ledge; an adit extends into the bedrock itself. Assay flakes are also common along the ledge exposed on extreme west edge locality. Small flaking stations are located on the edge of the rimrock on the northwest edge of canyon. The lowest terrace along the creek is a large flat covered with flakes and may have served for short-term residential use. (Several perennial springs are located in the base of Upper Velvet Canyon.)

Site Condition: Several small historic pits noted, but with minimal impact on prehistoric features.

Remarks: One of several intensive quarry localities in Upper Velvet Canyon; rockshelters (localities 83, 84) are located in the rimrock on the north side of the locality. Also may have open residential component.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

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DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 83 (Velvet Shelter) Type: Rockshelter Complex (Residential ?)

UTM: 536080E/4552080N

Size: 30m wide/50cm high at mouth/8m deep Max. Area (m^2): 900

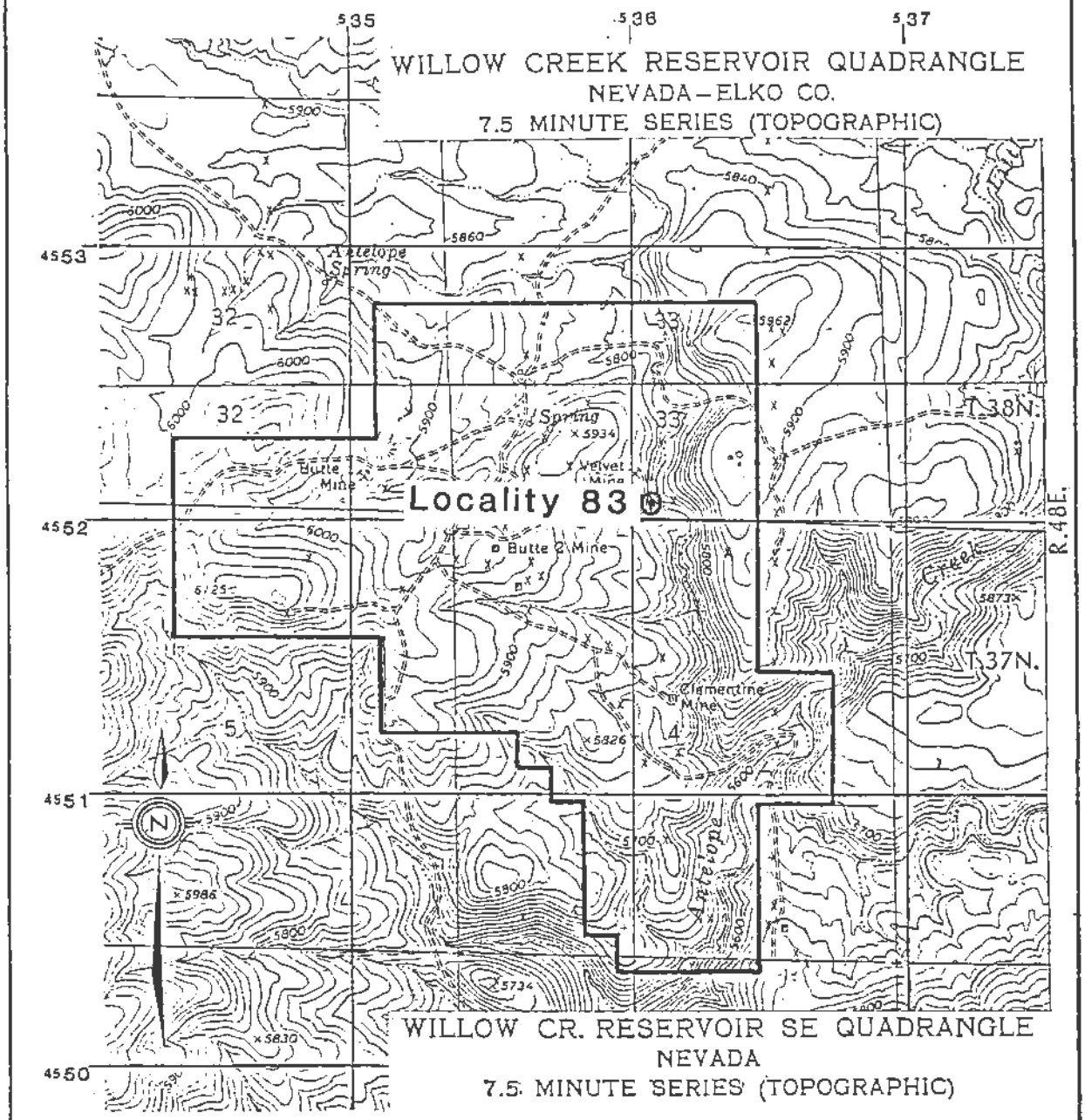
Topographic Data: Base of cliff, at contact colluvial slope, 5m (in elevation) above drainage on west edge Velvet Canyon. Perennial spring (seep) in base of drainage.

Quarry Data: No on-site source.

Description: Complex of three adjacent, but separate, rockshelter chambers (feature 66-12). Shelters are filled with soil and flakes and access to back of shelters requires a belly crawl; however, one chamber is at least 8m deep. Thick accumulation of cultural materials and soil to unknown depth in shelters and along steep apron slope in front.

Site Condition: Undisturbed. Road cuts colluvial slope on shelter apron; could provide profile for easy face-up.

Remarks: Potential for significant subsurface deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

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DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 84 Type: Small Reduction Station (Secondary Redeposition ?)

UTM: 536060E/4552060N

Size: 1m x 1m (45 cm high) Max. Area (m^2): 2

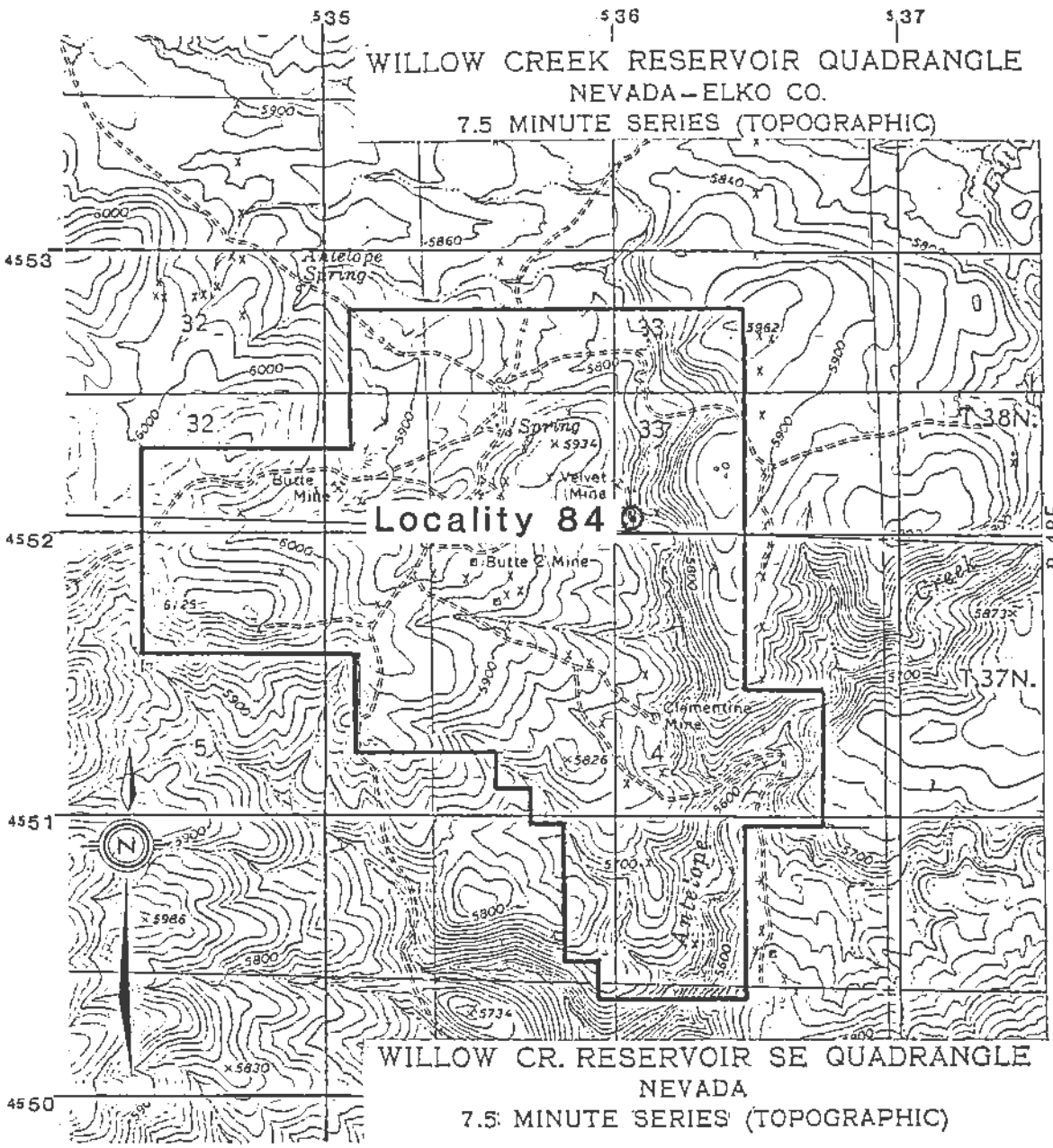
Topographic Data: In rocks on moderately steep (20%) slope on the west side of Velvet Canyon.

Quarry Data: No on-site source.

Description: Small accumulation of debitage and 2 bifaces in narrow rock crevice (feature 65-10); may be result of packrats or slopewash or other secondary deposition.

Site Condition: Apparently redeposited.

Remarks: Determine source of lithics and whether reflect secondary deposition.



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DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 85 Type: Outcrop Quarry Complex

UTM: 536140E/4552120N

Size: 150m NS/ 60m EW Max. Area (m^2): 9,000

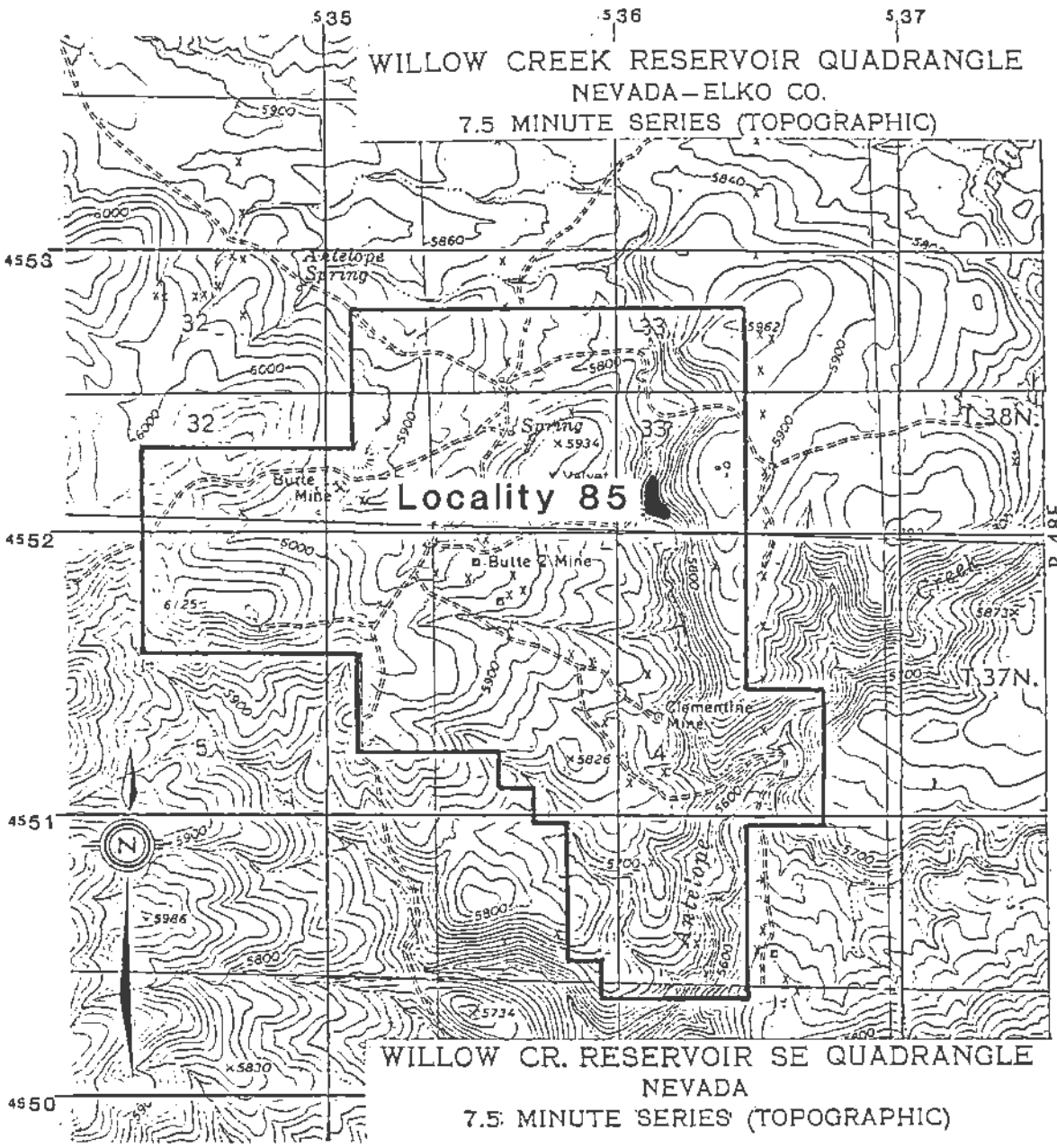
Topographic Data: Bedrock ledge exposure at base of Velvet Canyon, east side.

Quarry Data: Intensively quarried bedrock ledge.

Description: Large quarry along weathered bedrock; thick accumulation of reduction debitage (features 67-1, 67-1A). Intensive reduction zone with adits (see Localities 214, 215), a rockshelter (Locality 213), pits, and cultural talus (feature 67-2).

Site Condition: Road cuts edge site; otherwise undisturbed.

Remarks: One of several similar "pristine" bedrock ledge quarries in Upper Velvet Canyon.



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SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bordes Ridge

Locality No.: 86

Type: Quarry Pit Complex/ Reduction Station Complex

UTM: 535840E/4552060N

Size: 130m NS/ 30m EW

Max. Area (m^2): 3,900

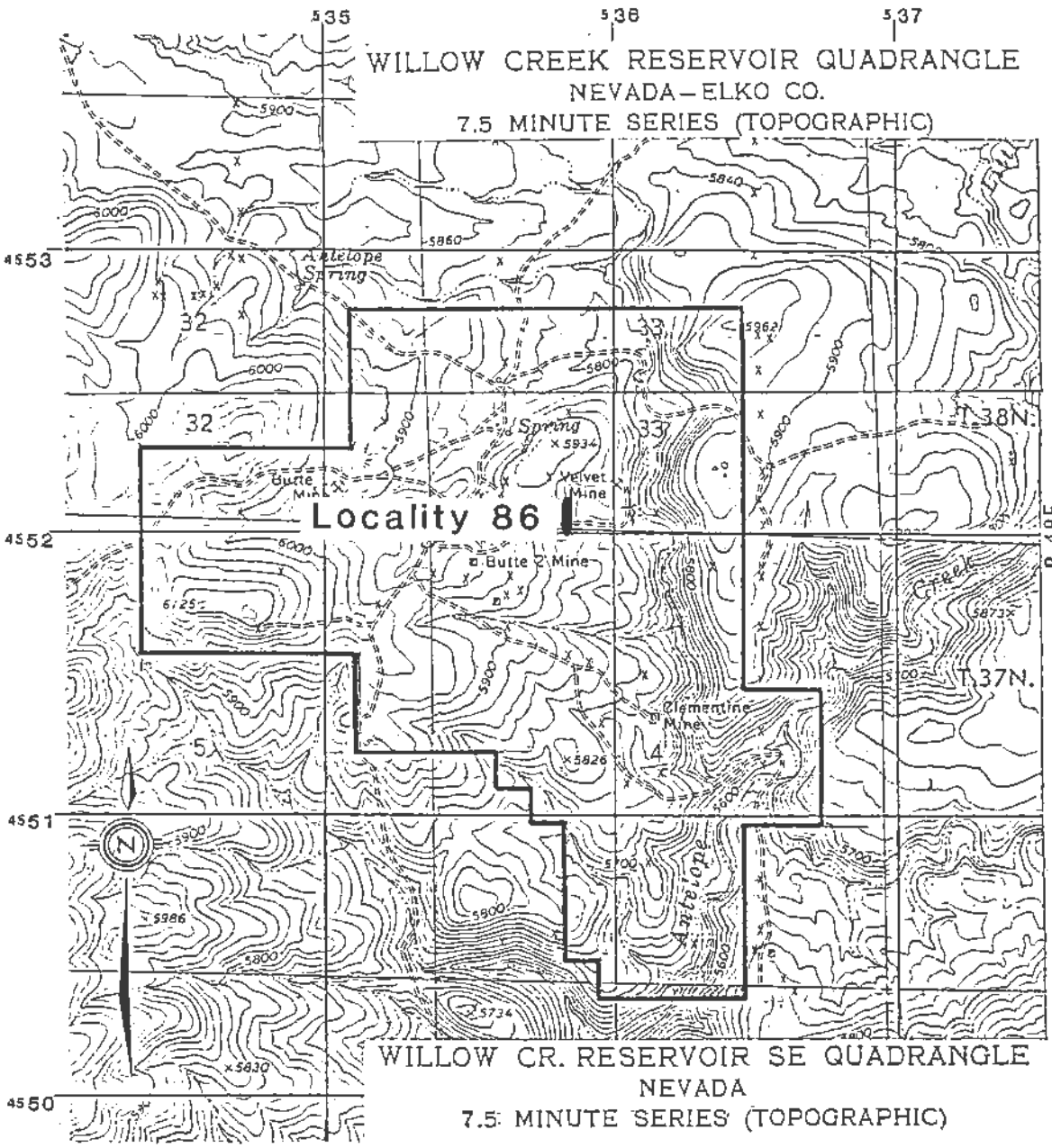
Topographic Data: Upper edge moderately steep (16%), east-facing colluvial slope and small bench above sloping (north-south trending) bedrock outcrop.

Quarry Data: Boulders in colluvium above bedrock ledge outcrop. Toolstone is good quality cream, cream-with-red-streaks, and salmon-colored; waste rock is grainy, vuggy opalite.

Description: Small complex of three pits (feature 57-1) in colluvium above bedrock, arranged in north-south line continuous with exposed bedrock, perpendicular to ridge slope. Exposed bedrock ledge evidences numerous small flaking stations.

Site Condition: Undisturbed.

Remarks: Similar-colored opalite visible in quarry pits at Locality 81.



INTERMOUNTAIN RESEARCH PROJECT 611

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butte No. 2 Group

Locality No.: 87 Type: Quarry Pit Complex

UTM: 535660E/4552060N

Size: 170 m x 75 m Max. Area (m^2): 12,750

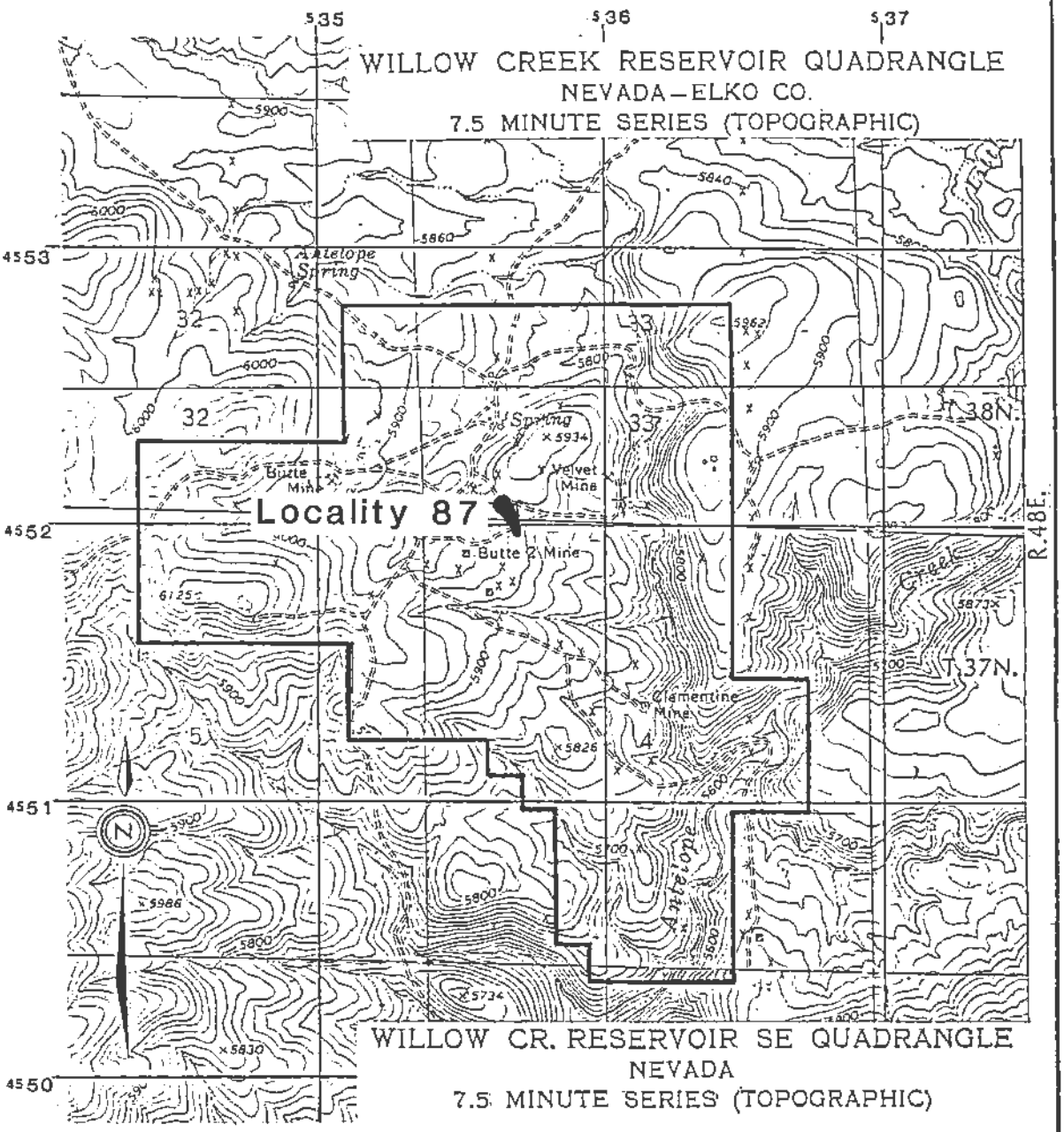
Topographic Data: Gentle slopes (6%) above saddle near top of ridge.

Quarry Data: Cobbles and boulders in colluvium.

Description: Nearly continuous series of deep pits in colluvium with thick reduction accumulation (features 49-1, 50-1, 51-2) and shallow pit complex along slope contour following near-surface bedrock (feature 52-2).

Site Condition: Adjacent extensive disturbance from Butte No. 2 Mine; undetermined (but significant) degree of historic pit disturbance in intensive prehistoric mining area.

Remarks: Historic overlay obscures prehistoric record.



INTERMOUNTAIN RESEARCH PROJECT 611

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Clementine Ridge

Locality No.: 88 Type: Rockshelter (Reduction Station)

UTM: 536140 E / 4551200 N

Size: shelter=2.5m wide/1m deep/1m high Max. Area (m^2): 50

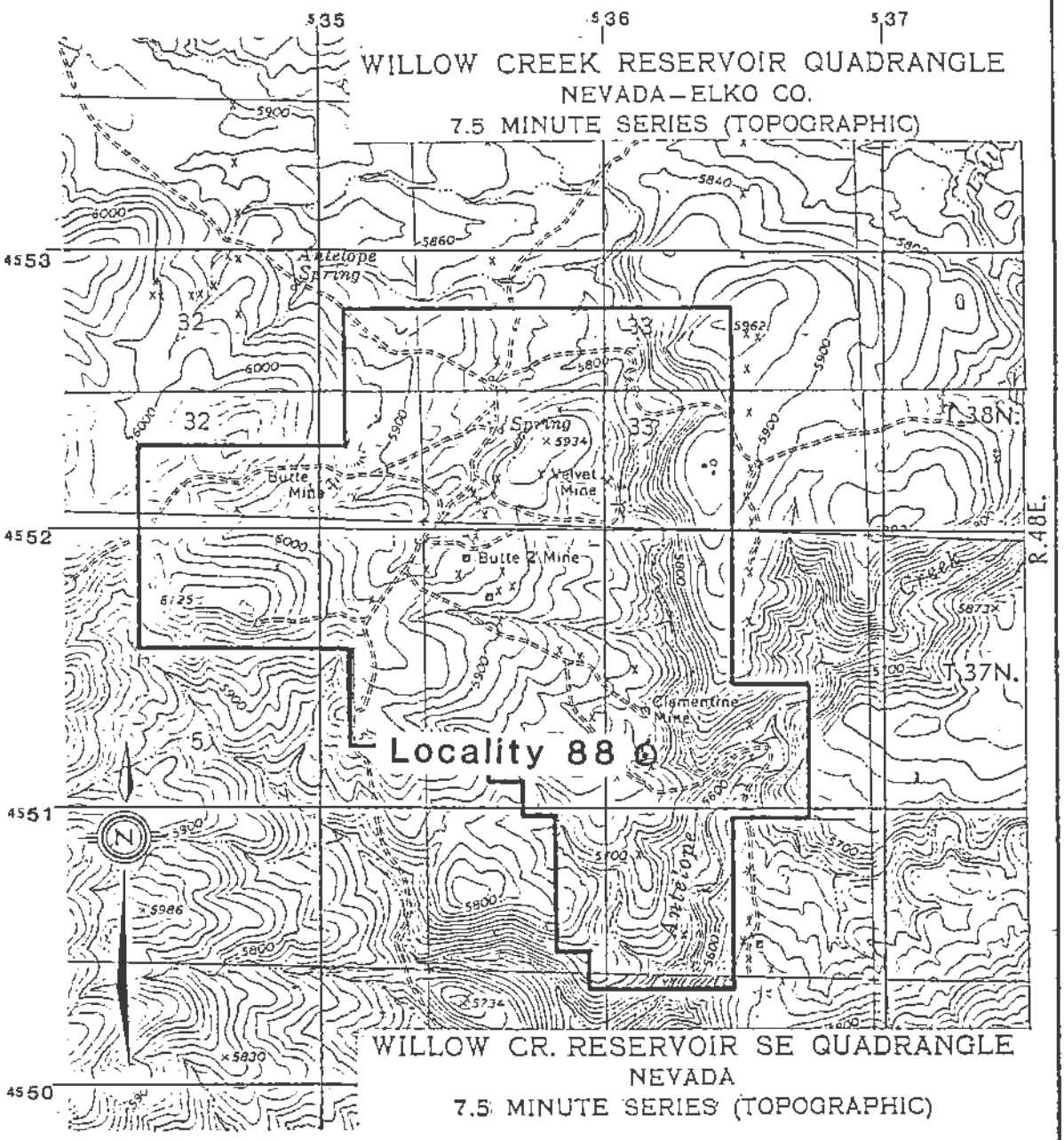
Topographic Data: South edge bedrock outcrop on moderately sloping (9%) knoll slope.

Quarry Data: No on-site opalite source.

Description: Small alcove with reduction debris eroding out of apron slope (feature 66-18); some potential for limited subsurface deposits. Artifacts include four finely made, salmon-pink bifaces and thinning flakes of both white and pink opalite.

Site Condition: Erosion gully, but otherwise undisturbed.

Remarks: Top and west edge of bedrock knoll has numerous small reduction scatters (see Locality 33). Pink opalite may derive from the Pink Pit (see Locality 38); nearby rockshelter (Locality 89) has similar pink materials.



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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Clementine Ridge

Locality No.: 89 Type: Rockshelter (Reduction Station)

UTM: 536140E/4551160N

Size: 2m wide/50cm deep/3m high Max. Area (m^2): 50

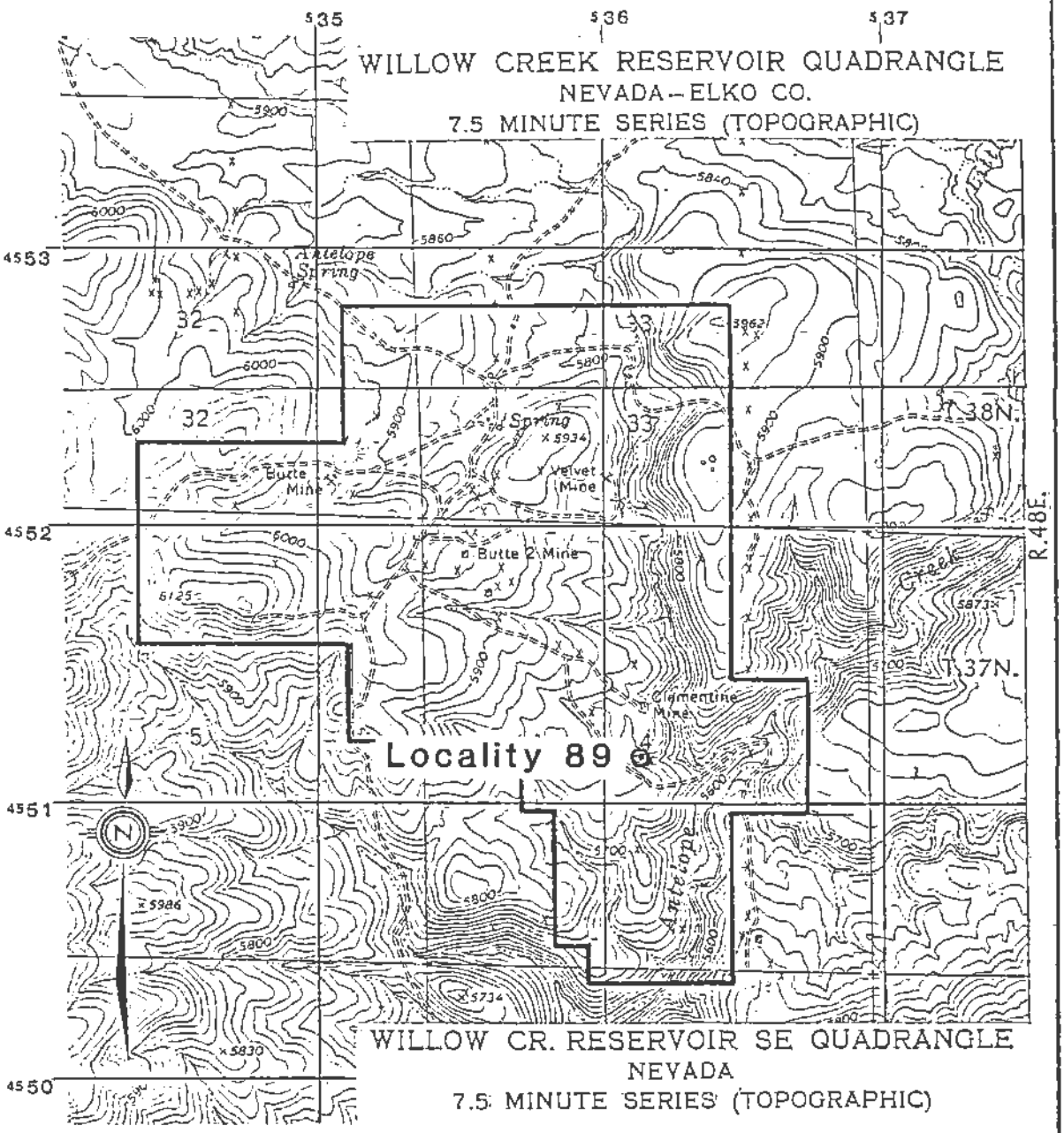
Topographic Data: Large Rock near base of ephemeral drainage.

Quarry Data: No on-site opalite source.

Description: Slight overhang in large rock at base drainage apparently used as reduction station (feature 66-19); small scatter pink flakes on apron in front overhang.

Site Condition: Undisturbed.

Remarks: Pink opalite may derive from the Pink Pit (Locality 38); see also nearby shelter Locality 88.



INTERMOUNTAIN RESEARCH PROJECT 611

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Clementine Ridge

Locality No.: 90 Type: Isolated Artifacts

UTM: 536160E/4551160N

Size: N/A Max. Area (m²): N/A

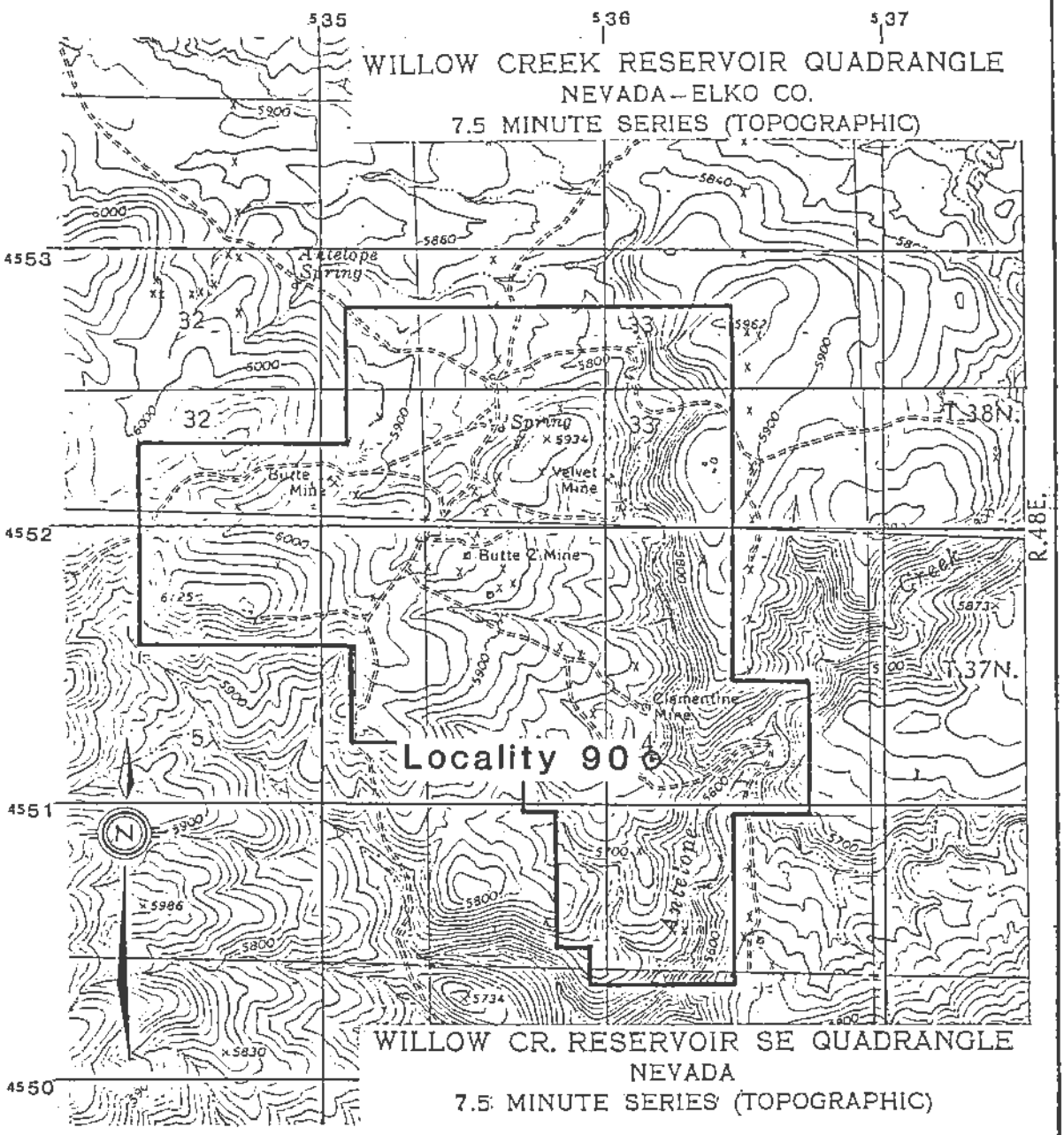
Topographic Data: Rocks along edge outcrop knoll, facing east.

Quarry Data: No on-site opalite source.

Description: Two white opalite, Stage II bifaces sitting on a flat rock (feature 67-12). Derivation unknown.

Site Condition: Unknown; may reflect recent removal from original context.

Remarks: Perhaps bifaces are related to the numerous flaking stations scattered over the outcrop knoll (Locality 33).



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SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 91 Type: Quarry Pit Complex

UTM: 535760E / 4551480N

Size: 60m x 60m Max. Area (m^2): 3,600

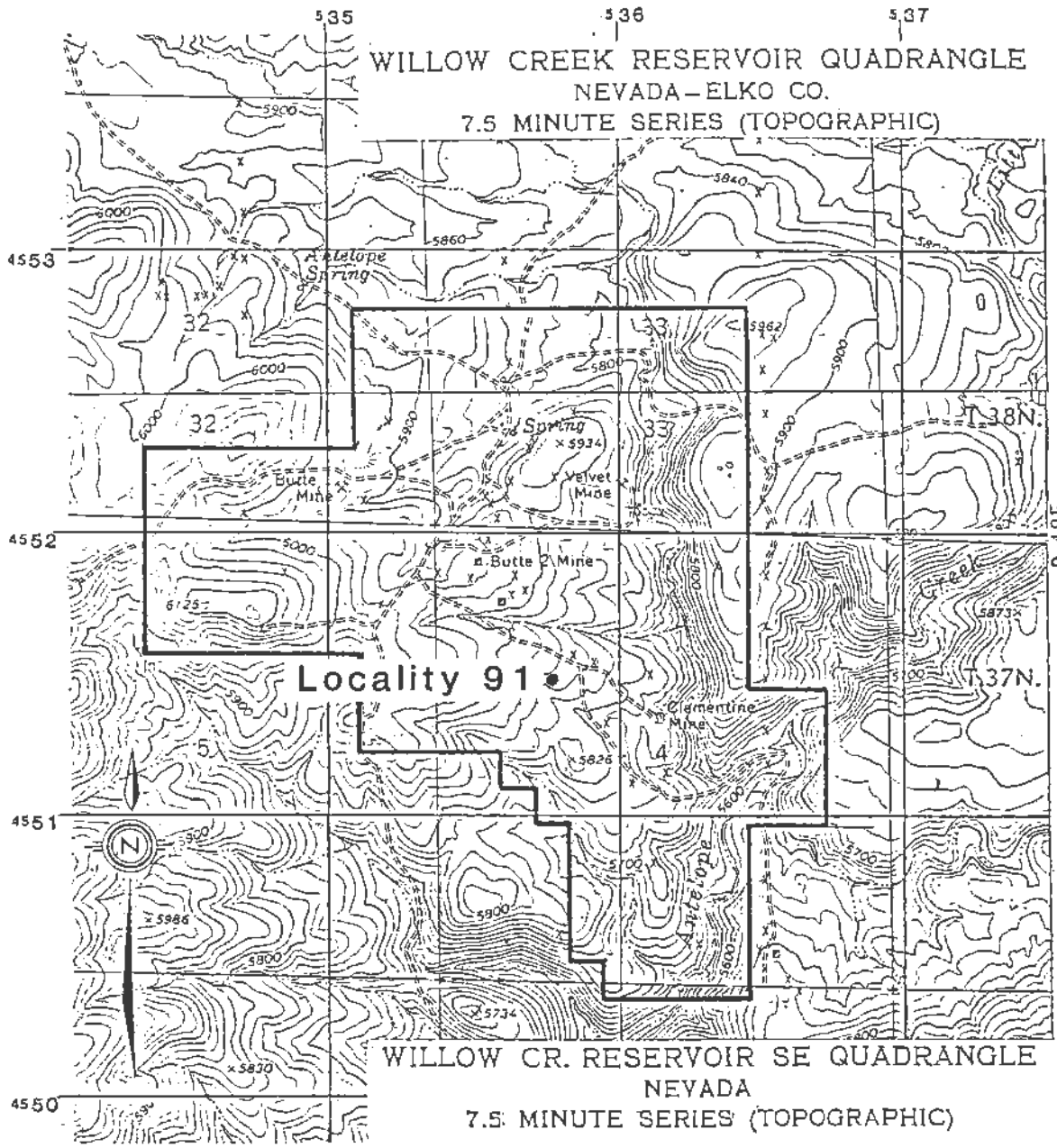
Topographic Data: Break in slope at lower edge $ephemeral drainage, south-facing, moderately (8%) to strongly sloping (10%).

Quarry Data: Pits excavated into colluvium between bedrock boulders; cream to tan opaque chert. Similar to Locality 47 (same geologic unit), but poorer quality material.

Description: Small quarry pit complex of 7 pits (feature 55-3) surrounded by moderate density flake scatter. More waste rock and smaller average flake size compared to nearby Locality 47.

Site Condition: Undisturbed.

Remarks: Compare to Locality 47, apparently components of same geologic formation.



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DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 92 Type: Small Outcrop-Assay Quarry

UTM: 536120E/4551820N

Size: 15m NS/20m EW Max. Area (m^2): 300

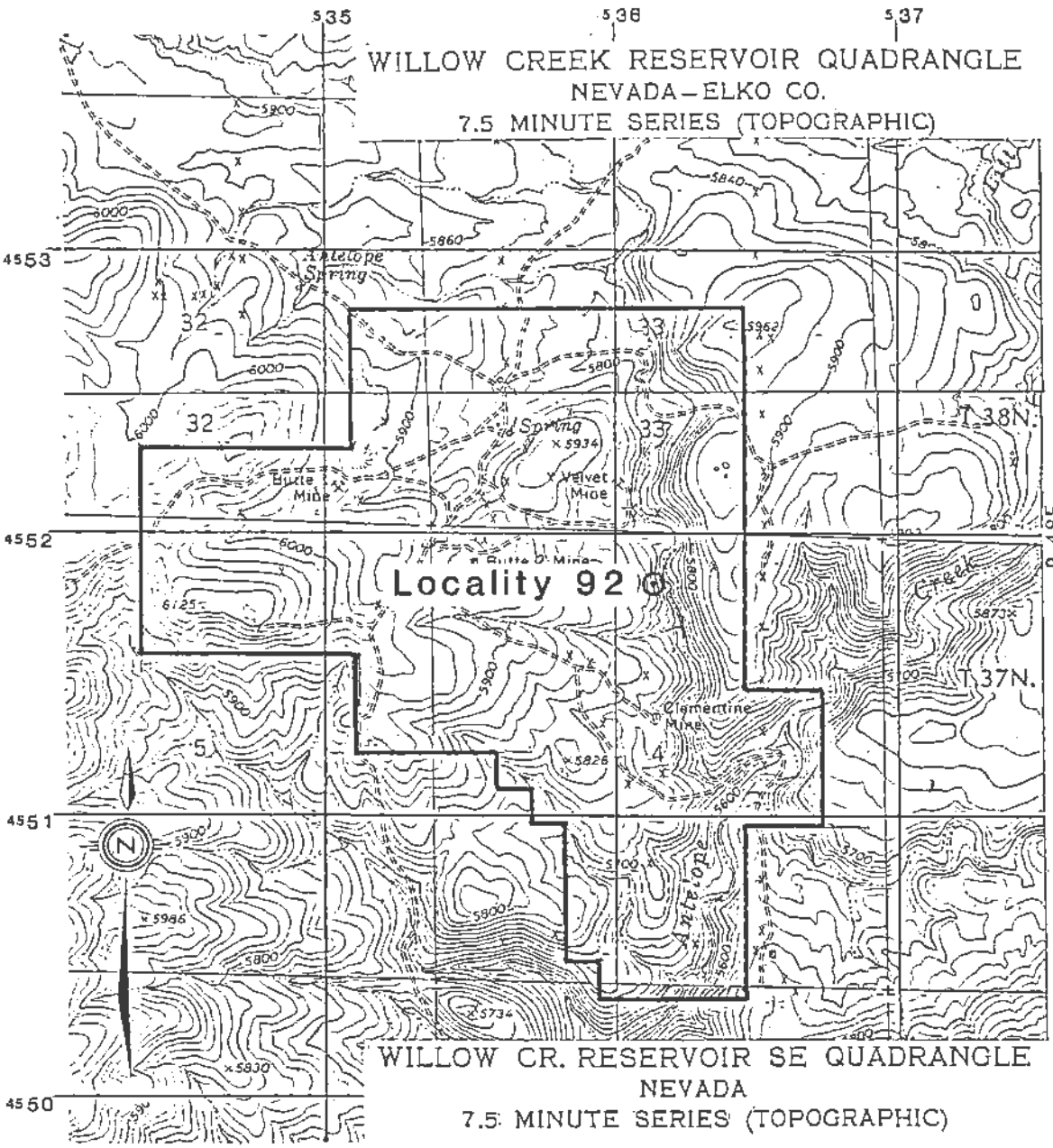
Topographic Data: On steep (40%) canyon slope, west side, upper Velvet Canyon.

Quarry Data: Poor quality bedrock exposure.

Description: Small outcrop quarry with conspicuous assay materials and a few cores (feature 67-5); cascading down steep slope.

Site Condition: Eroded; historic adit and other nearby disturbances.

Remarks: Poor integrity.



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DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Red Hill Ridge

Locality No.: 93 Type: Isolated Artifact

UTM: 536000E/4550640N

Size: 25cm/15cm/8cm Max. Area (m^2): N/A

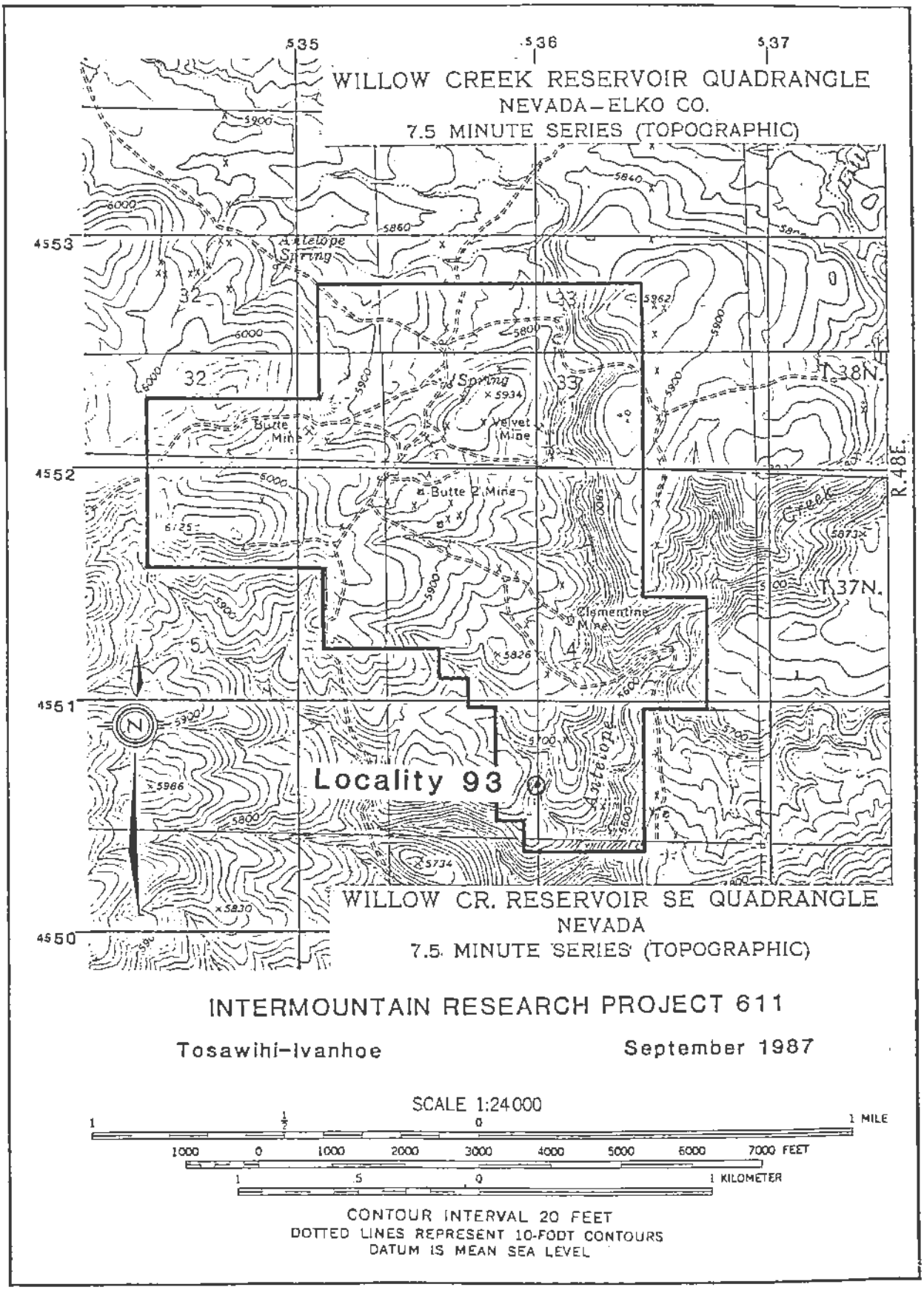
Topographic Data: Steep (33%) colluvial slope, facing east.

Quarry Data: No on-site opalite source.

Description: Isolated metate split down long axis (feature 62-8); very heavily worn grinding surface; found lying face-down. No apparent cultural associations.

Site Condition: N/A

Remarks: Odd position on landscape.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FODT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Southern Owl Ridge

Locality No.: 94 Type: Small Reduction Station

UTM: 5364000E/4551300N

Size: 3m NS/ 1m EW Max. Area (m^2): 3

Topographic Data: On moderately steep (25%) colluvial slope, south-facing.

Quarry Data: May be related to Locality 30 source.

Description: Small, discrete reduction station with one core and ca. 200 flakes (feature 78-3).

Site Condition: Eroding downslope.

Remarks: One of several similar localities on Owl Ridge above intensive ledge quarry (Locality 30).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Southern Owl Ridge

Locality No.: 95 Type: Isolated Artifacts

UTM: 536440E / 4551320N

Size: 2m NS/ 1m EW Max. Area (m^2): 2

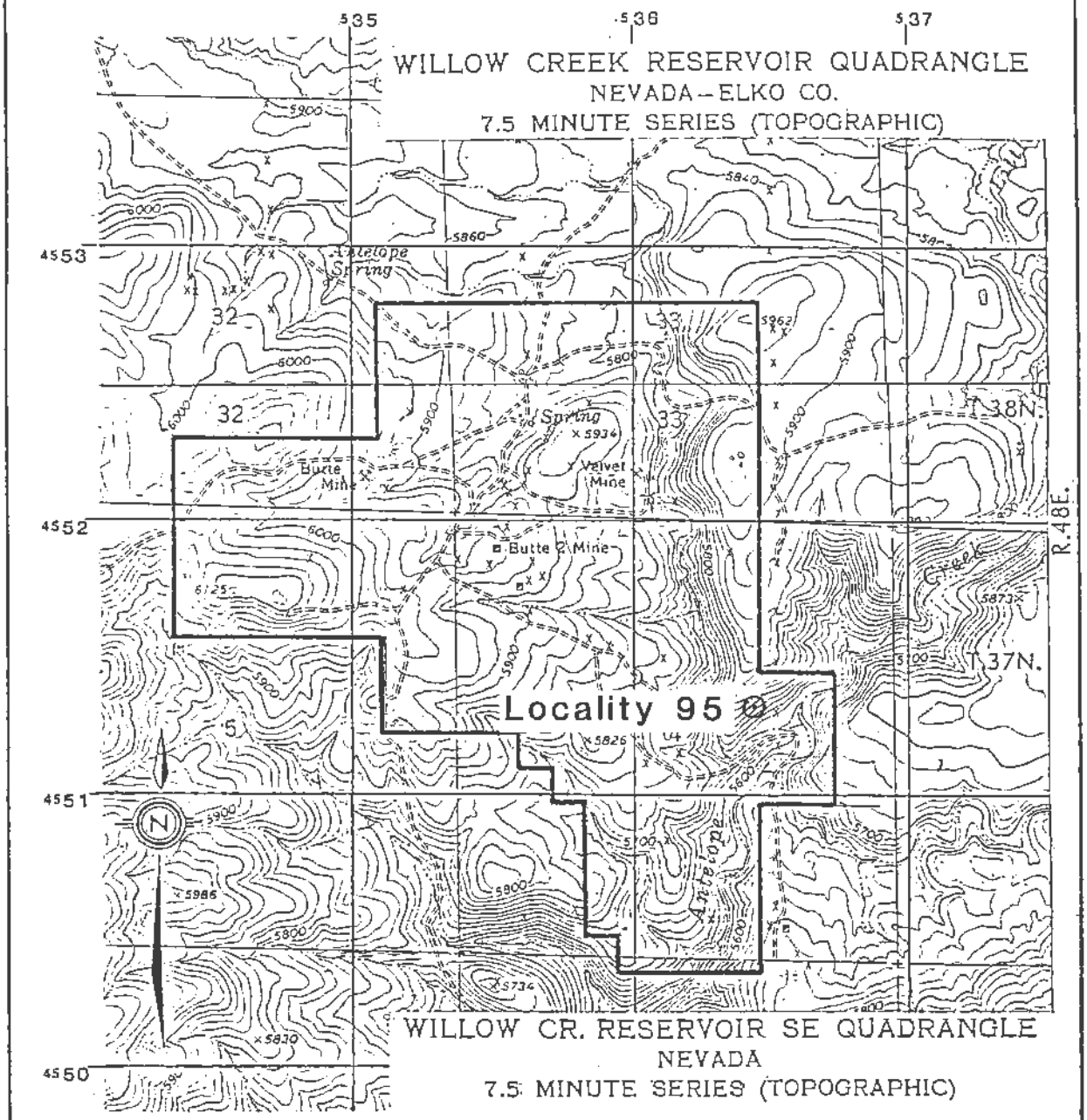
Topographic Data: On steep (33%) colluvial slope, south-facing.

Quarry Data: May be related to Locality 30 source.

Description: Biface drop (?); 3 bifaces (one complete, 2 broken (feature 76-K1).

Site Condition: N/A

Remarks: Similar to small reduction localities on Owl Ridge above intensive ledge quarry Locality 30.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 96 Type: Rockshelter (Undetermined Type)

UTM: 536300E/4551300N

Size: shelter=5m wide/4m high, 2m deep Max. Area (m^2): 50

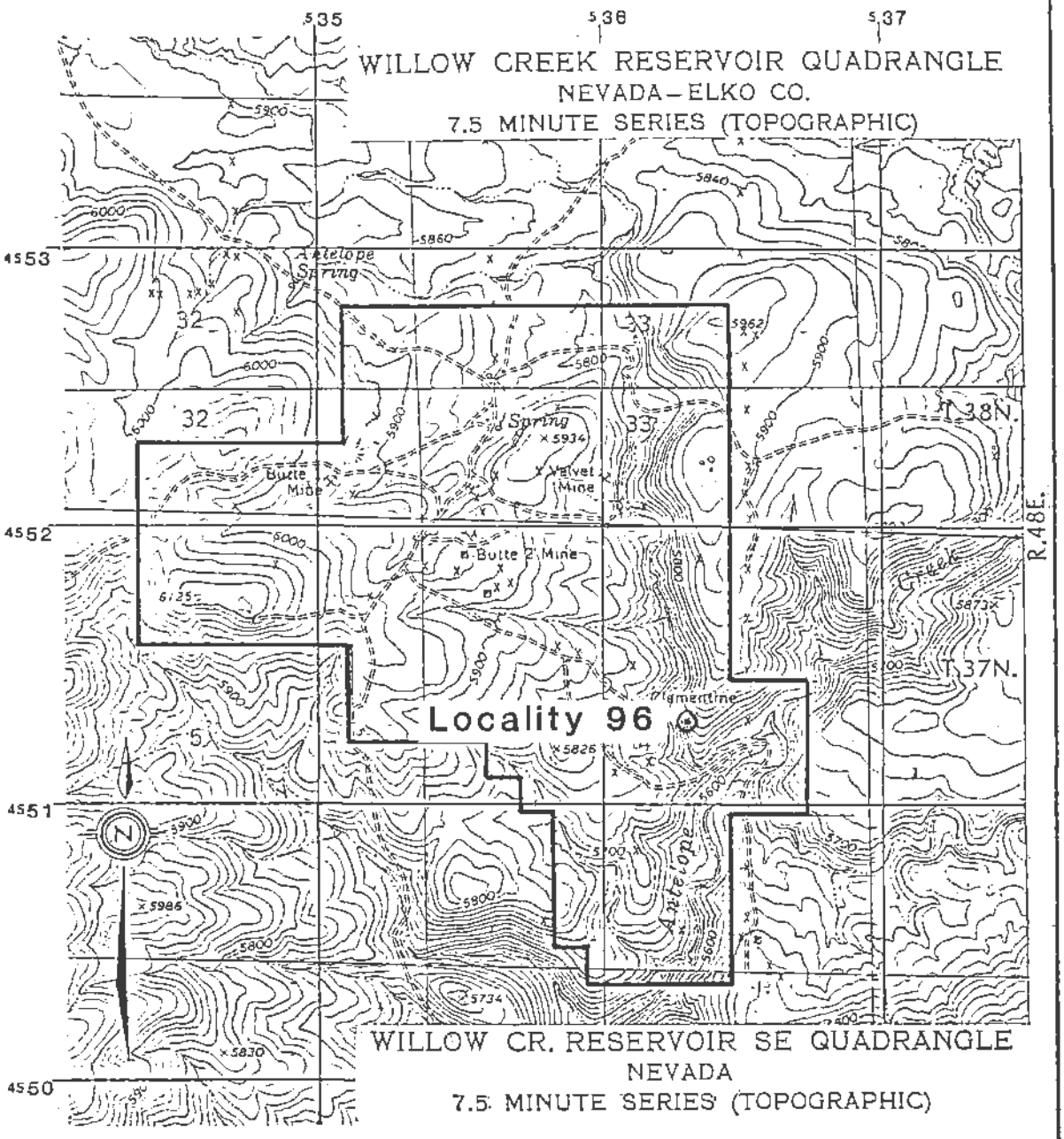
Topographic Data: In cliffs along steep (45%) slope, facing west, about 15m (elevation) above drainage bottom, Velvet Canyon. south-facing.

Quarry Data: No on-site opalite source.

Description: Small rockshelter with light to moderate flake scatter and numerous bifaces (feature 72-6).

Site Condition: Undisturbed.

Remarks: Rockshelter needs systematic assessment by testing.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 97 Type: Rockshelter/ Undetermined Type

UTM: 536320E/4551280

Size: shelter 12m wide/4m high/1m deep Max. Area (m^2): 75

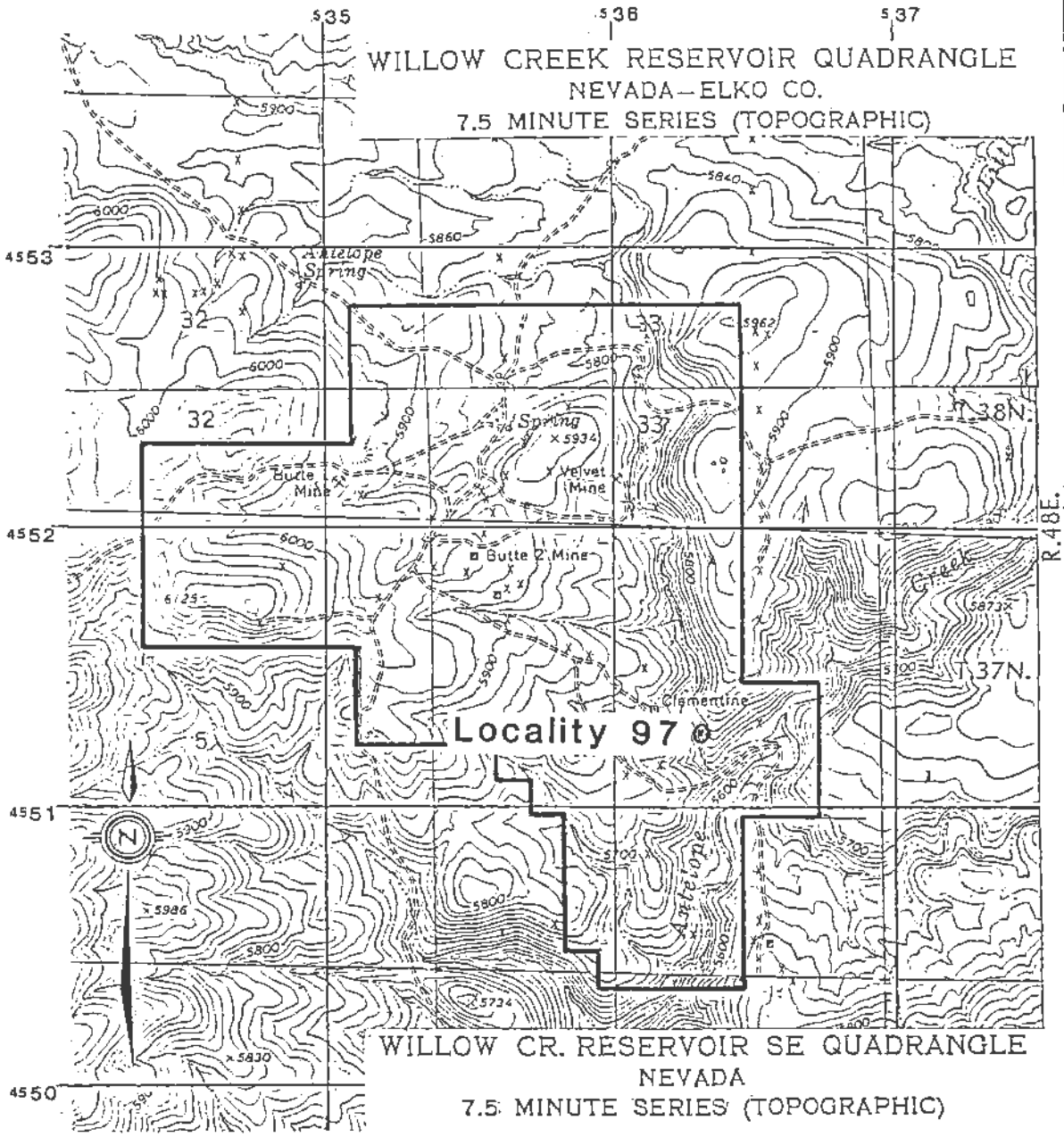
Topographic Data: Near bottom of Velvet Canyon, east side drainage, at base of quarried bedrock outcrop ledge (Locality 30).

Quarry Data: Residue in shelter is partially related to quarry source on top of shelter (Locality 30).

Description: Wide shallow overhang with thick reduction debris from Locality 30 quarry on top of bedrock ledge (feature 72-5). May also have some deposit from uses unrelated to Locality 30.

Site Condition: Undisturbed.

Remarks: Needs further field assessment and possibly testing.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Little Antelope Canyon

Locality No.: 98 Type: Small Outcrop-Assay Quarry

UTM: 536320E/4550900N

Size: 60m NS/15m EW Max. Area (m^2): 900

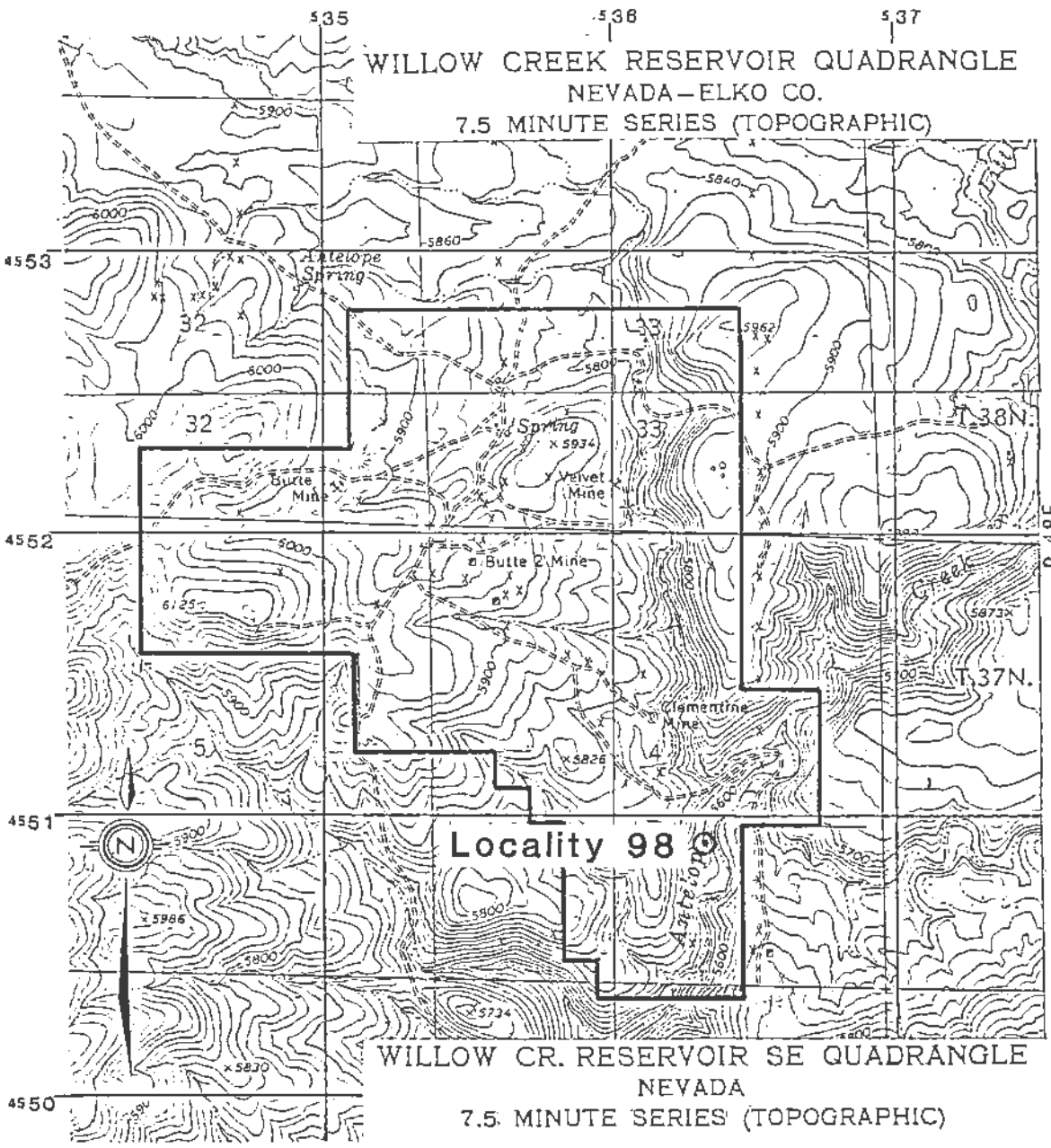
Topographic Data: On narrow bench, low bedrock ledge, on steep (45%) colluvial slope, west side Little Antelope Canyon.

Quarry Data: Poor quality bedrock outcrop.

Description: Small outcrop quarry with moderate scatter of primary flakes and assay shatter (designated M4).

Site Condition: Undisturbed.

Remarks: Recorded during assessment of enigmatic moderate density plots.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 99 Type: Small Reduction Station

UTM: 536180E/4551280N

Size: 2m x 1m Max. Area (m^2): 2

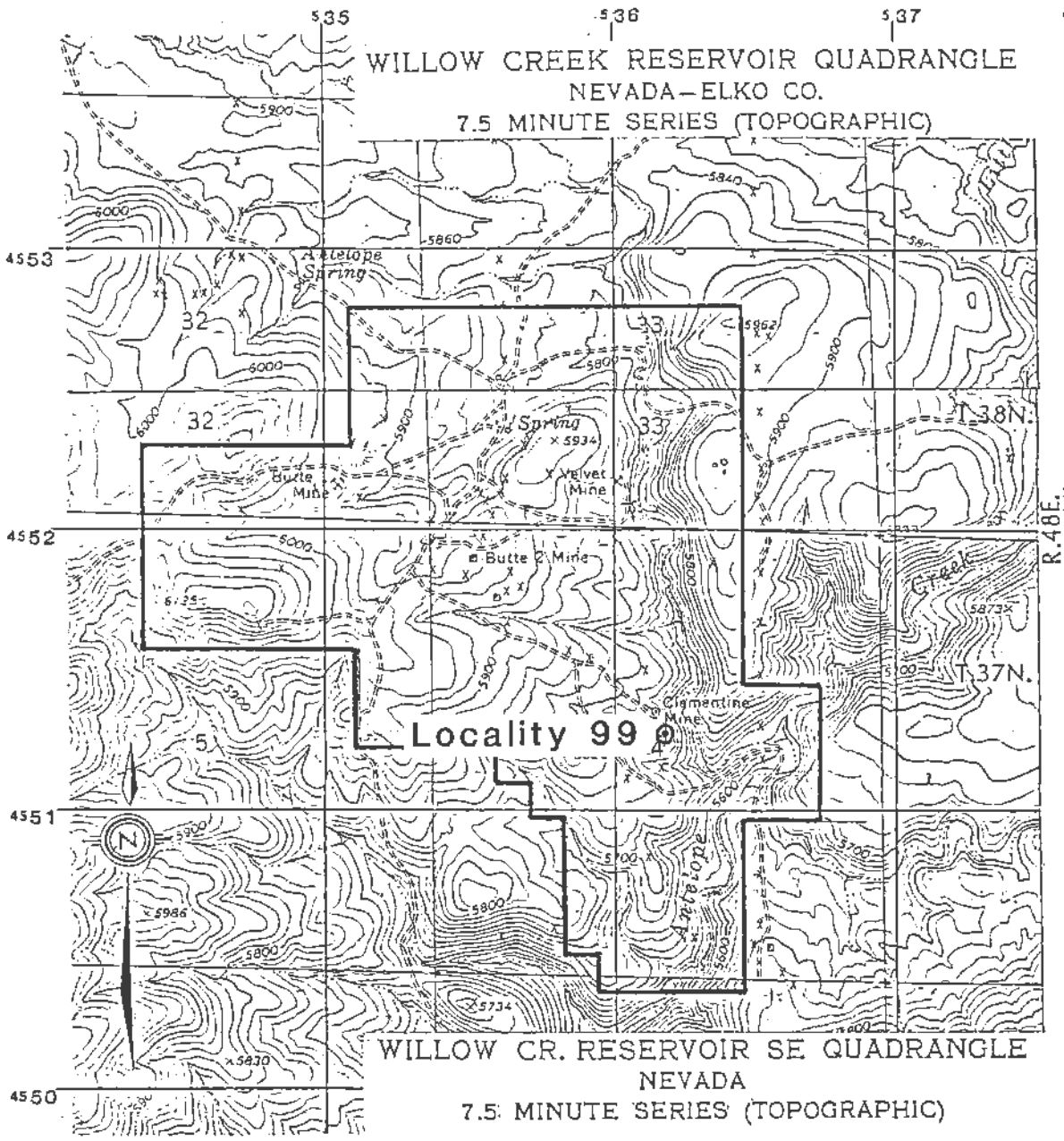
Topographic Data: On small bench, top of rimrock, west edge Velvet Canyon.

Quarry Data: No on-site opalite source.

Description: Small, discrete reduction station; about 500 flakes (feature 68-8).

Site Condition: Undisturbed.

Remarks: May be related to localities 49, 50, and 51.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Sagehen Ridge

Locality No.: 100 Type: Isolated Quarry Pit

UTM: 536020E/4551540N

Size: pit = 5 m x 5 m Max. Area (m^2): 2,700

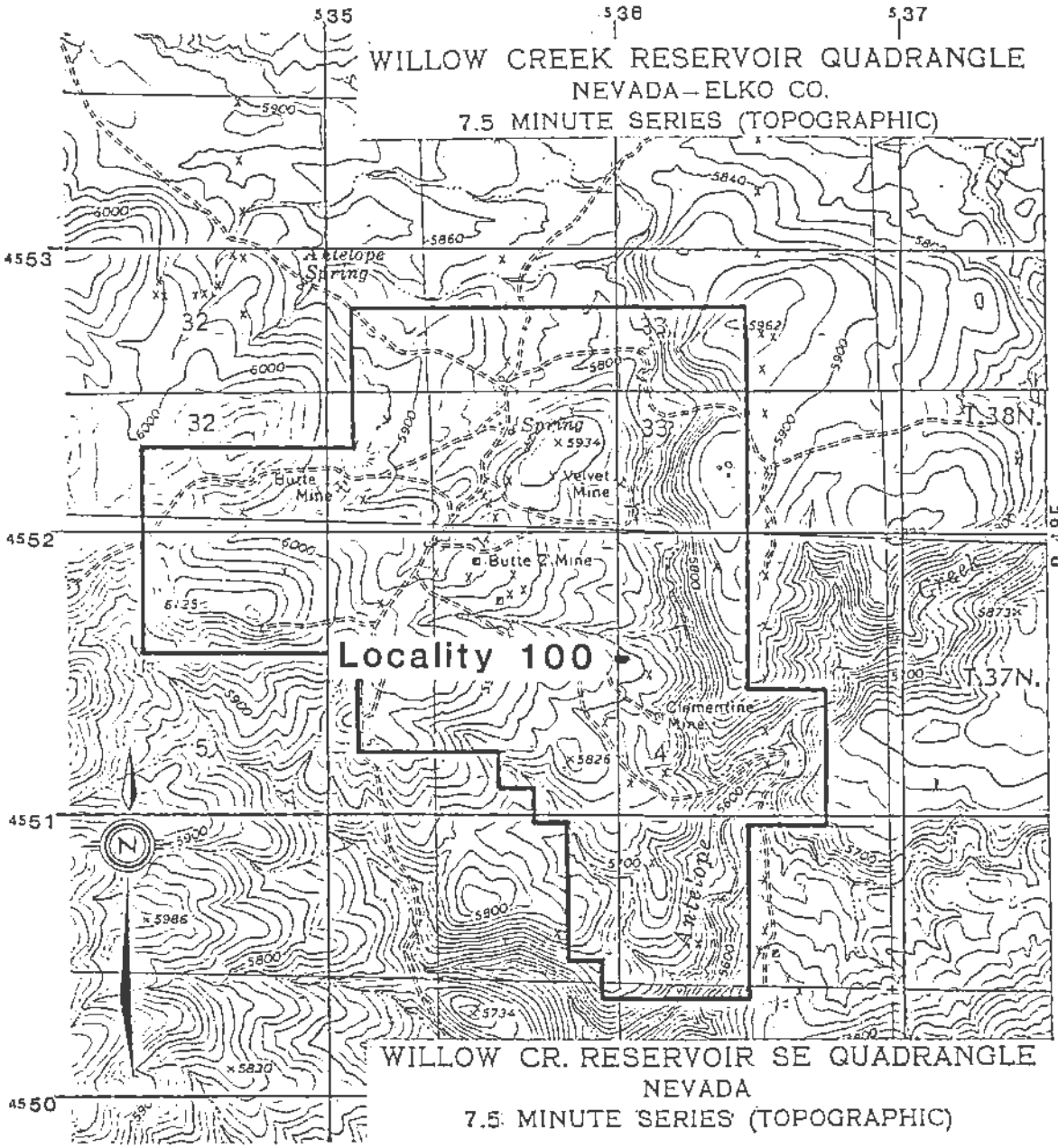
Topographic Data: Flat bench on low ridge top, facing east.

Quarry Data: Thin mantle of colluvium over bedrock; good quality material; variable color.

Description: Isolated shallow quarry pit in moderate density flake scatter (designated M3).

Site Condition: Fair. Adjacent road and several historic exploratory features associated with Clementine Mine. Overlapping historic and prehistoric features in the vicinity Clementine obscure clear patterns beyond marked site boundaries.

Remarks: Recorded as site during field assessment of M3 (moderate density scatter without previously identified feature).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: North Boundary Ravine

Locality No.: 101 Type: Isolated Quarry Pit

UTM: 535840E/4551280N

Size: pit = 10m x 10m x 1m (deep) Max. Area (m^2): 100

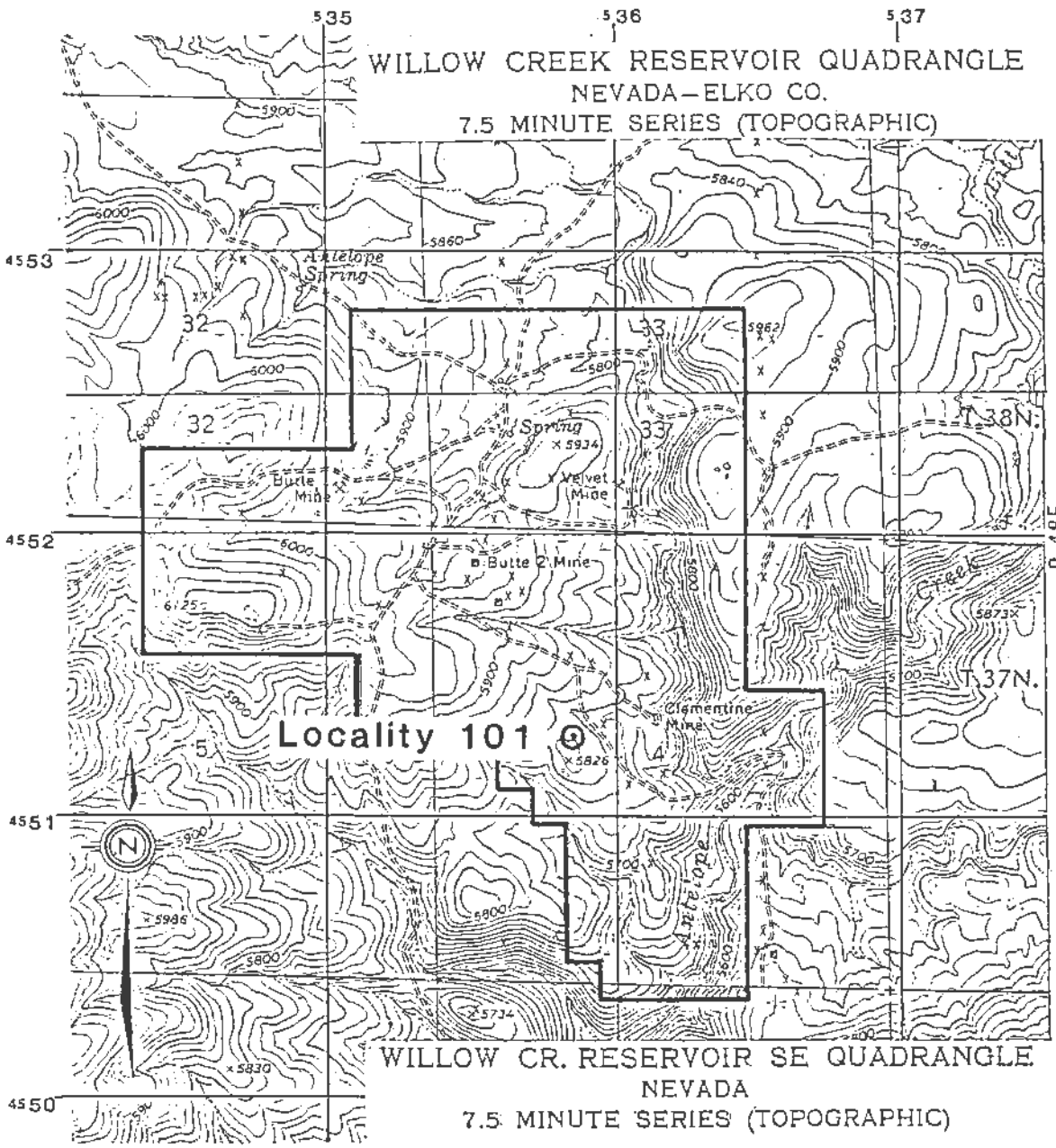
Topographic Data: On flat saddle, top of ridge ? (or possibly on slope to south of map plot).

Quarry Data: Cobbles in colluvium?

Description: Large, deep, isolated quarry pit with thick primary debitage and numerous bifaces (feature 57-5).

Site Condition: Apparently undisturbed.

Remarks: May be misplotted; actual location may be to the south of map plot in vicinity Locality 41. Needs field check.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 102 Type: Flaking Station Complex

UTM: 535800E/4551300N

Size: Each station=5m x5m Max. Area (m^2): 6,000

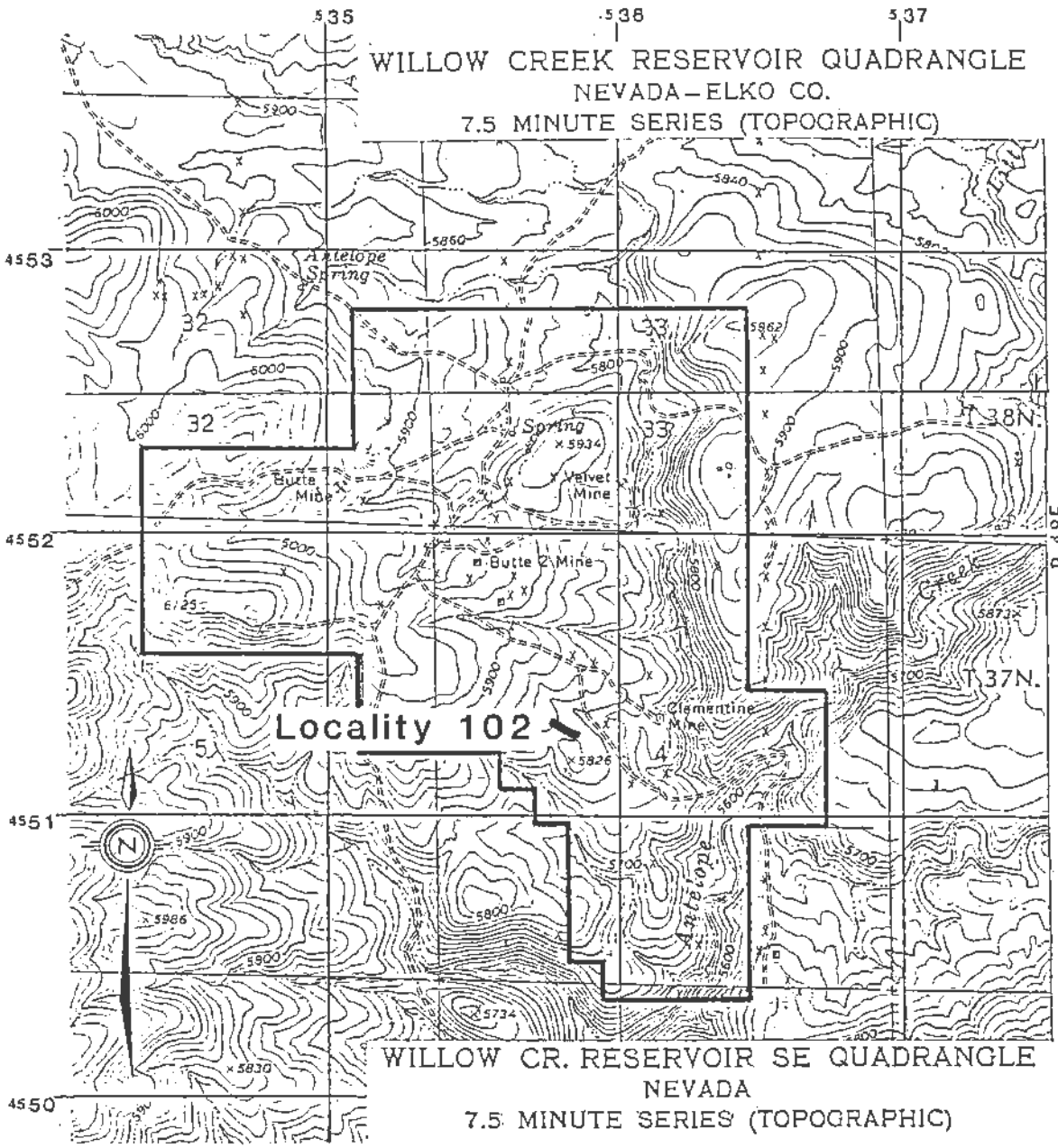
Topographic Data: On edges of flat saddle on ridge top.

Quarry Data: No on-site opalite source.

Description: Three small, discrete flaking stations in sparse density scatter on top saddle (designated L3). Several flakes of obsidian noted. A white opalite projectile point preform was collected.

Site Condition: Undisturbed.

Remarks: Located during assessment of saddles and ridge tops in sparse to light density areas.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Rainbow Ridge

Locality No.: 103 Type: Quarry Pit Complex

UTM: 535900E/4551880N

Size: 30m NS/ 60m EW Max. Area (m^2): 900

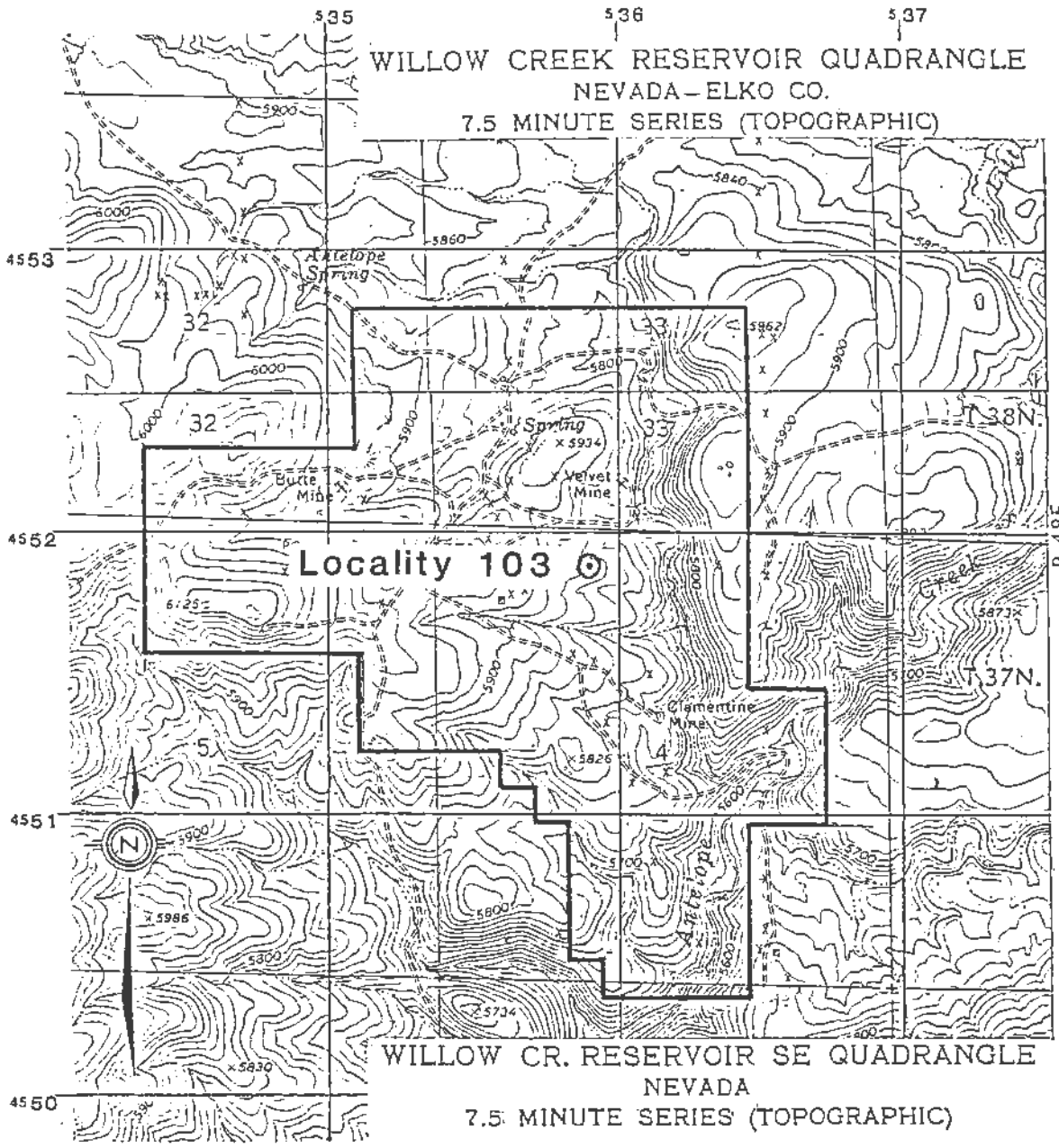
Topographic Data: Top and north edge gently sloping (5%) colluvial slope (in Big Sagebrush Clump).

Quarry Data: Cobbles in colluvium; high quality toolstone; multi-colored brown-purple-pink).

Description: Complex of four pits (undesignated feature) in deep colluvium. Multicolored opalite similar to exposures in bulldozer scrape at Clementine Mine; similar to opalite in rockshelter 72 (feature 66-9).

Site Condition: Undisturbed.

Remarks: Located subsequent to transect survey; see possible relationships to Localities 81 and 71.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Sagehen Ridge

Locality No.: 104 Type: Isolated Quarry Pit

UTM: 535940E/4551600N

Size: 30m NS/60m EW Max. Area (m^2): 900

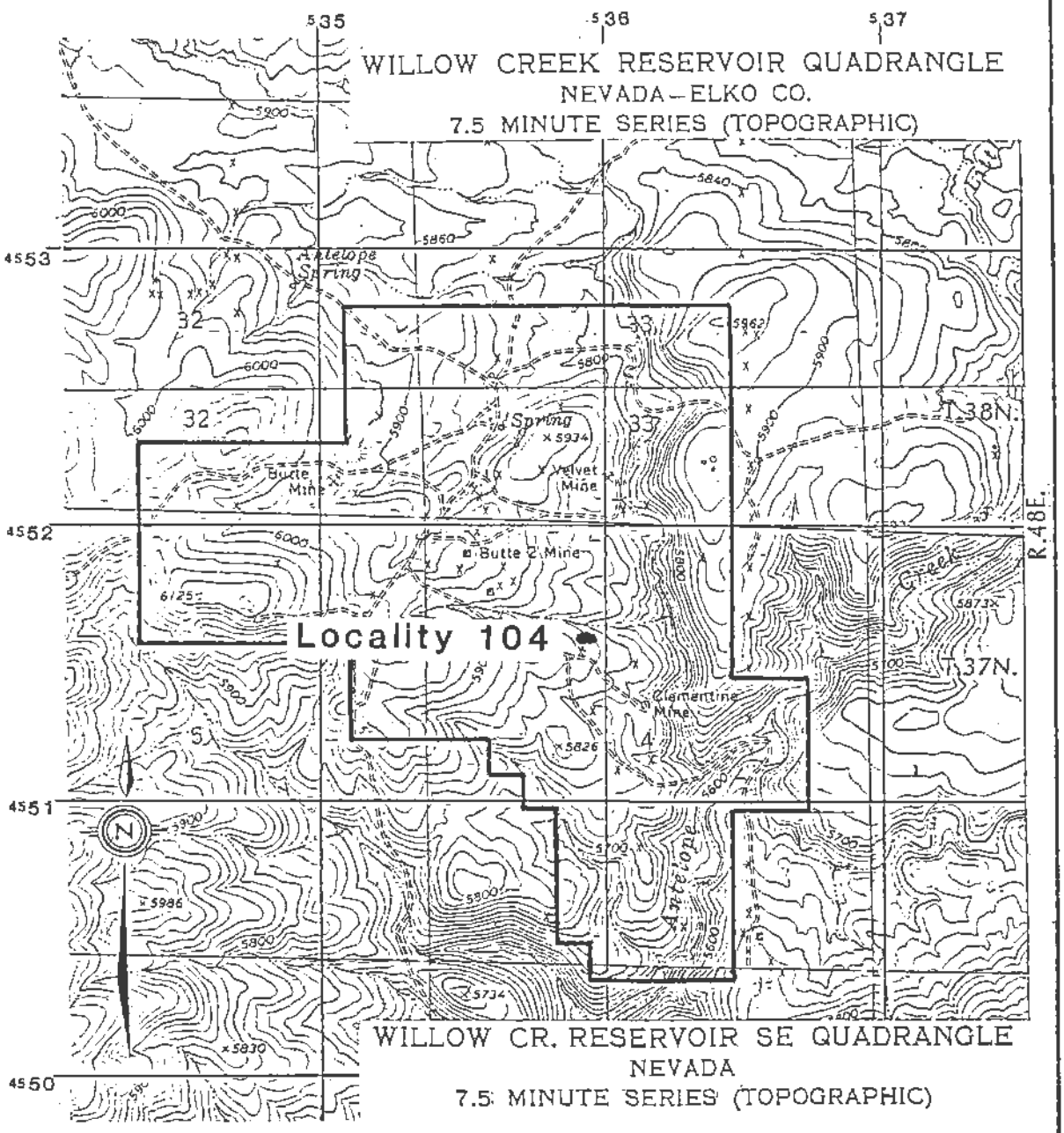
Topographic Data: At break in slope, moderate (8%) to strongly (10%) sloping colluvial slope, north-facing.

Quarry Data: Cobbles in colluvium.

Description: Large (8m diameter) isolated pit (feature 59-7) with high density secondary reduction edging pit and moderate flake scatter over surrounding slope.

Site Condition: Apparently undisturbed.

Remarks: Overlooked during priority field assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Rainbow Ridge

Locality No.: 105 Type: Isolated Quarry Pit

UTM: 536000E/4551920N

Size: 5m x 5m Max. Area (m^2): 25

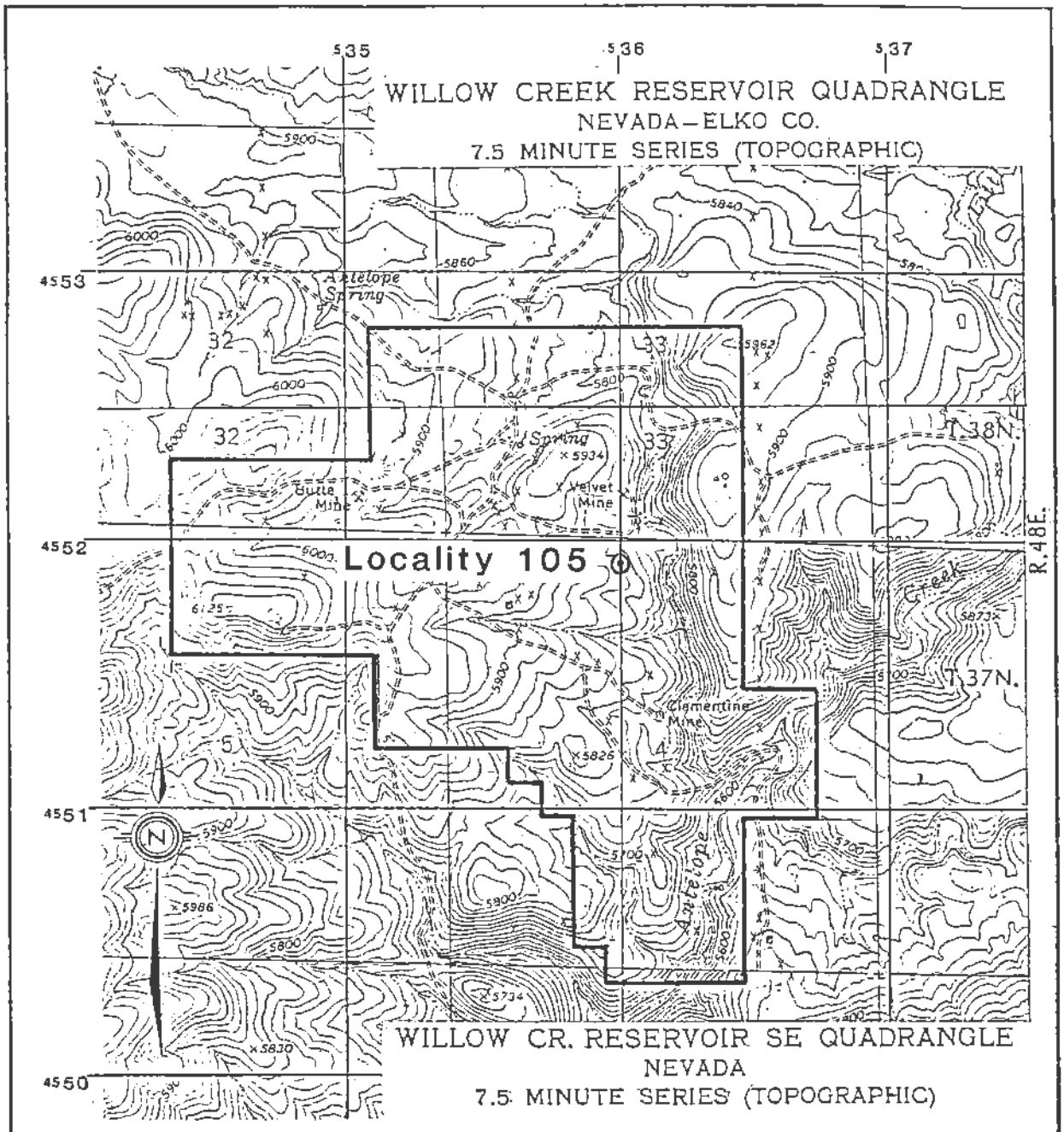
Topographic Data: Upper edge of ridge at break in slope, moderately (8%) to strongly (10%) sloping colluvium.

Quarry Data: Cobbles in colluvium.

Description: Isolated quarry pit (feature 62-4A); moderate debitage density in small area surrounding pit feature. Large obsidian flake at edge scatter.

Site Condition: Undisturbed but adjacent historic mining disturbance.

Remarks: Recorded during transect assessment and added to inventory (trench and pits).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Rainbow Ridge

Locality No: 106 Type: Reduction Station Complex

UTM: 535960E/4551880N

Size: 40m NS/90m EW Max. Area (m^2): 3,600

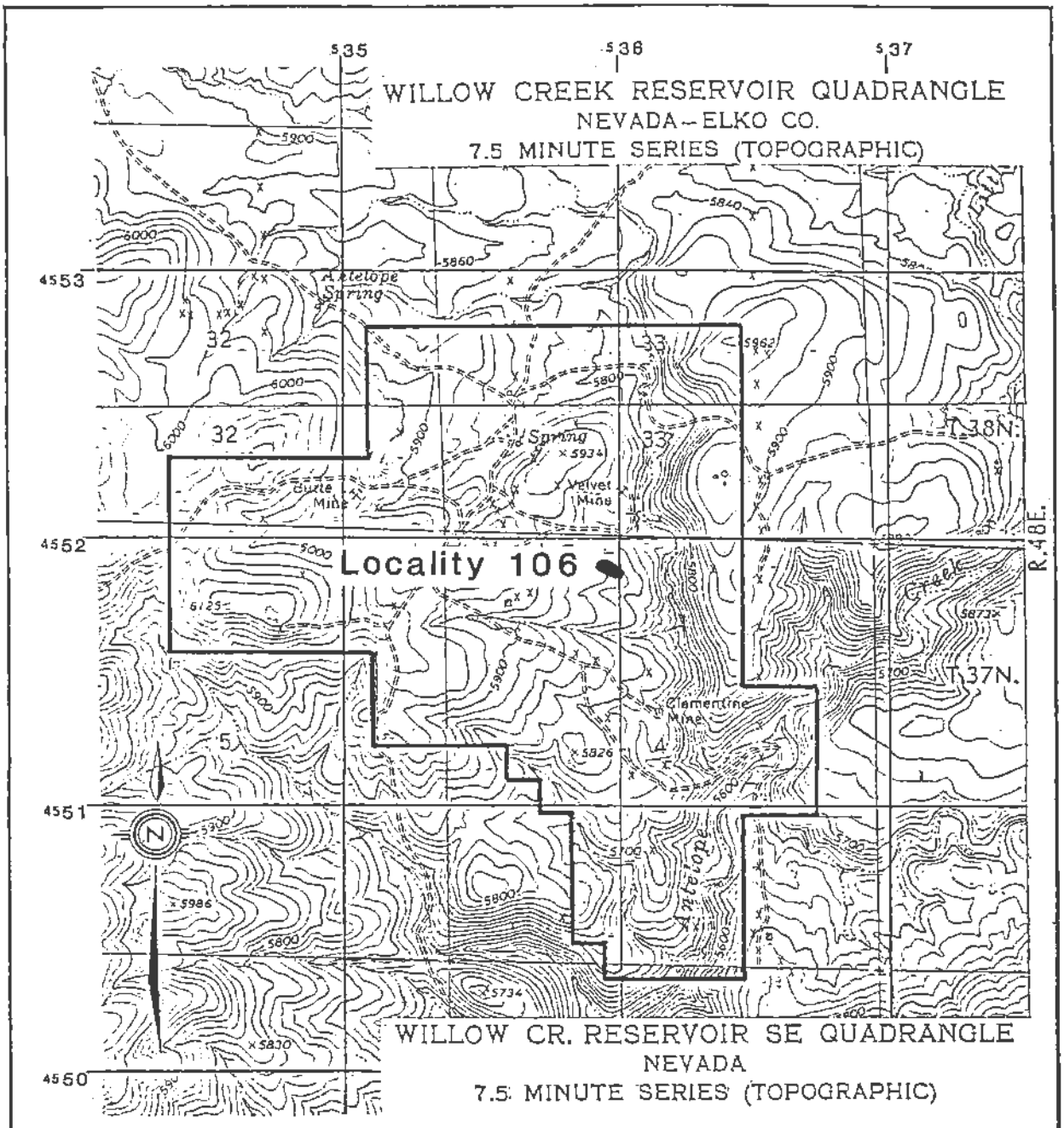
Topographic Data: Top of gently sloping (5%), east-west trending ridge.

Quarry Data: No on-site opalite source.

Description: Series of many discrete flaking stations (not separate feature designations) in sparse density scatter.

Site Condition: Undisturbed.

Remarks: Recorded during assessment of flat-to-gentle slopes during priority reassessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butte No. 2 Group

Locality No.: 107 Type: Large Open Residential

UTM: 535660E/4552100N

Size: 90m x 60m Max. Area (m^2): 5,400

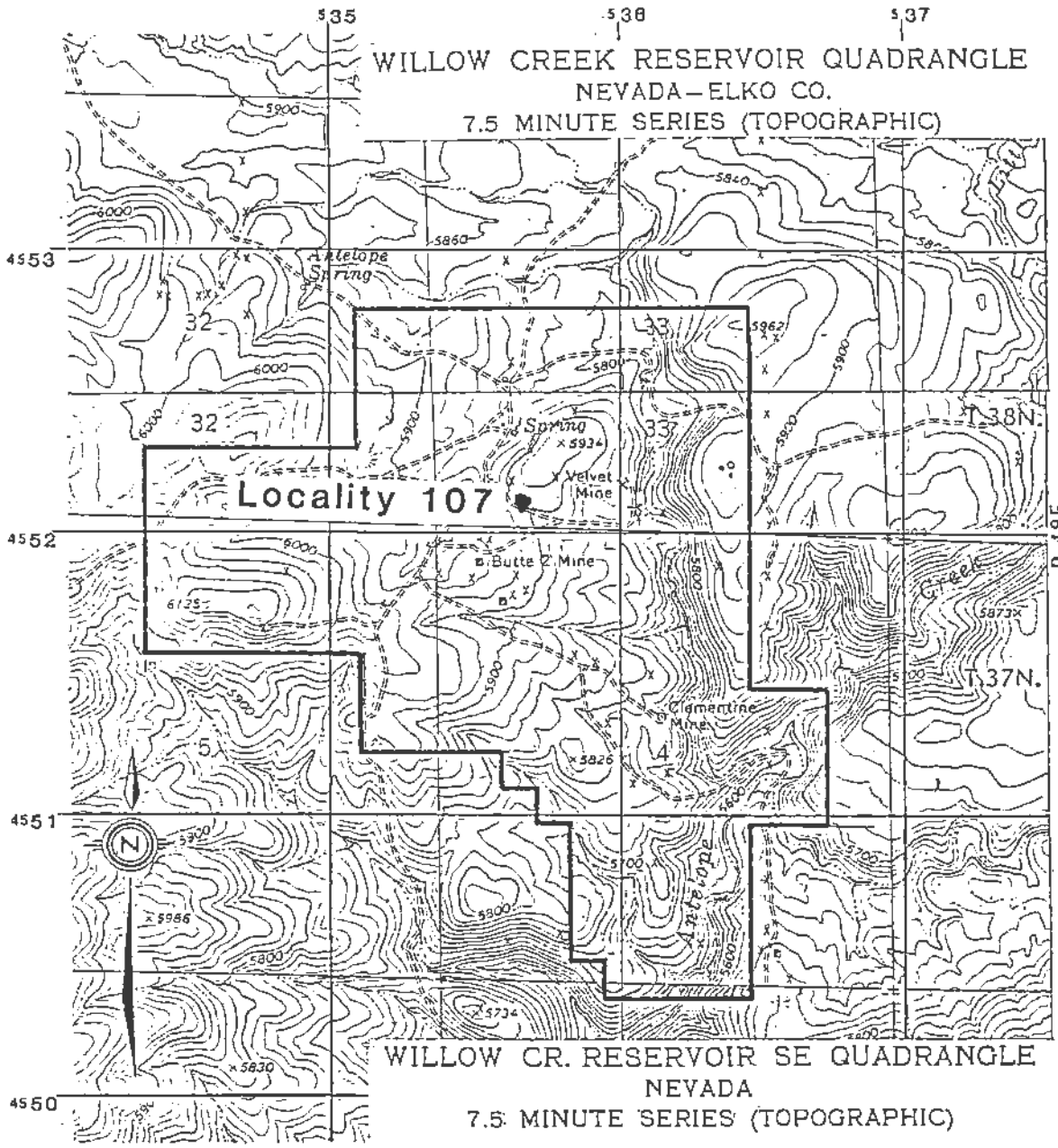
Topographic Data: In small saddle just south of Tosawihi Spring.

Quarry Data: No on-site opalite source, but many nearby (cf. Locality 87).

Description: Light to moderate density flake scatter in saddle; many different colored and sized materials; numerous bifaces of of variable size range. Collected a biface feature (collection locality datum is designated L1A) consisting of 7 bifaces and 1 Elko projectile point (all of white chert), all within a 1 x 1m area.

Site Condition: Road through west edge site; otherwise undisturbed.

Remarks: In addition to secondary reduction, site may contain subsistence data and/or evidence of residential use. Should be considered in relation to nearby South Tosawihi Spring (permanent water source and probable residential site).



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butte No. 2 Group

Locality No.: 108 Type: Quarry Pit Complex

UTM: 535520 E/4552060 N

Size: 30m NS/45m EW Max. Area (m^2): 1,350

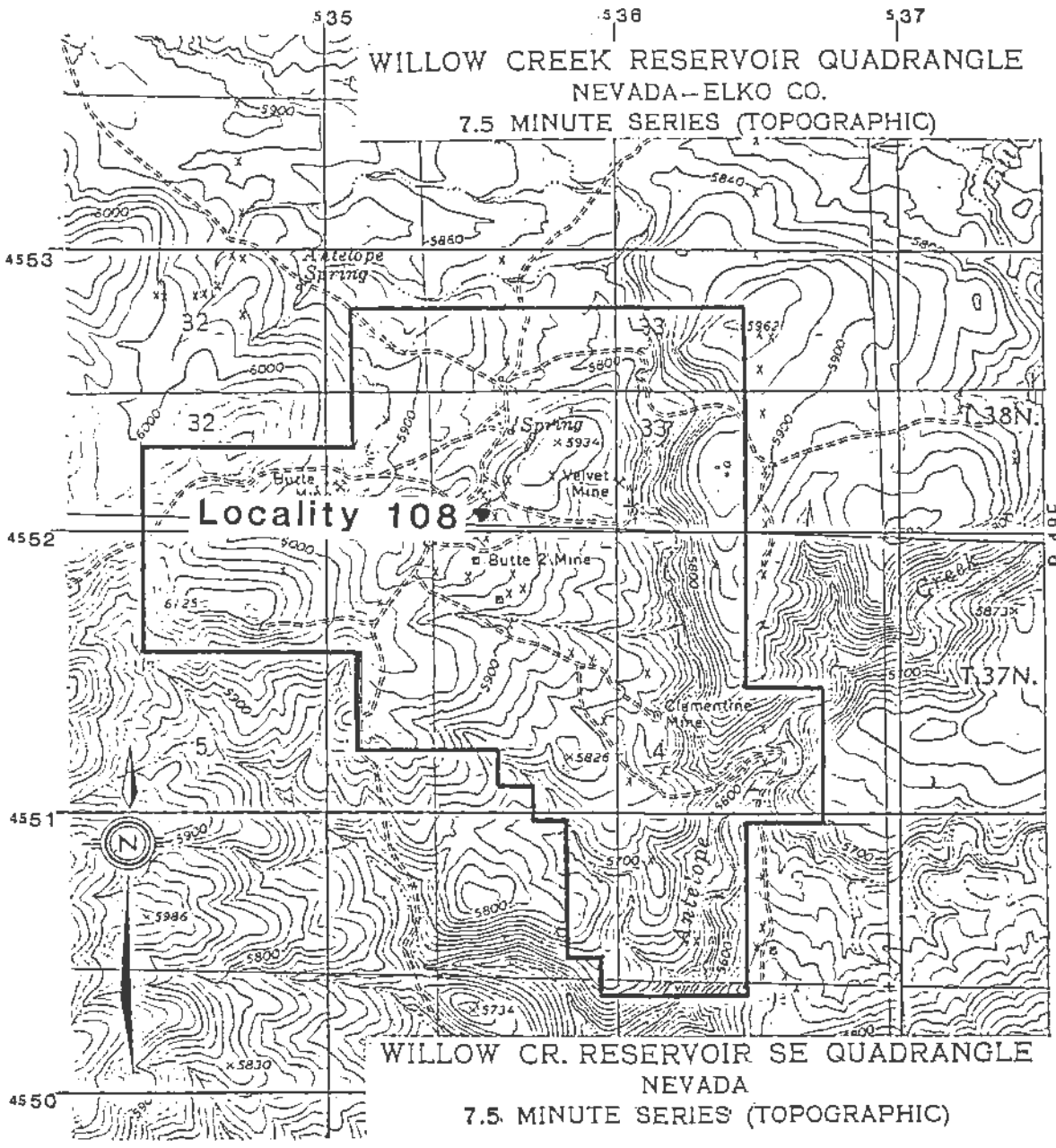
Topographic Data: North edge of strongly sloping (12%) ridge slope.

Quarry Data: Cobbles in colluvium/ possible natural talus exposure.

Description: Series of four deep pits (feature 47-5) with dense flake and reduction accumulation. Severe disturbance from historic Butte No. 2 Mine obscures prehistoric patterns here, but opalite was intensively quarried prior to recent past.

Site Condition: Severe historic mining disturbance.

Remarks: Structural relationships obscured by historic disturbance.



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Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 109 Type: Rockshelter (Reduction Stations)/ Outcrop Quarry

UTM: 536120E/4551880N

Size: 15m NS/ 5m EW Max. Area (m^2): 75

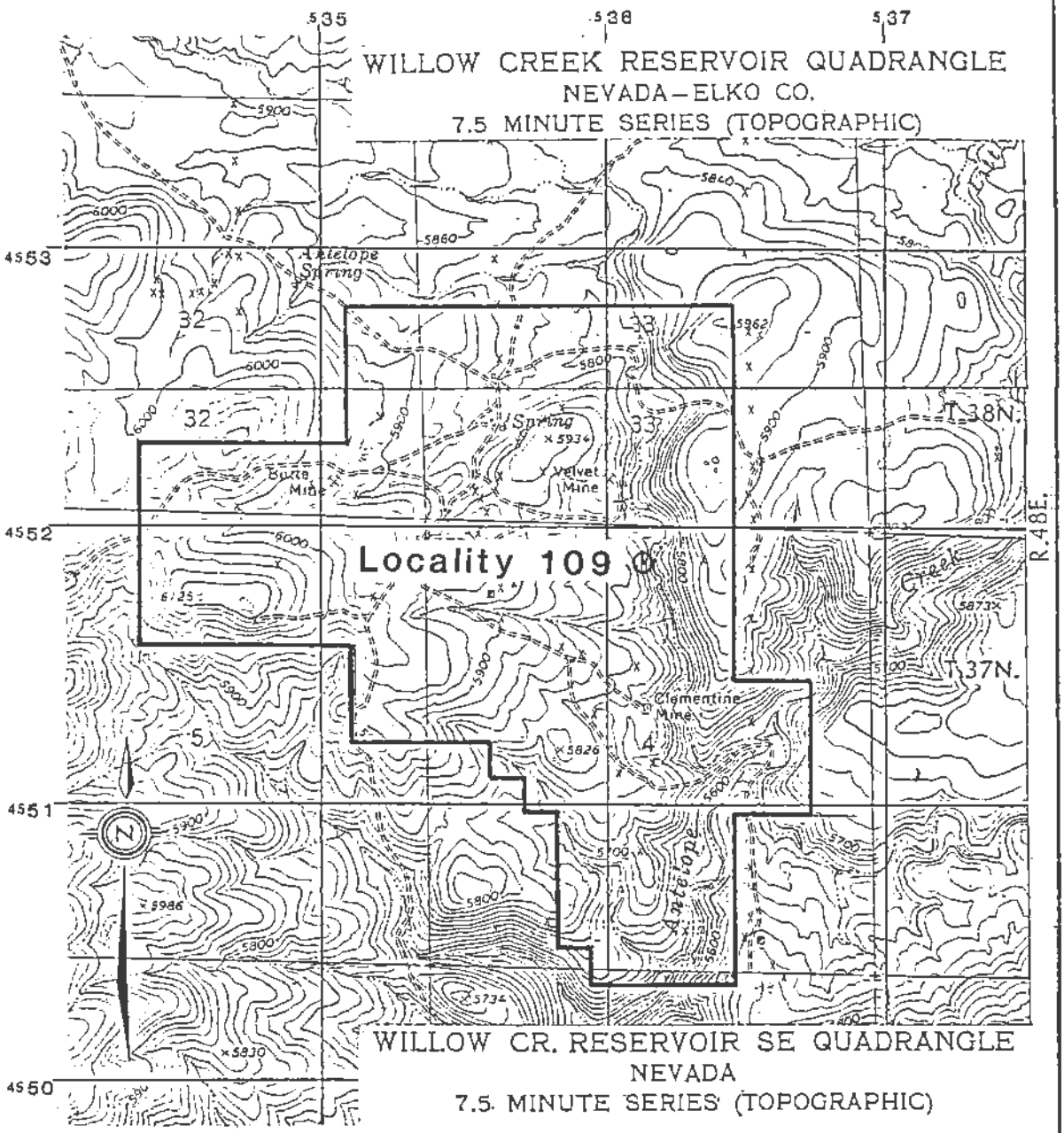
Topographic Data: Top of bedrock ledge and steep (45%) colluvial slope at base of outcrop; lower portion of Velvet Canyon (10m elevation above drainage bottom), west side canyon.

Quarry Data: Poor quality bedrock ledge outcrop.

Description: Complex quarry/reduction feature with reduction stations on top 2 m high bedrock ledge and quarry residue (largely angular shatter) cascading downslope at base bedrock where it contacts steep colluvial slope (feature 67-6). Small alcoves at base bedrock also may have served as flaking stations. Adits into rock are recent or historic explorations.

Site Condition: Historic explorations obscure prehistoric patterns.

Remarks: Lacks integrity of structural relationships.



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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 110 Type: Rockshelter (Reduction Station)

UTM: 536160E/4551880N

Size: 5m wide/1m deep Max. Area (m^2): 25

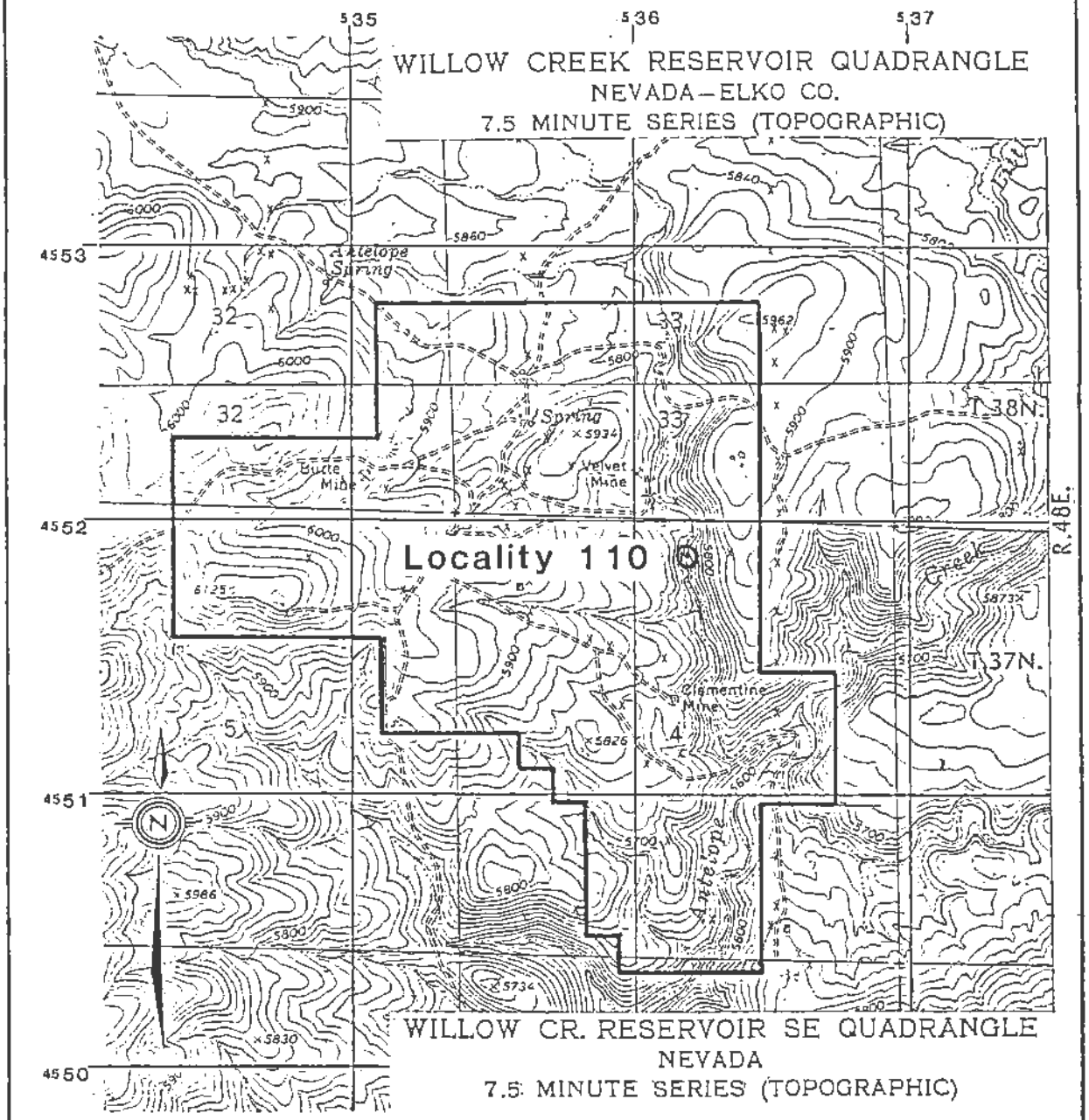
Topographic Data: Alcove in base outcrop in bottom of Velvet Canyon, east side.

Quarry Data: No on-site opalite source.

Description: Shallow alcove with bedrock floor near bottom of drainage; light density debitage in front shelter. Seems to have served as limited use reduction station.

Site Condition: Undisturbed.

Remarks: Paucity of artifactual associations suggests ephemeral use.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 111 Type: Rockshelter
Assay Station ?

UTM: 536160E/4551820N

Size: not given Max. Area (m²):

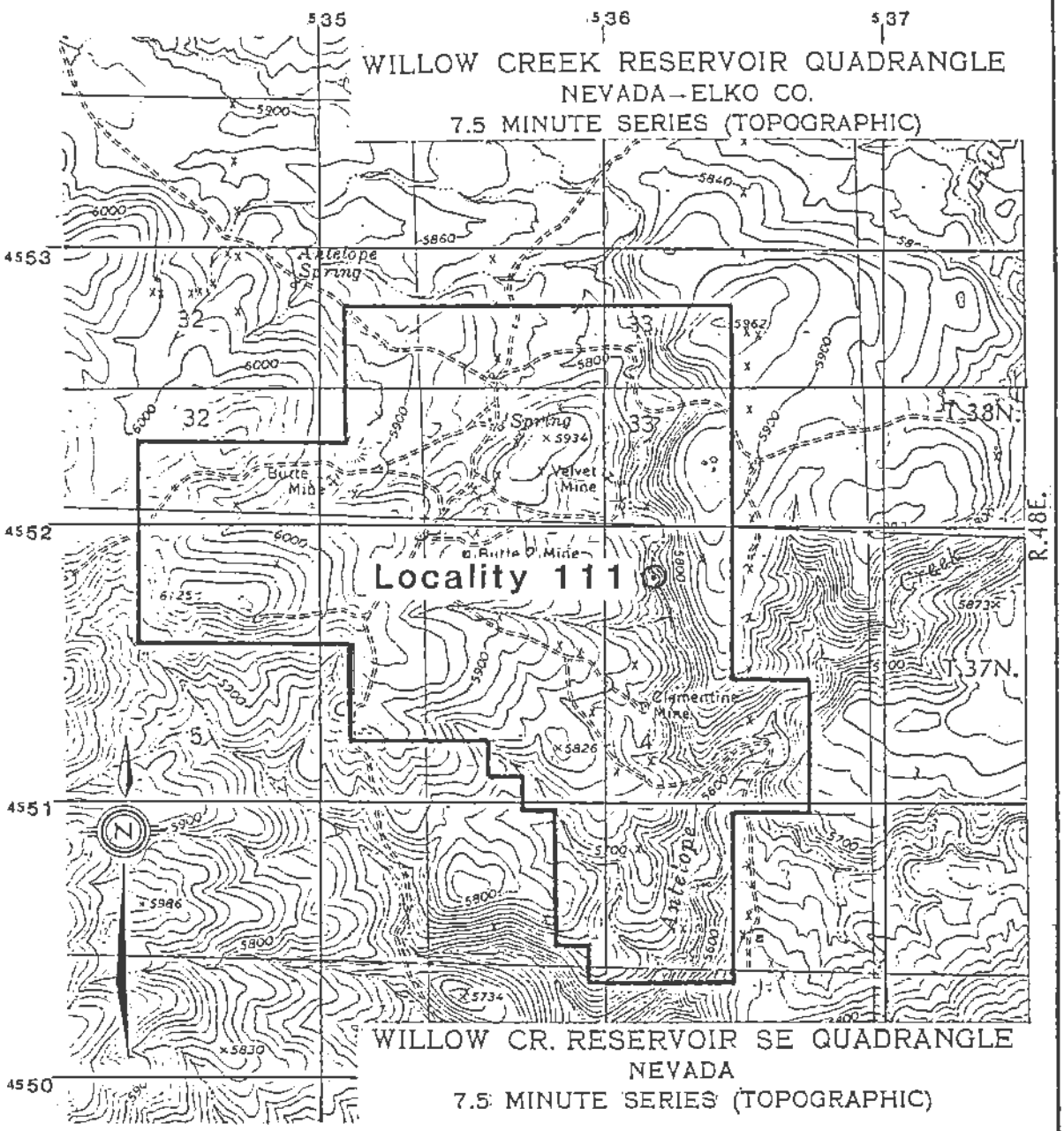
Topographic Data: In base of drainage, east edge Velvet Canyon.

Quarry Data: Possible assay of cobbles embedded in bedrock outcrop.

Description: Small shelter alcove in streambed (68-4). Portions of shelter evidence flake scars suggesting aboriginal assay, but location precludes habitation use. No prehistoric artifact associations.

Site Condition: Historic bore hole evident under overhang.

Remarks: No further study warranted.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 112 Type: Small Reduction Station

UTM: 536140E/4551800N

Size: 4m NS/7m EW Max. Area (m^2): 28

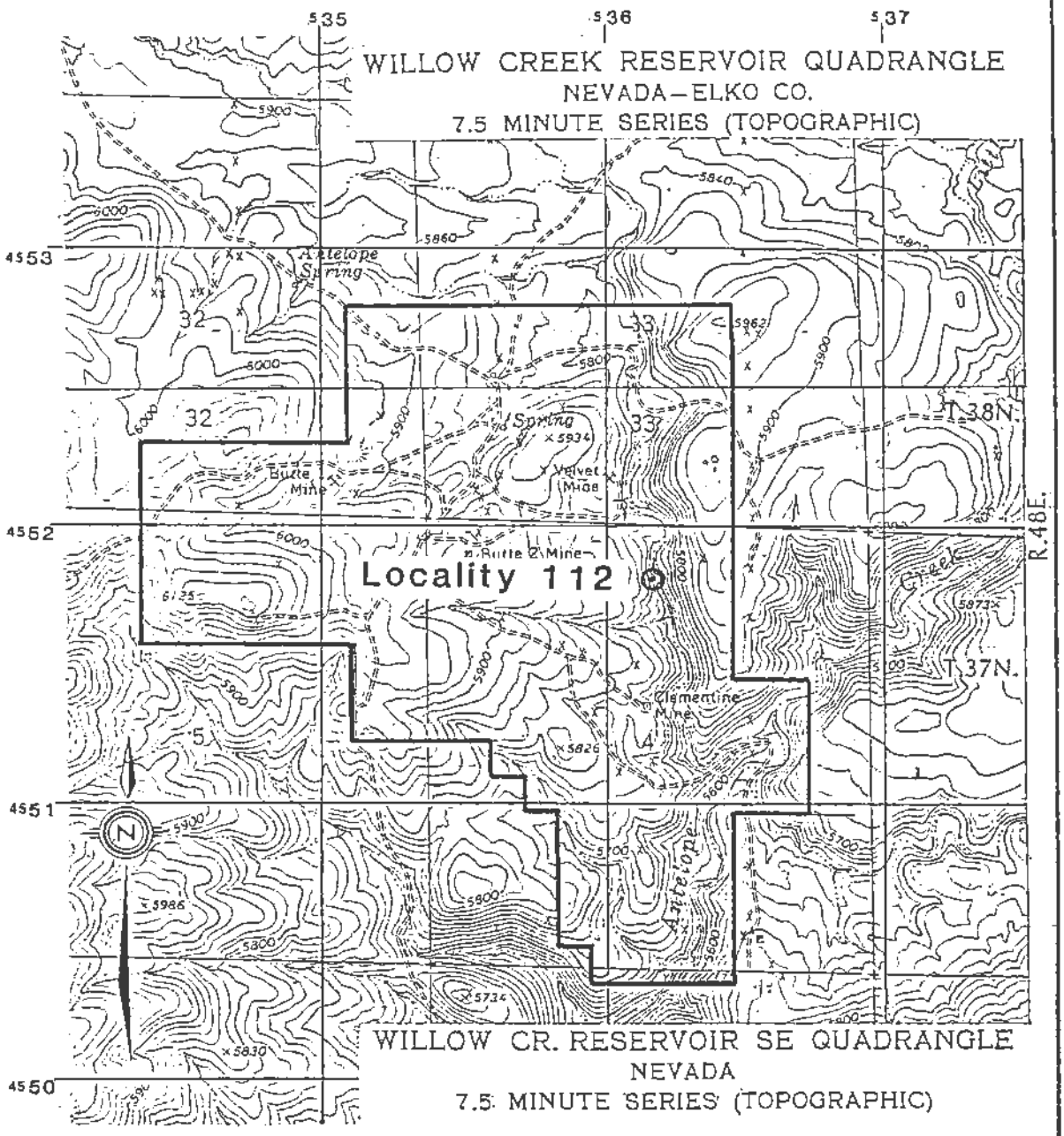
Topographic Data: Top of bedrock ledge on steep (45%) canyon slope, west side of Velvet Canyon.

Quarry Data: No on-site opalite source.

Description: A small area (feature 68-3) along the top of a bedrock bench evidencing a high density of reduction flakes; likely reflecting reduction of materials from a nearby source (many quarry localities are located nearby in Upper Velvet Canyon, cf. Locality 82).

Site Condition: Undisturbed.

Remarks: Possible relationships to Upper Velvet Canyon quarries.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Velvet Canyon

Locality No.: 113 Type: Small Outcrop-Assay Quarry

UTM: 536200E/4551800N

Size: see below Max. Area (m^2): 150

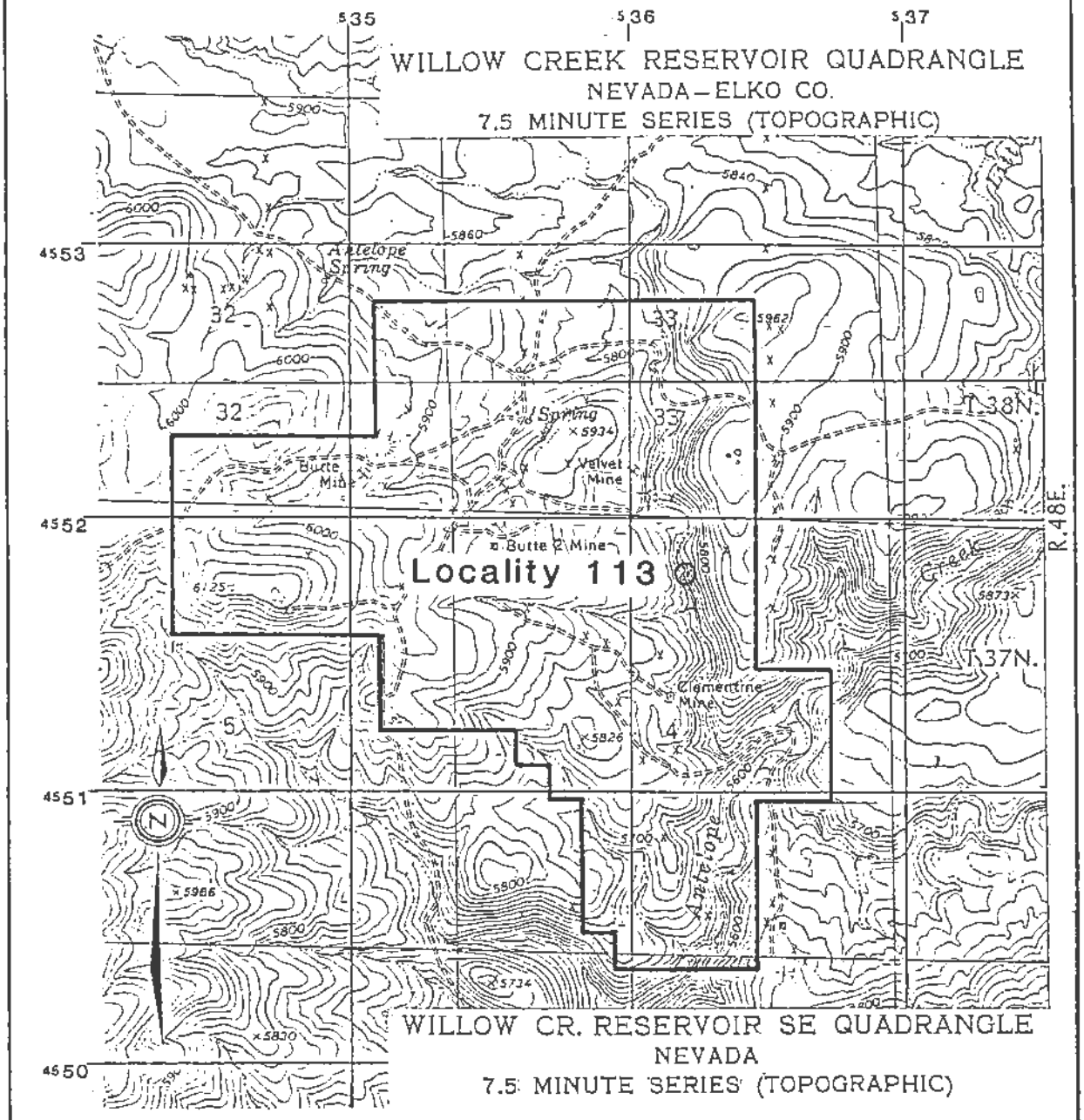
Topographic Data: Base and top of bedrock outcrop near bottom of Velvet Canyon, east side.

Quarry Data: Poor quality bedrock outcrop.

Description: Two small quarries (feature 69-2 is 7m x 3m; feature 69-3 is 20m x 15m) located along the edge of a bedrock outcrop. Primary debitage and assay flakes and shatter are most abundant materials associated with each.

Site Condition: Undisturbed.

Remarks: Example prehistoric exploration strategies along large outcrops in the bottom of Velvet Canyon.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Owl Ridge

Locality No.: 114 Type: Small Reduction Station

UTM: 536320E/4551860N

Size: 4m x 4m Max. Area (m^2): 16

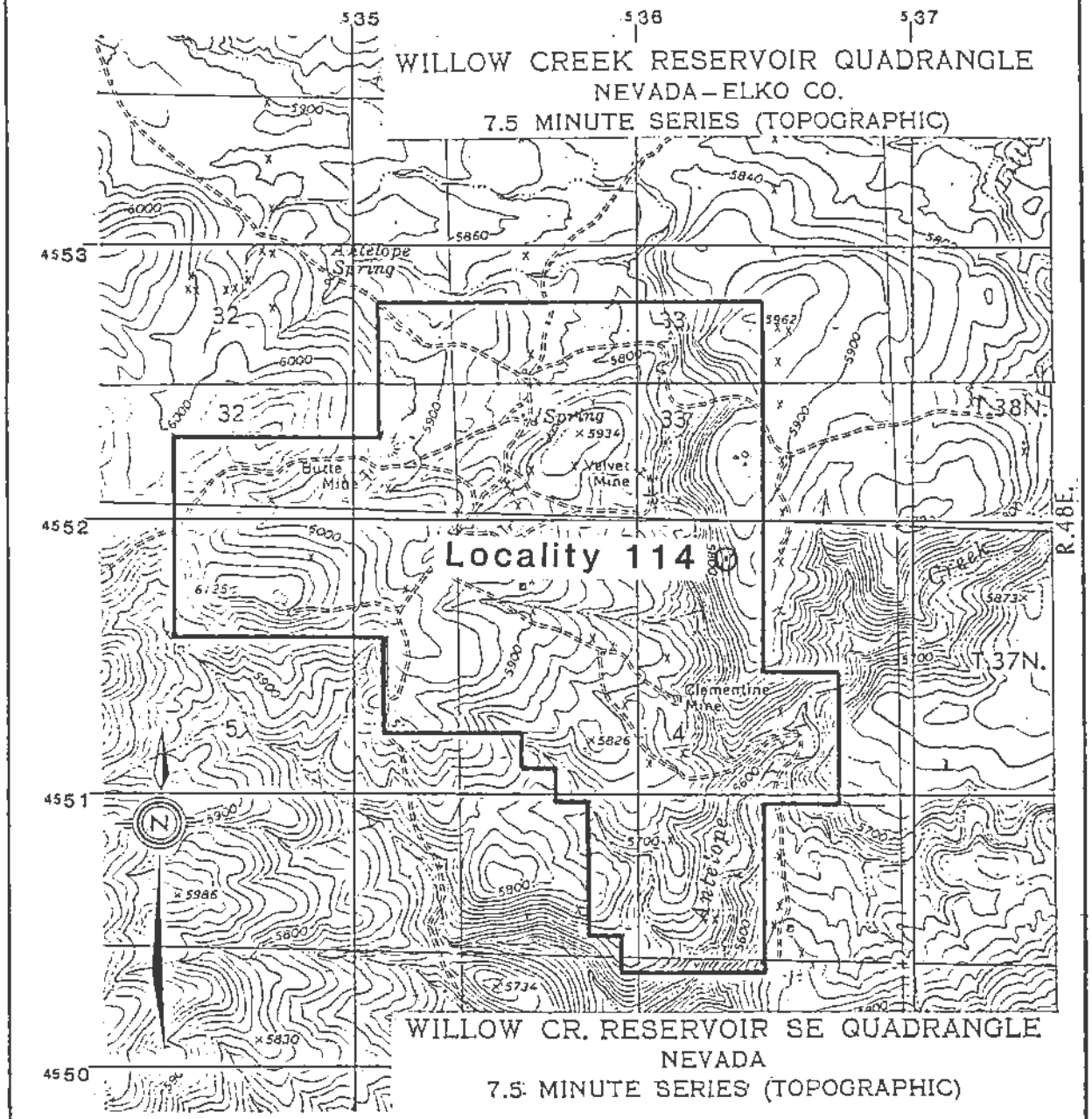
Topographic Data: Base of rimrock at upper edge of moderately steep (25-30%), west-facing slope near top of Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small scatter of ca. 200 white opalite flakes, one core, and 2 biface fragments (feature 73-K2); a small reduction station located a base of rock ledge.

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Owl Ridge

Locality No.: 115 Type: Rockshelter (Reduction Station)

UTM: 536340E/4551700N

Size: shelter=4m wide/3m high Max. Area (m^2): 10

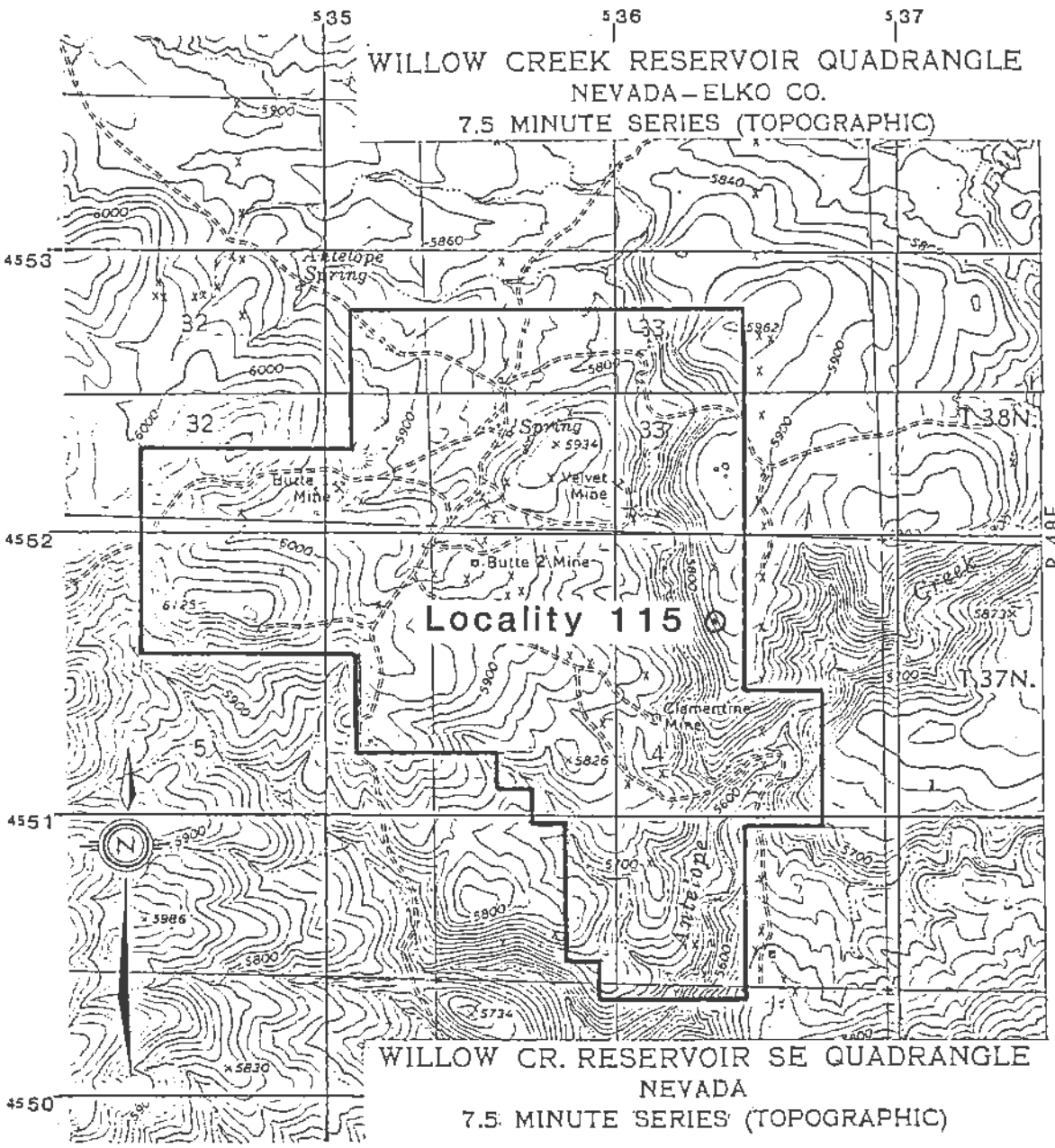
Topographic Data: Small rock overhang at base of rimrock at upper edge of steep (45%), west-facing slope near top of Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small scatter of ca. 100 white opalite flakes (secondary) and one biface fragment (feature 73-K3). No subsurface deposit (bedrock controlled).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Owl Ridge

Locality No.: 116 Type: Small Reduction Station

UTM: 536360E/4551960N

Size: 10m x 10m Max. Area (m^2): 100

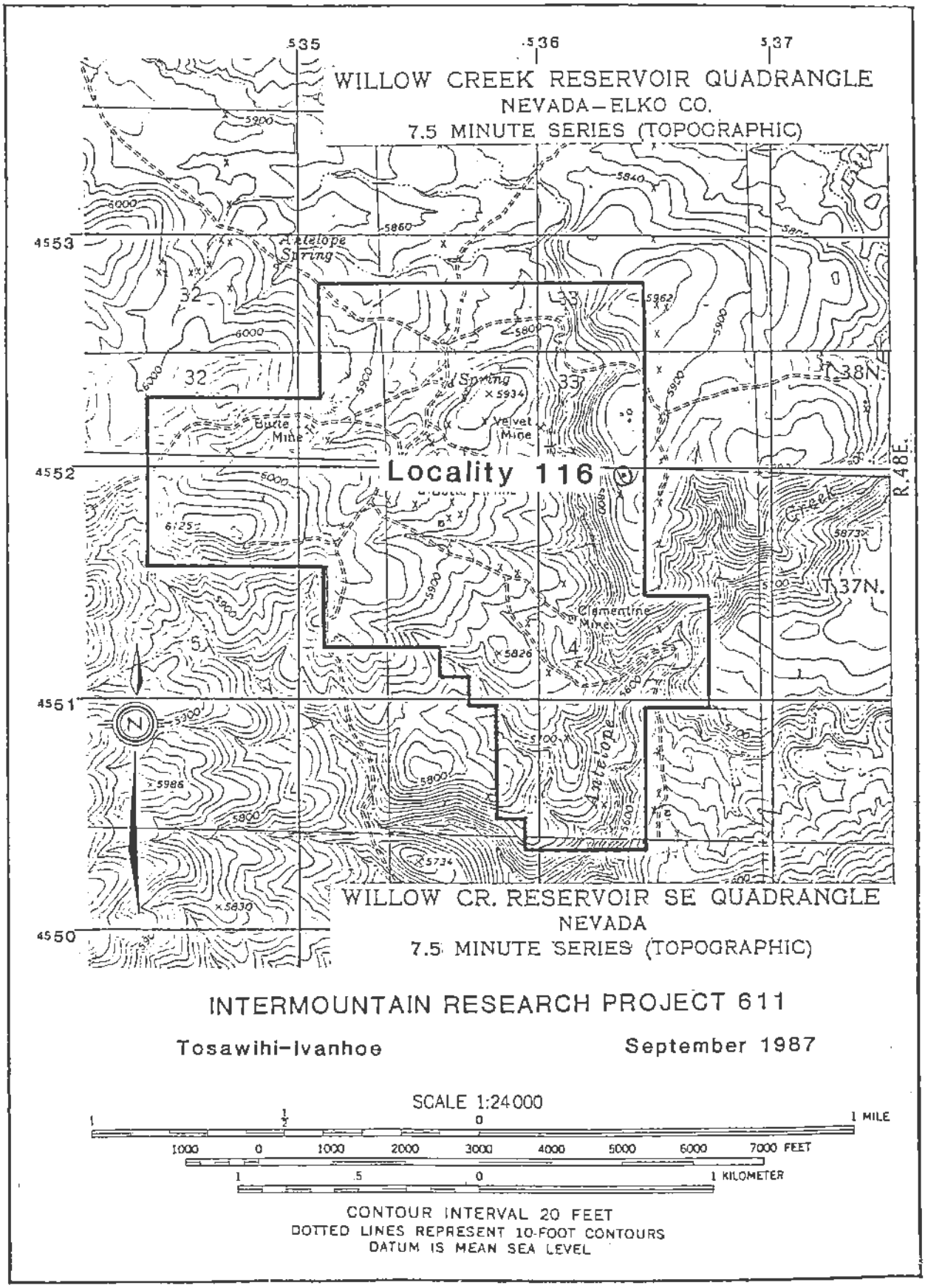
Topographic Data: Top of rimrock on Owl Ridge, near edge of moderately steep (16%), west-facing slope.

Quarry Data: No on-site opalite source.

Description: Small scatter of ca. 300 white opalite secondary flakes and one biface tip fragment (feature 74-E1); a small reduction station located on top of rimrock.

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Owl Ridge

Locality No.: 117

Type: Lithic Scatter/ Undetermined Type

UTM: 536400E/4552060N

Size: 20m NS/ 15m EW

Max. Area (m^2): 300

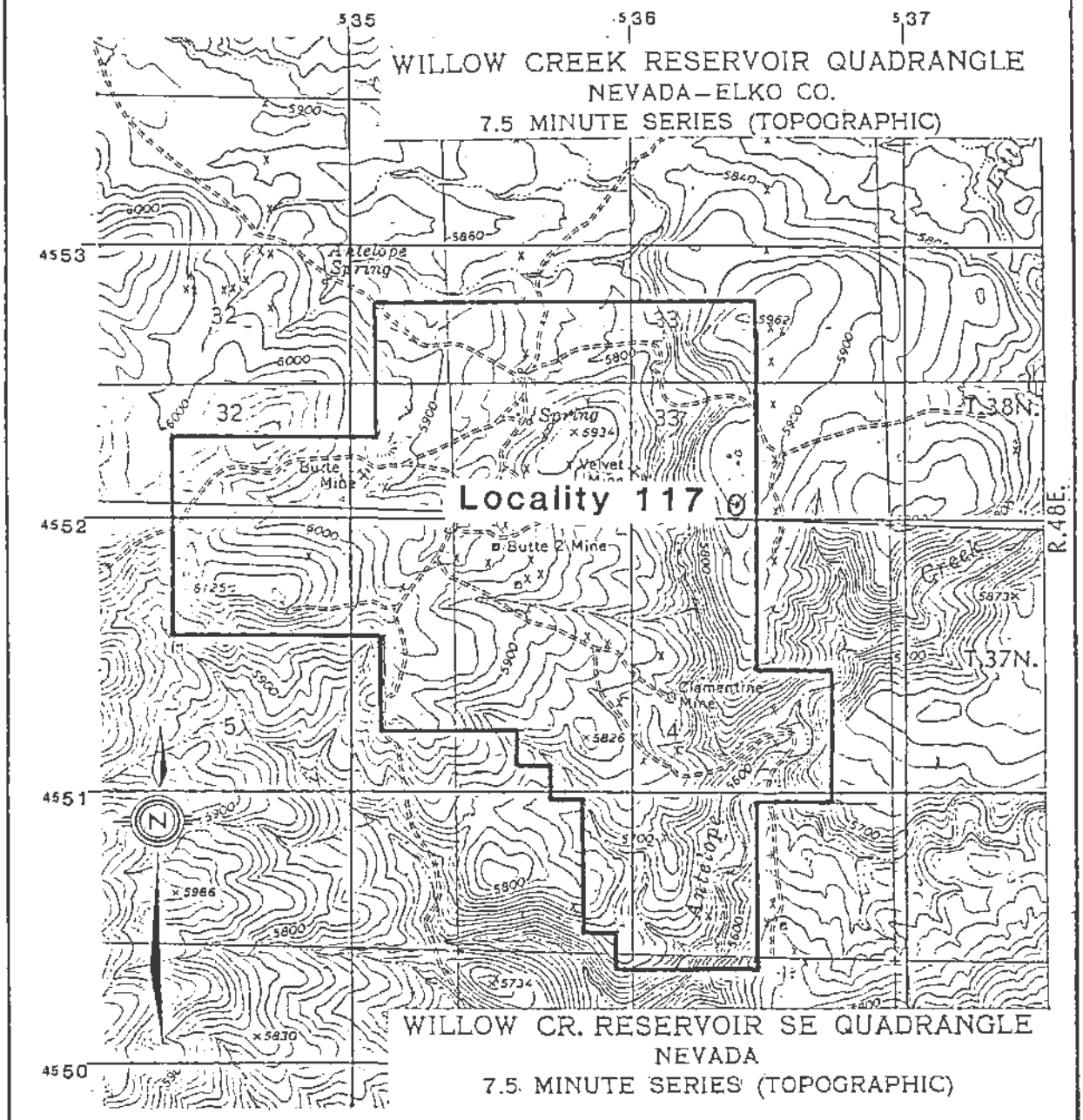
Topographic Data: On small flat, top of gently sloping (5%), south-trending Owl Ridge; colluvium.

Quarry Data: No on-site opalite source.

Description: Small lithic scatter of white opalite coincident with a clump of Big Sagebrush (an indicator of deeper soil) (feature 75-E4). Lithic scatter is undetermined type; may reflect small camp, resource collection station, or merely another lithic reduction locality.

Site Condition: Pristine.

Remarks: Similar to several other enigmatic lithic scatters which are coincident with Big Sage; deeper soils provide opportunity for subsurface deposits; should be test excavated.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Owl Ridge

Locality No.: 118

Type: Lithic Scatter (Undetermined Type)/ Soil Mound

UTM: 536400E/4552080N

Size: 9m NS/ 9m EW

Max. Area (m^2): 81

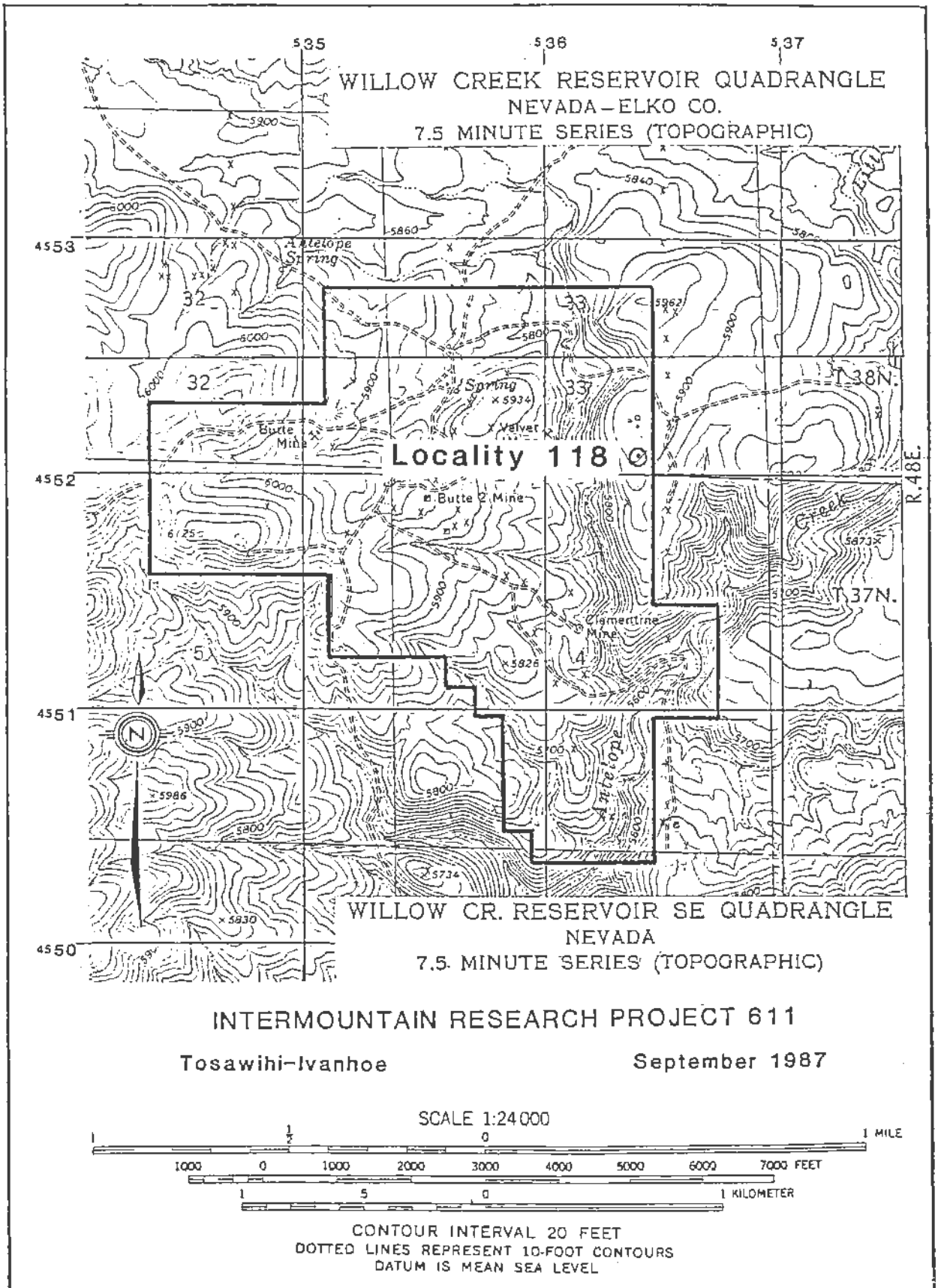
Topographic Data: On small flat, top of gently sloping (5%), south-trending Owl Ridge; colluvium.

Quarry Data: No on-site opalite source.

Description: Small, light density lithic scatter of white opalite coincident with a clump of Big Sagebrush (an indicator of deeper soil) (feature 75-N2). Lithic scatter is undetermined type; may reflect small camp, resource collection station, or merely another lithic reduction locality.

Site Condition: Pristine.

Remarks: Similar to several other enigmatic lithic scatters which are coincident with Big Sage; deeper soils provide opportunity for subsurface deposits; should be test excavated.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Owl Ridge

Locality No.: 119 Type: Small Reduction Station

UTM: 536380E/4552400N

Size: 1.5m / 2m Max. Area (m^2): 2

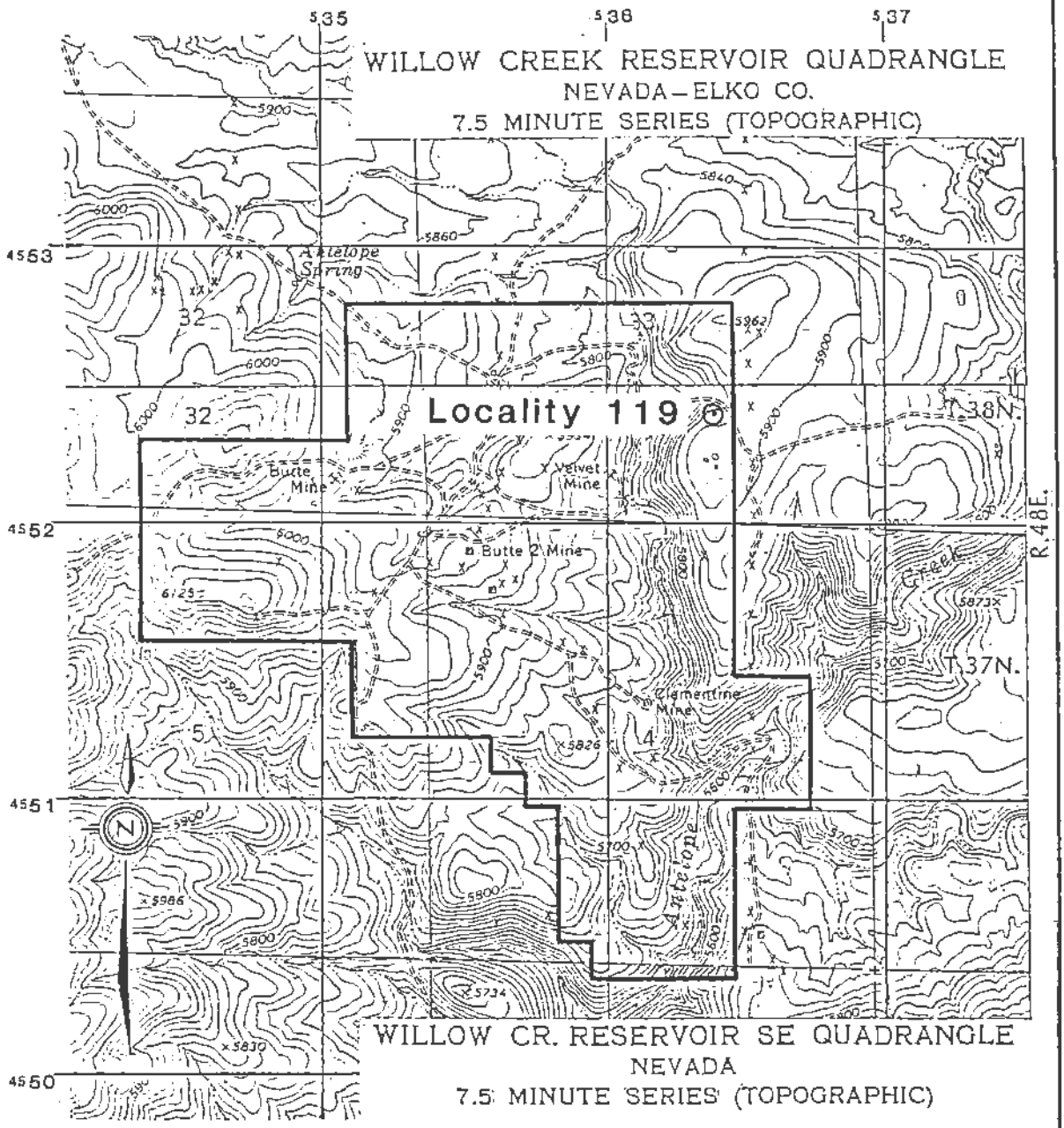
Topographic Data: Rimrock at west edge saddle on Owl Ridge, overlooking steep slope (40%), facing northwest.

Quarry Data: No on-site opalite source.

Description: Small, discrete reduction scatter of ca. 60 white opalite secondary flakes (feature 75-N1).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Owl Ridge

Locality No.: 120 Type: Reduction Station Complex

UTM: 536400E/4552720N

Size: 30m x 20m Max. Area (m^2): 600

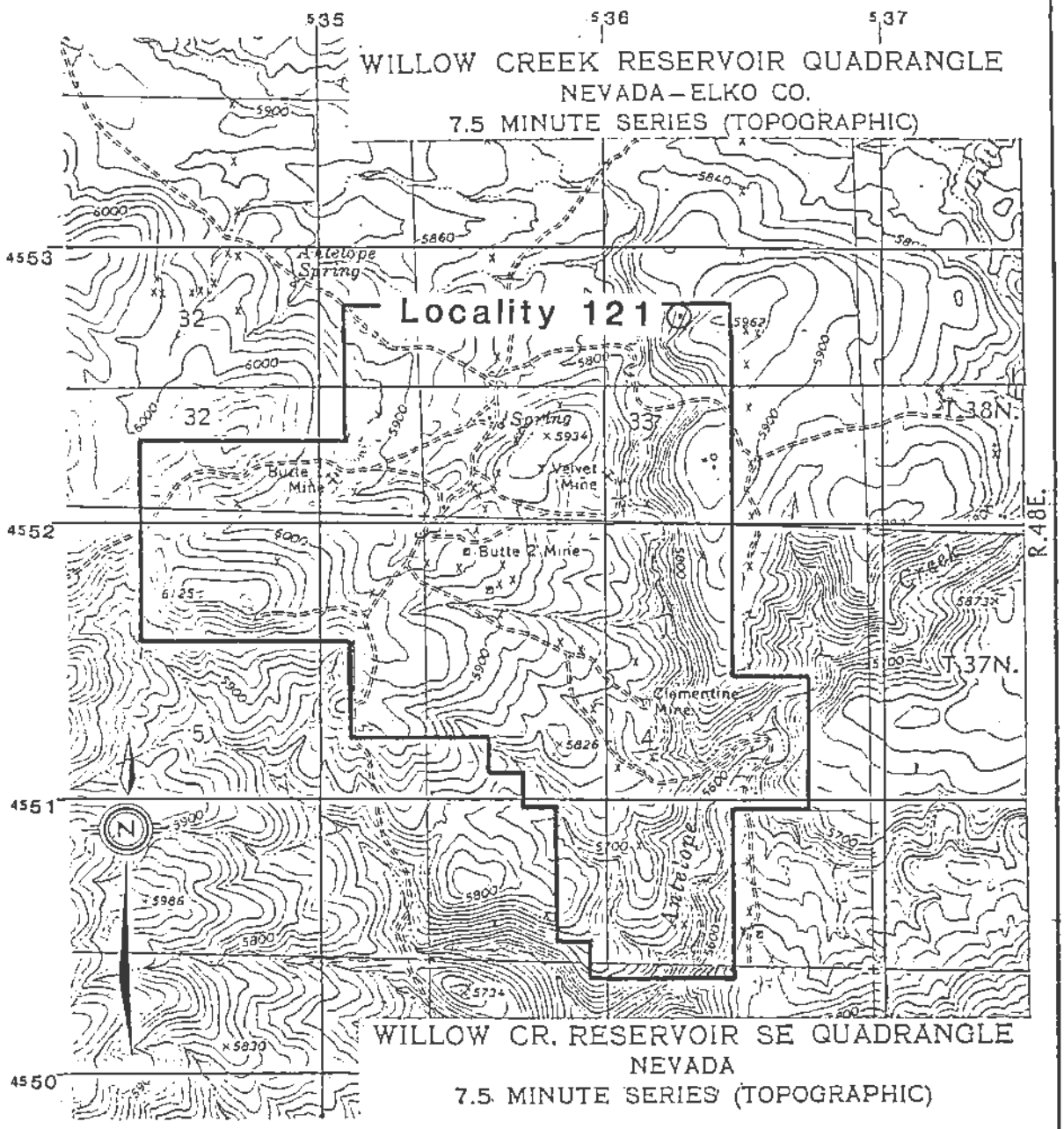
Topographic Data: In rock outcrop on edge knoll near top of Owl Ridge, facing south, moderately sloping (6%).

Quarry Data: No on-site opalite source.

Description: Small, light density scatter; most are white opalite biface thinning flakes, but a few flakes of red and yellow opalite as well; one red opalite biface (feature 76-N1); inferred overlapping reduction stations.

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Owl Ridge

Locality No.: 122 Type: Small Reduction Station

UTM: 536240E/4552580N

Size: 30m x 15m Max. Area (m^2): 25

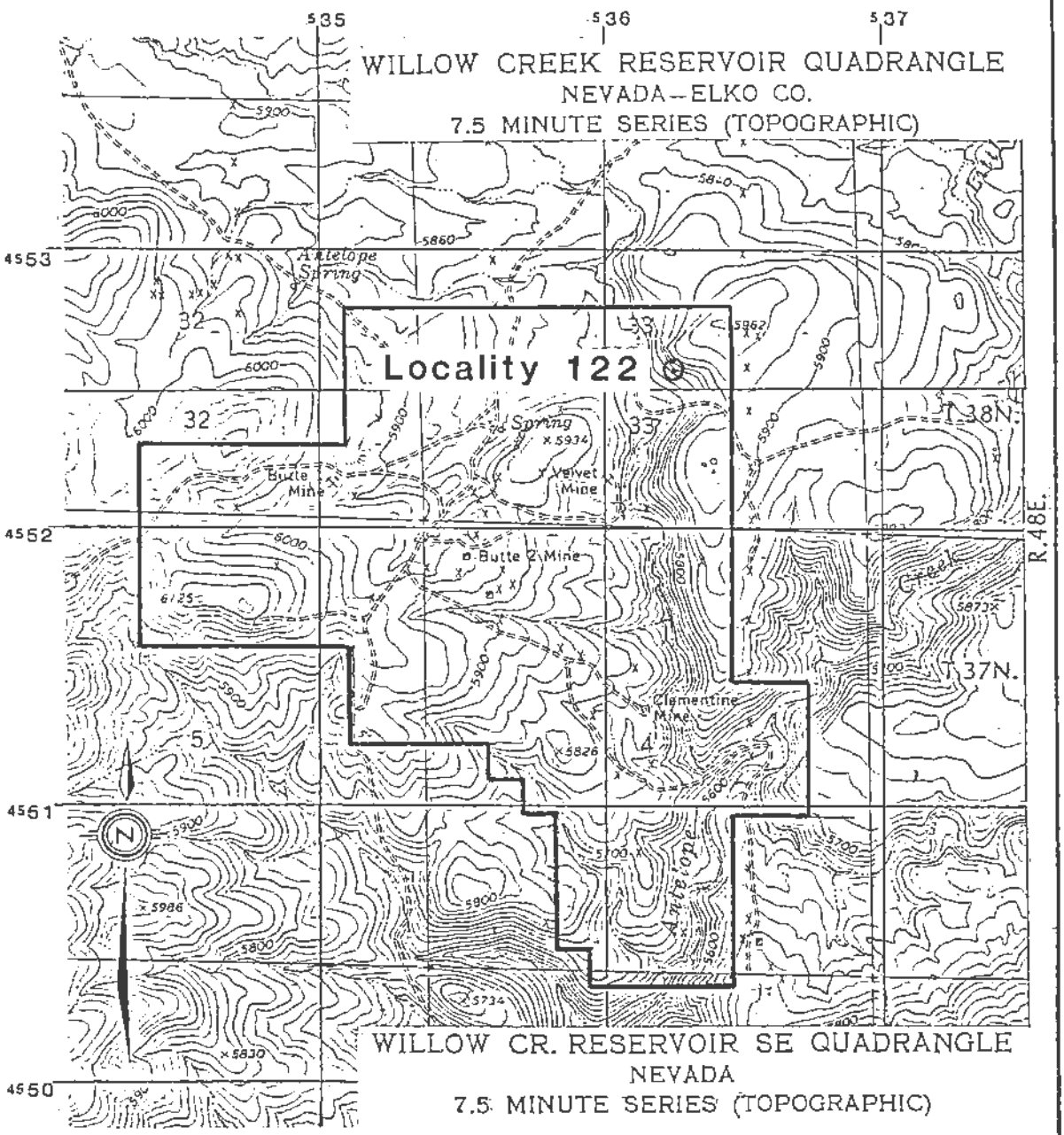
Topographic Data: Base of cliff face on steep (30%), southwest-facing slope, edge of Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small flake scatter extending along base of cliff face; about 100 white opalite flakes; no tools observed (feature 71-2).

Site Condition: Undisturbed

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Owl Ridge

Locality No.: 123 Type: Rockshelter (Reduction Station)

UTM: 536300E/4552580N

Size: shelter=7m wide Max. Area (m^2): 35

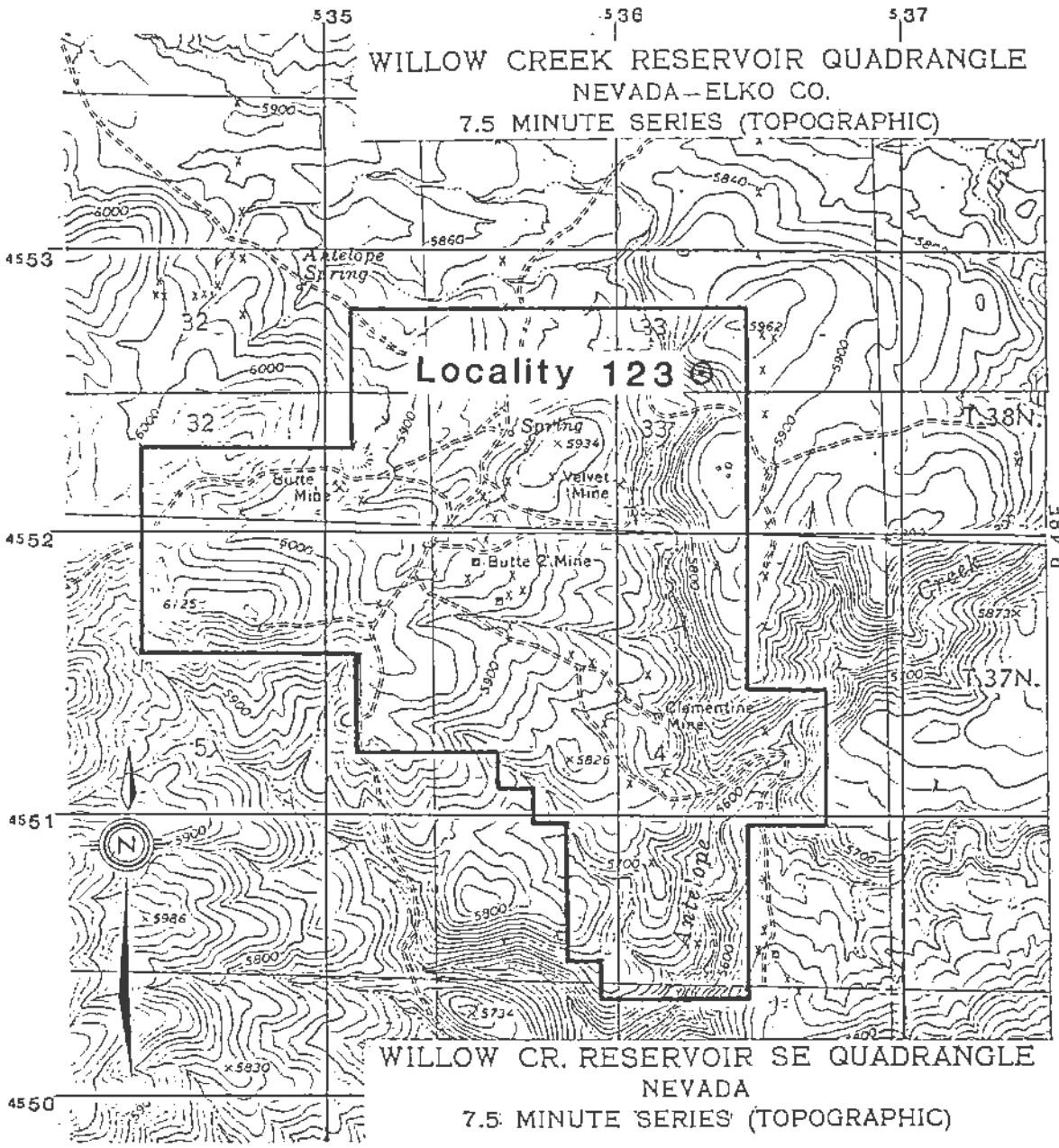
Topographic Data: Large, but shallow rock overhang at base of rimrock at upper edge of steep (45%), west-facing slope near top of Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small scatter of ca. 50 opalite flakes; most flakes are quite large (feature 72-1). Maximum of 10 cm colluvial deposit (bedrock controlled).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District. Should be tested.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 124 Type: Small Reduction Station

UTM: 536180E/4552240N

Size: 5m x 3m Max. Area (m^2): 15

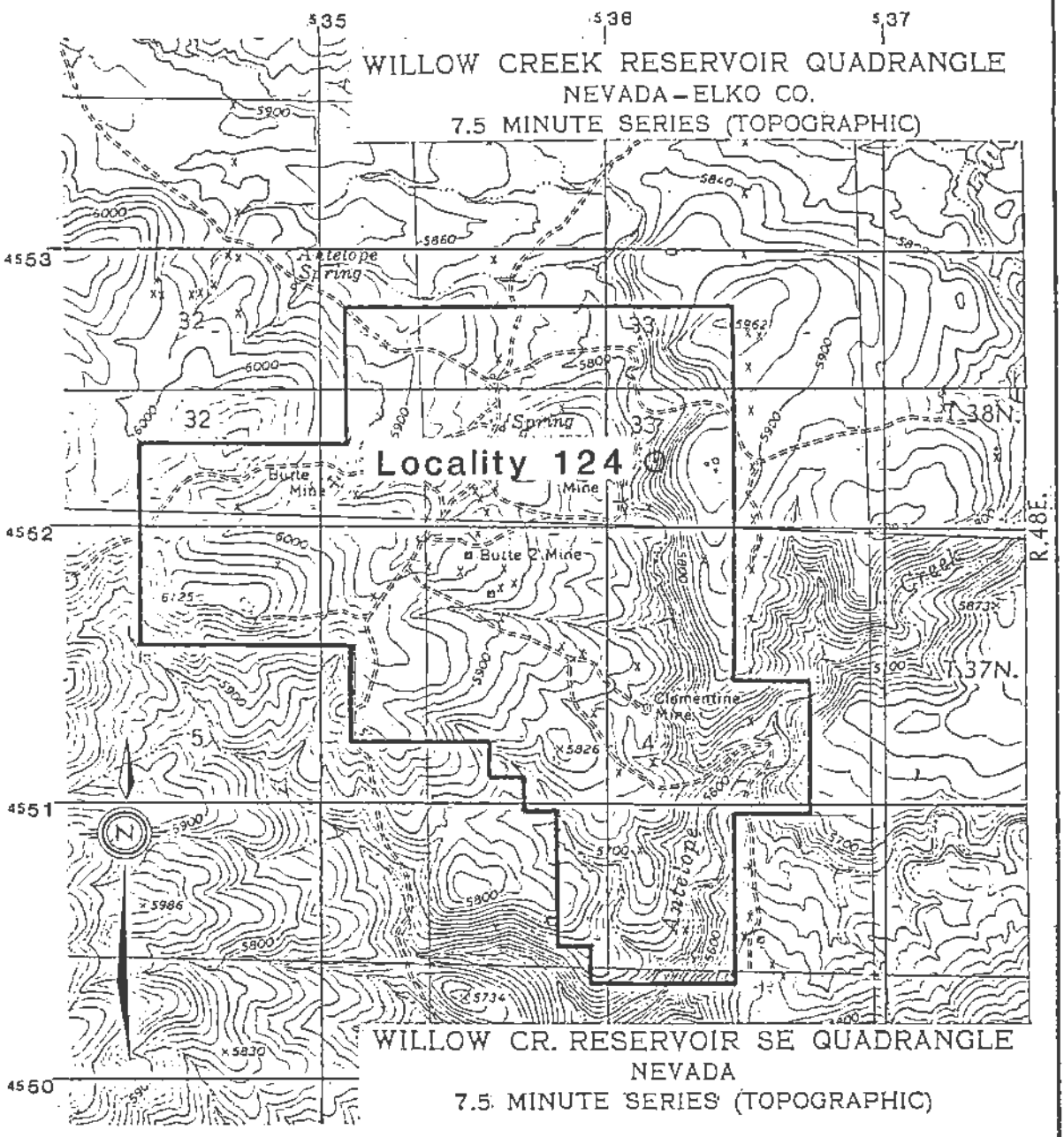
Topographic Data: Edge of steep (40%) colluvial slope, facing northwest, on lower slopes Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small reduction station comprised of several large biface fragments and both large and small opalite flakes (feature 68-1).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations along the edge of Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Owl Ridge

Locality No.: 125 Type: Small Reduction Station

UTM: 536160E/4552640N

Size: 15m x 15m Max. Area (m^2): 225

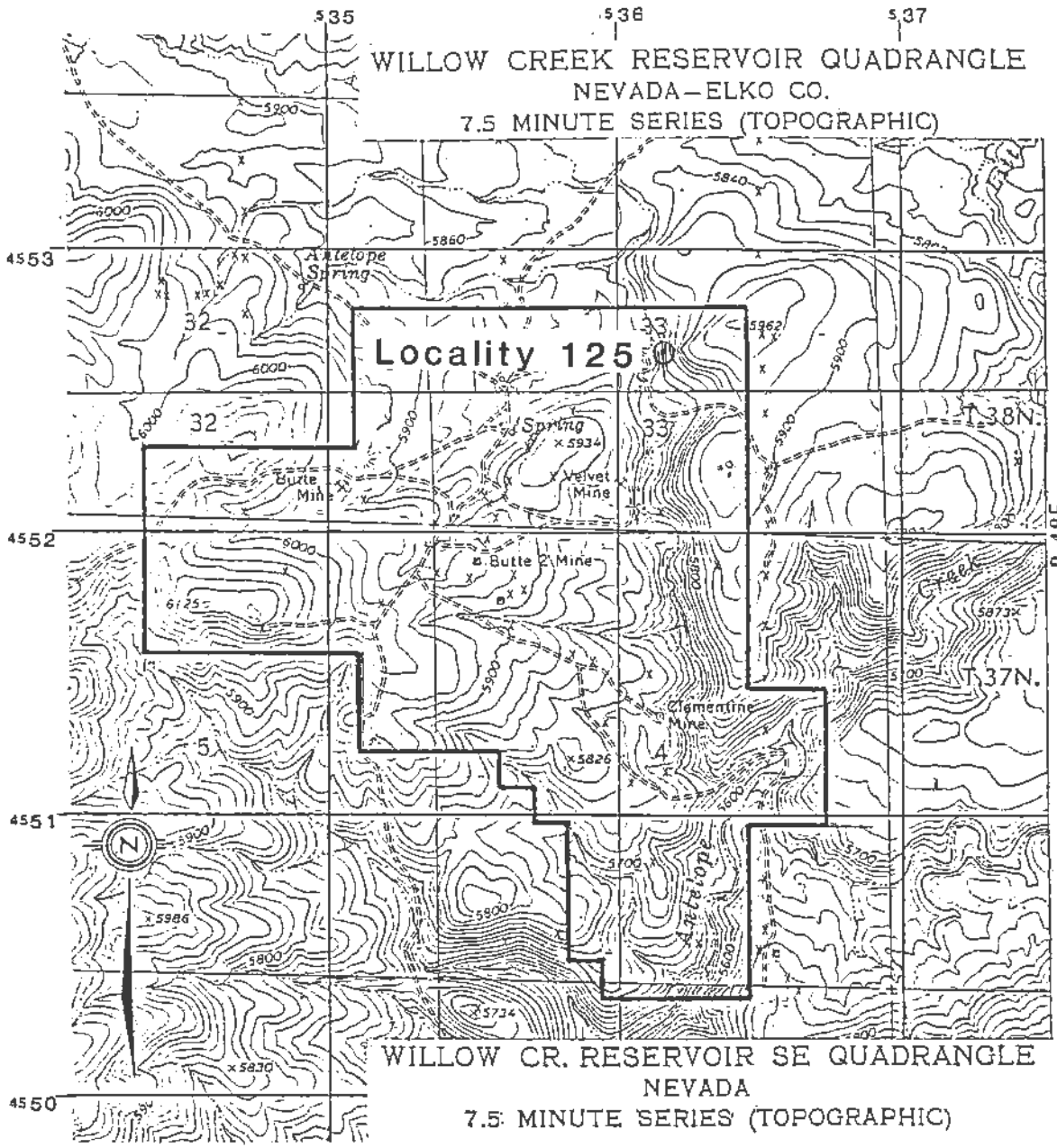
Topographic Data: Base of cliff face on steep (50%) slope, facing west, on lower slopes Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small reduction station comprised of ca. 300 opalite flakes; many flakes are quite small (feature 68-2).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations along the edge of Owl Ridge on the east edge of the Tosawihi Quarry District.



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Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 126 Type: Rockshelter (Reduction Station)

UTM: 536320E/4550680N

Size: 6 m wide Max. Area (m^2): 50

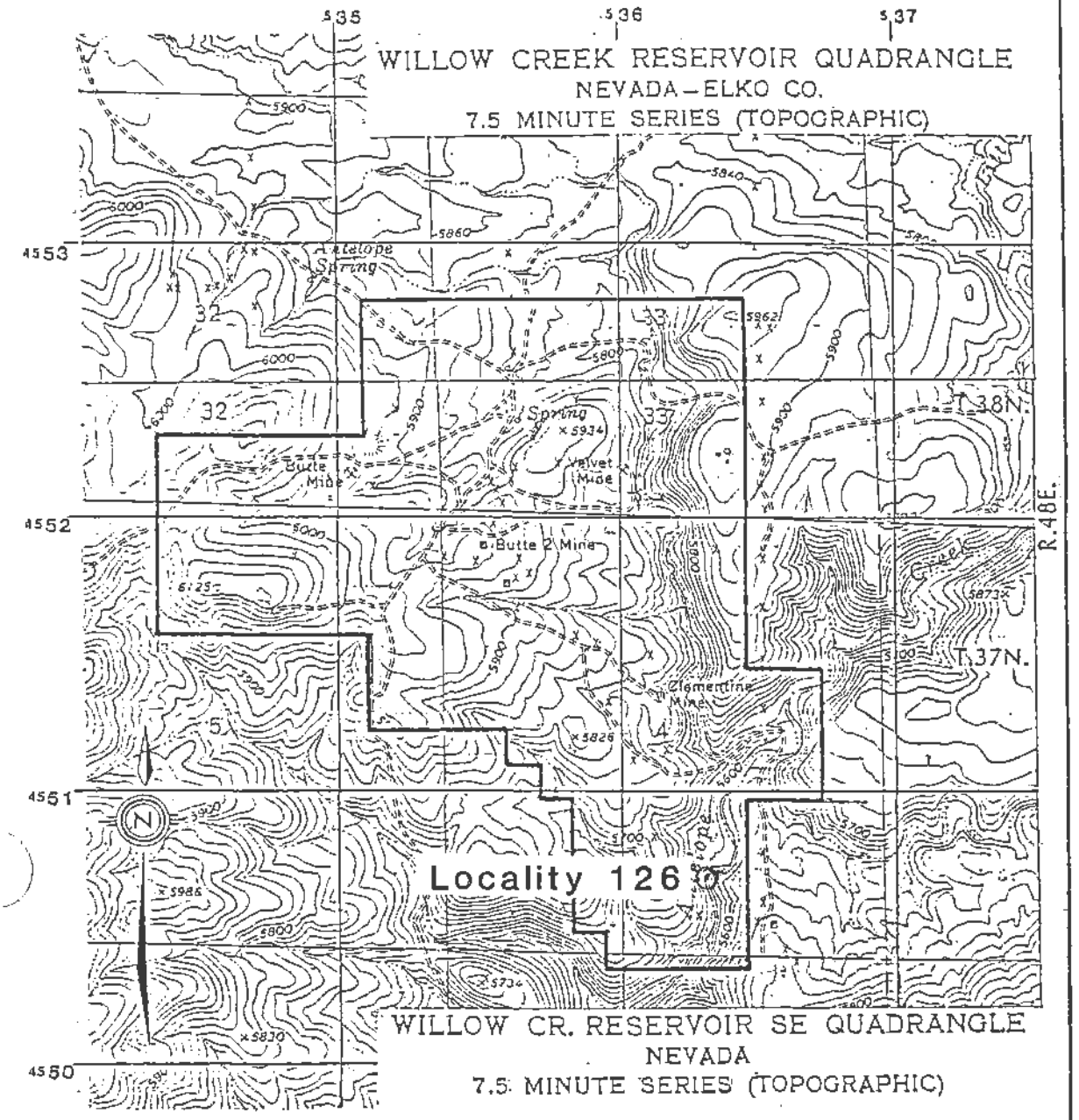
Topographic Data: Located near base of bedrock ledge, three meters above drainage bottom, on the east side of Little Antelope Canyon.

Quarry Data: High quality opalite is available near the top of the bedrock ledge where the outcrop contacts colluvium. Intensive quarrying was conducted by shallow pit excavations along this contact (see Locality 15).

Description: A small rockshelter in the base of an intensively quarried outcrop (feature 72-3) apparently was used as a reduction station; artifacts in the shelter consist of a light density scatter of white opalite flakes.

Site Condition: Undisturbed.

Remarks: See relationships to intensive quarry, locality 152.



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Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 127 Type: Outcrop Quarry Complex

UTM: 536100E/4552280N

Size: 150m x 75m Max. Area (m^2): 11,250

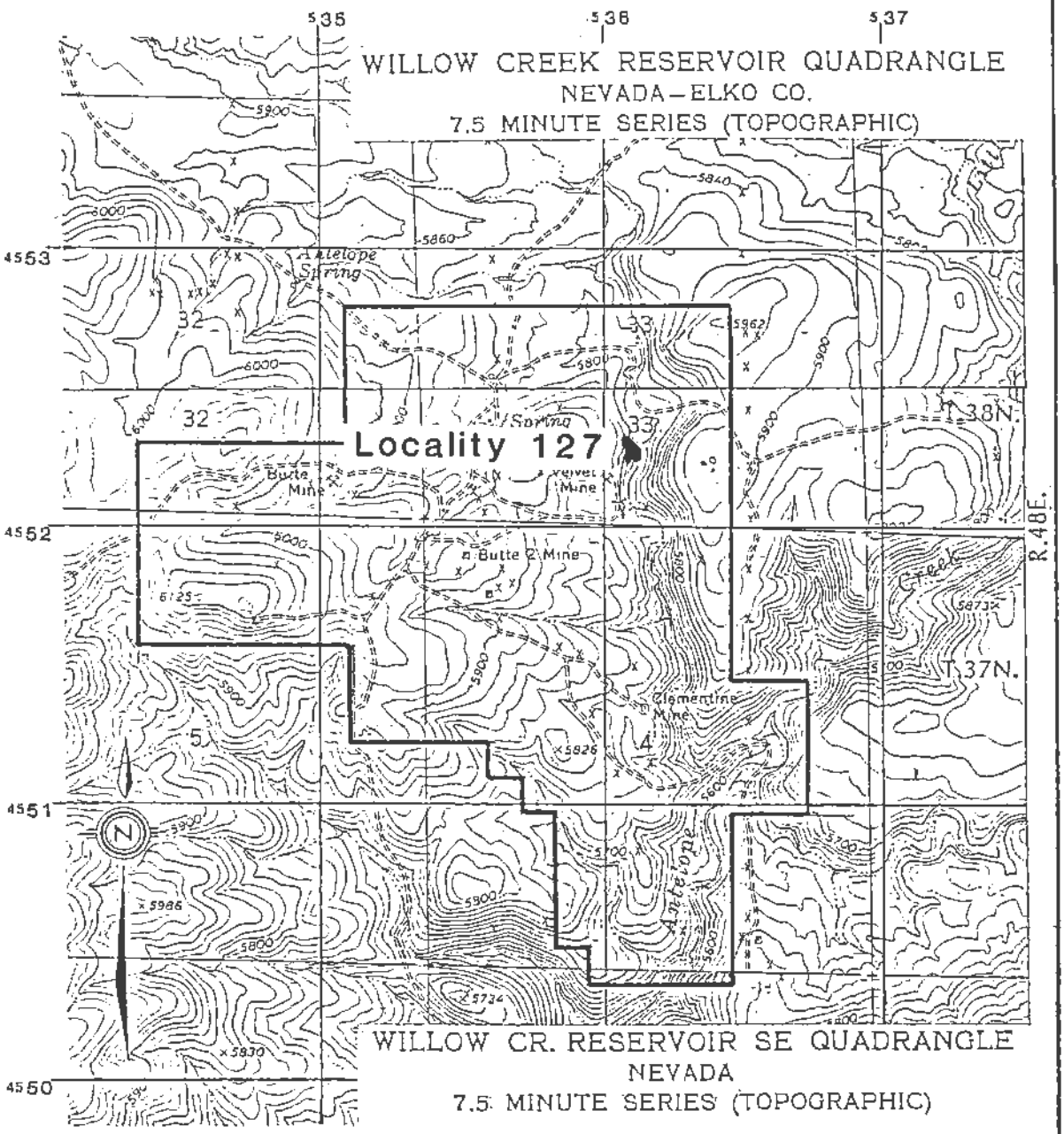
Topographic Data: Moderately steep (15-25%), southeast facing slope, along middle to lower reaches of Upper Velvet Canyon.

Quarry Data: Bedrock ledge outcrop; thick talus on slopes.

Description: Large, intensively quarried bedrock-talus zone with quarry pits excavated into colluvium on lower slope. Three major pit complexes (features 64-1, 66-6, 65-4) and a smaller outcrop nearby (feature 65-3) are among the significant features segregated, but the complex of prehistoric activities at this locality warrants closer scrutiny.

Site Condition: Some historic pits identified, but the site is little disturbed in general.

Remarks: One of the most intensively quarried bedrock outcrops in the Tosawihi Quarry District.



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 128

Type: Lithic Scatter (Undetermined Type)

UTM: 535940E/4552320N

Size: 75m x 45m

Max. Area (m^2): 3,375

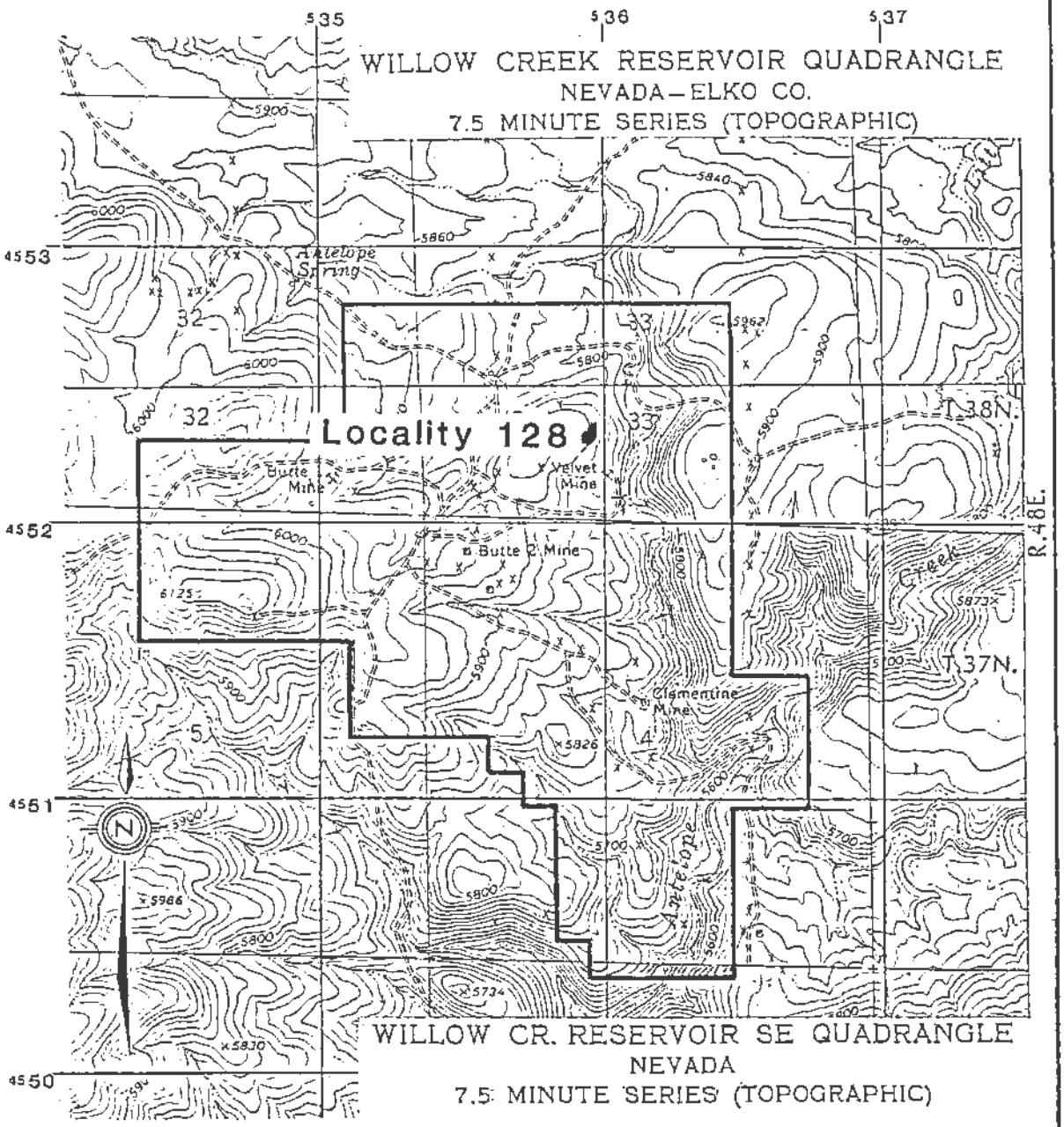
Topographic Data: Strongly sloping (10%), east facing colluvial ridge.

Quarry Data: No on-site opalite source identified; but may be derived from bedrock near surface.

Description: A moderate density flake scatter derived from coded density inventory; no features identified. Needs further field assessment to determine validity as distinct locality.

Site Condition: Near intensive historic disturbance from Velvet Mine; precise condition unknown.

Remarks: Conduct field examination.



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 129

Type: Lithic Scatter (Undetermined Type)

UTM: 535980E/4552680N

Size: 60m x 30m

Max. Area (m^2): 1,800

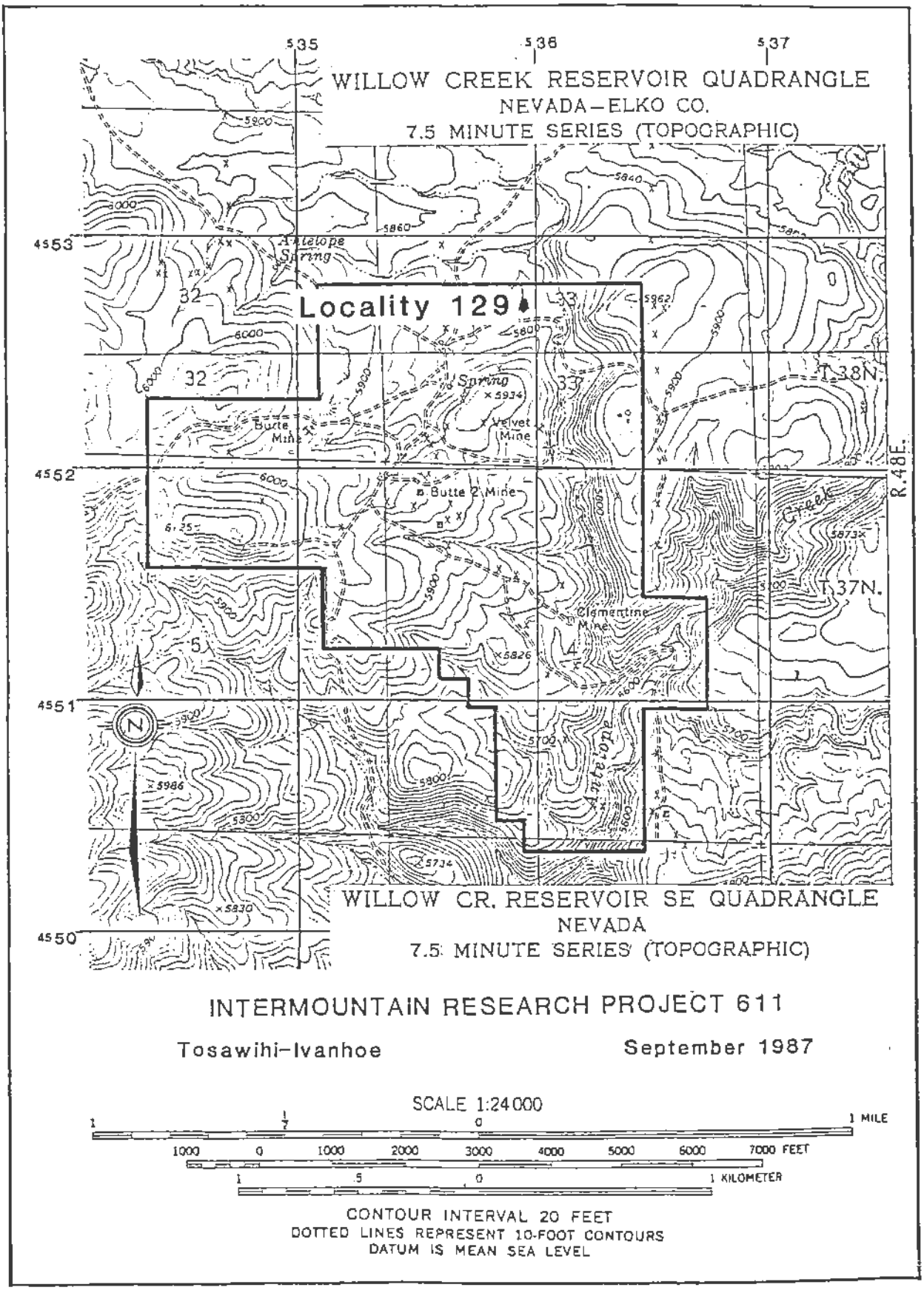
Topographic Data: In western Big Butte Valley, on flat terrace along low ephemeral drainage into Velvet Canyon.

Quarry Data: No on-site toolstone source.

Description: A moderate density flake scatter derived from coded density inventory; no features identified. Needs further field assessment to determine nature of scatter.

Site Condition: Apparently undisturbed.

Remarks: Conduct field examination.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 130 Type: Large Open Residential/ Soil Mound

UTM: 536000E/4552840N

Size: 150m NS/45m EW Max. Area (m^2): 6,750

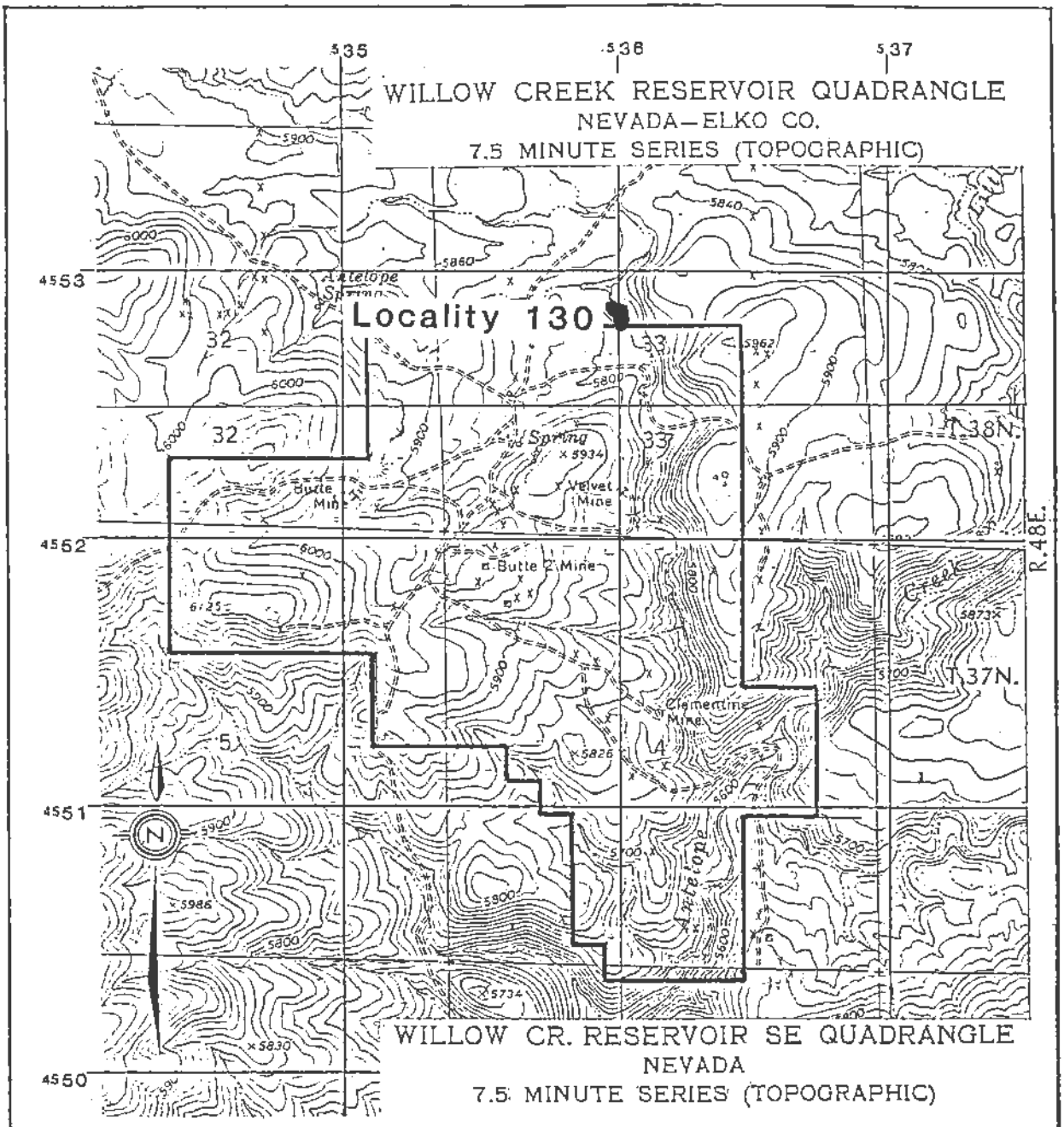
Topographic Data: On top and gentle (2%) slopes of low rise in western Big Butte Valley; near confluence of two ephemeral drainages feeding into Velvet Canyon.

Quarry Data: No on-site toolstone source.

Description: Undifferentiated lithic scatter (feature 63-1) in open flats north of primary opalite outcrops. Big Sagebrush on rise indicates deeper soil and potential for subsurface deposits. May be an open residential site similar to several localities identified in western Big Butte Valley.

Site Condition: Pristine.

Remarks: Will need subsurface tests to determine extent and nature of deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 130 Type: Large Open Residential/ Soil Mound

UTM: 536000E/4552840N

Size: 150m NS/45m EW Max. Area (m^2): 6,750

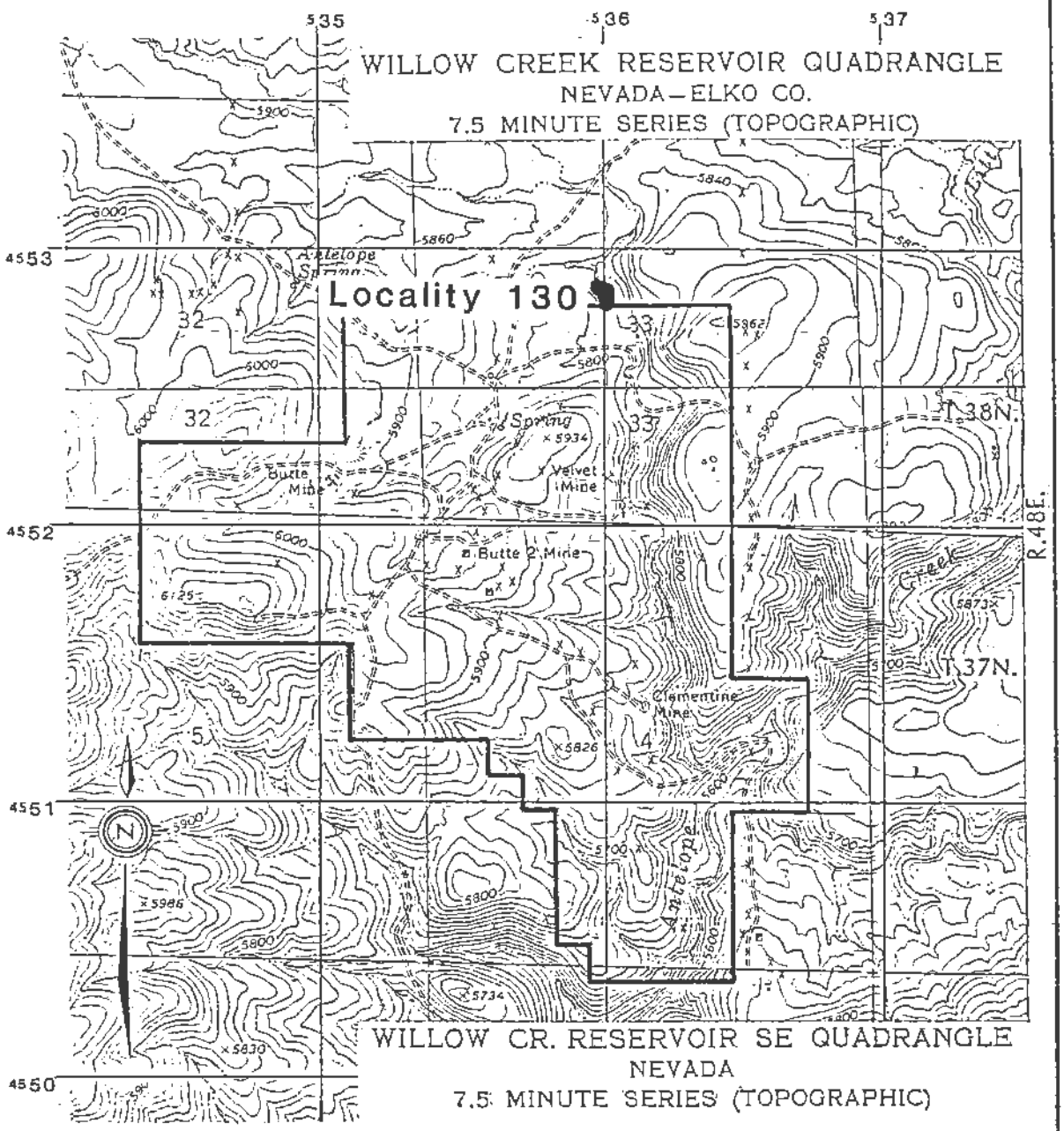
Topographic Data: On top and gentle (2%) slopes of low rise in western Big Butte Valley; near confluence of two ephemeral drainages feeding into Velvet Canyon.

Quarry Data: No on-site toolstone source.

Description: Undifferentiated lithic scatter (feature 63-1) in open flats north of primary opalite outcrops. Big Sagebrush on rise indicates deeper soil and potential for subsurface deposits. May be an open residential site similar to several localities identified in western Big Butte Valley.

Site Condition: Pristine.

Remarks: Will need subsurface tests to determine extent and nature of deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 131 Type: Small Open Residential/ Rock Circle

UTM: 535860E/4552680N

Size: circle=3.5m diameter Max. Area (m^2): 25

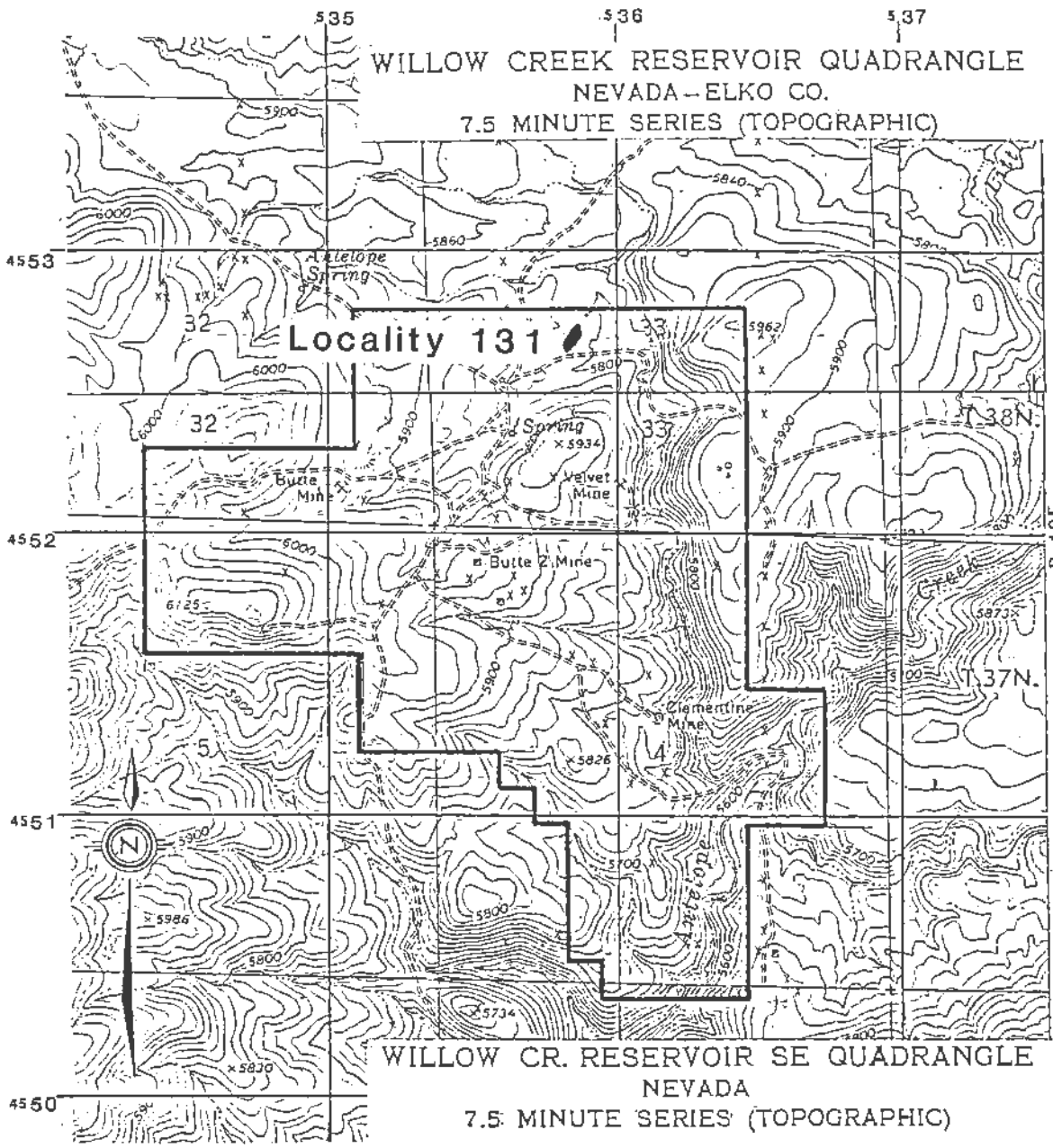
Topographic Data: On gentle (3%), southeast facing slope in western Big Butte Valley.

Quarry Data: Poor quality, variegated pebbles; no primary opalite source.

Description: Possible small rock circle (feature 58-5), partially buried in soil; very ephemeral alignment and perhaps illusory. Moderate density flake scatter in vicinity feature, but no clear association of artifacts and rock alignment.

Site Condition: Eroded, but otherwise undisturbed.

Remarks: Will need subsurface tests to determine extent and nature of deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 132 Type: Small Open Residential/ Soil Mound

UTM: 535880E/4552540N

Size: mound = 15m diameter, 2m high. Max. Area (m^2): 150

Topographic Data: On low grassy mound, on moderately sloping (9%), north facing slope in western Big Butte Valley.

Quarry Data: No primary opalite source on site.

Description: Grassy mound (feature 58-4) characterized by dark grey soil well mixed with opalite flakes. May be an old spring mound, or possibly reflects cultural build up.

Site Condition: Some rodent turbation, otherwise undisturbed.

Remarks: Will need subsurface tests to determine extent and nature of deposits.

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 132 Type: Small Open Residential/ Soil Mound

UTM: 535880E/4552540N

Size: mound = 15m diameter, 2m high. Max. Area (m^2): 150

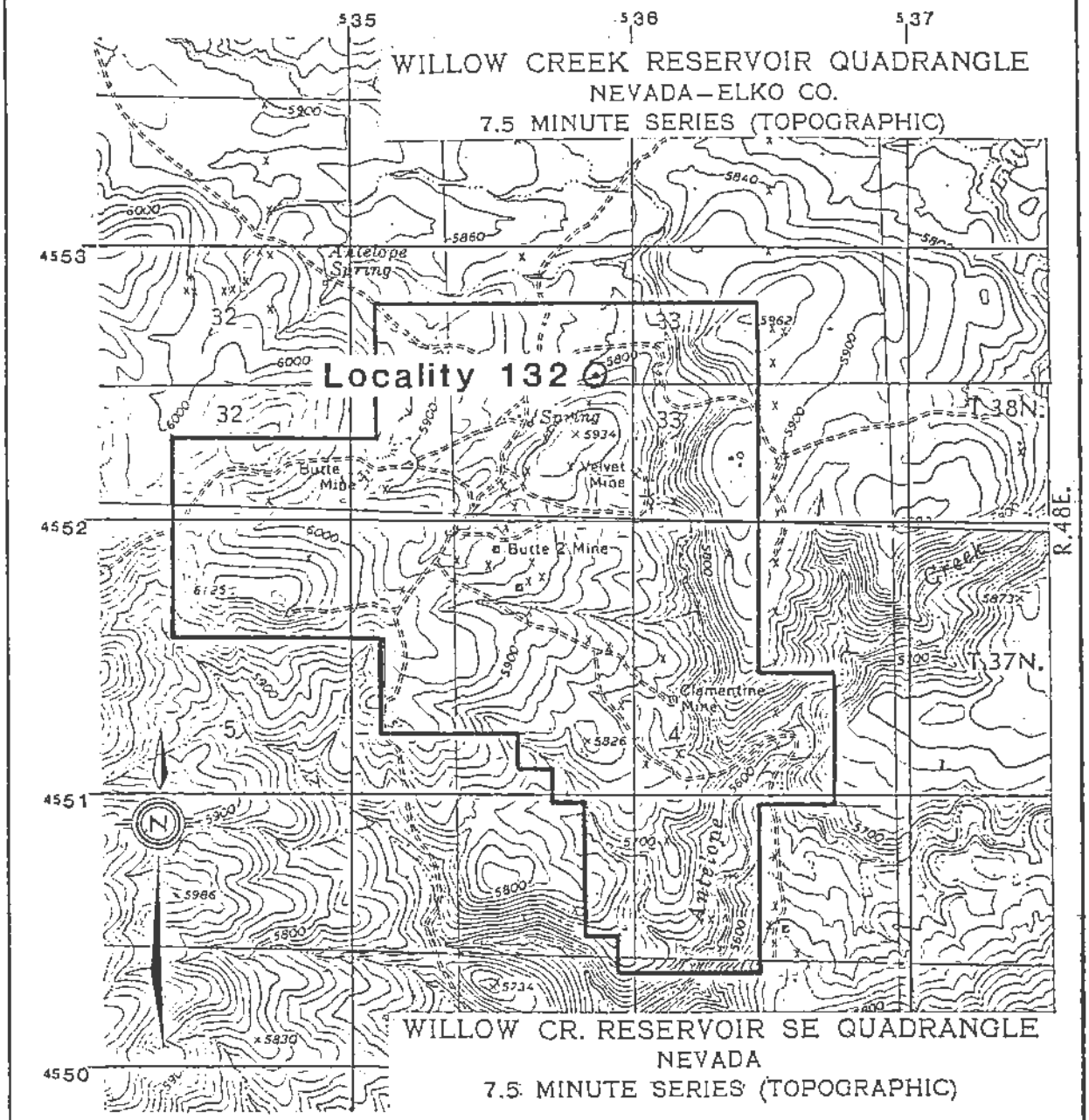
Topographic Data: On low grassy mound, on moderately sloping (9%), north facing slope in western Big Butte Valley.

Quarry Data: No primary opalite source on site.

Description: Grassy mound (feature 58-4) characterized by dark grey soil well mixed with opalite flakes. May be an old spring mound, or possibly reflects cultural build up.

Site Condition: Some rodent turbation, otherwise undisturbed.

Remarks: Will need subsurface tests to determine extent and nature of deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 133 Type: Small Open Residential/ Soil Mound

UTM: 535800E/4552520N

Size: mound = 12 x 9 (1.5m high) Max. Area (m^2): 110

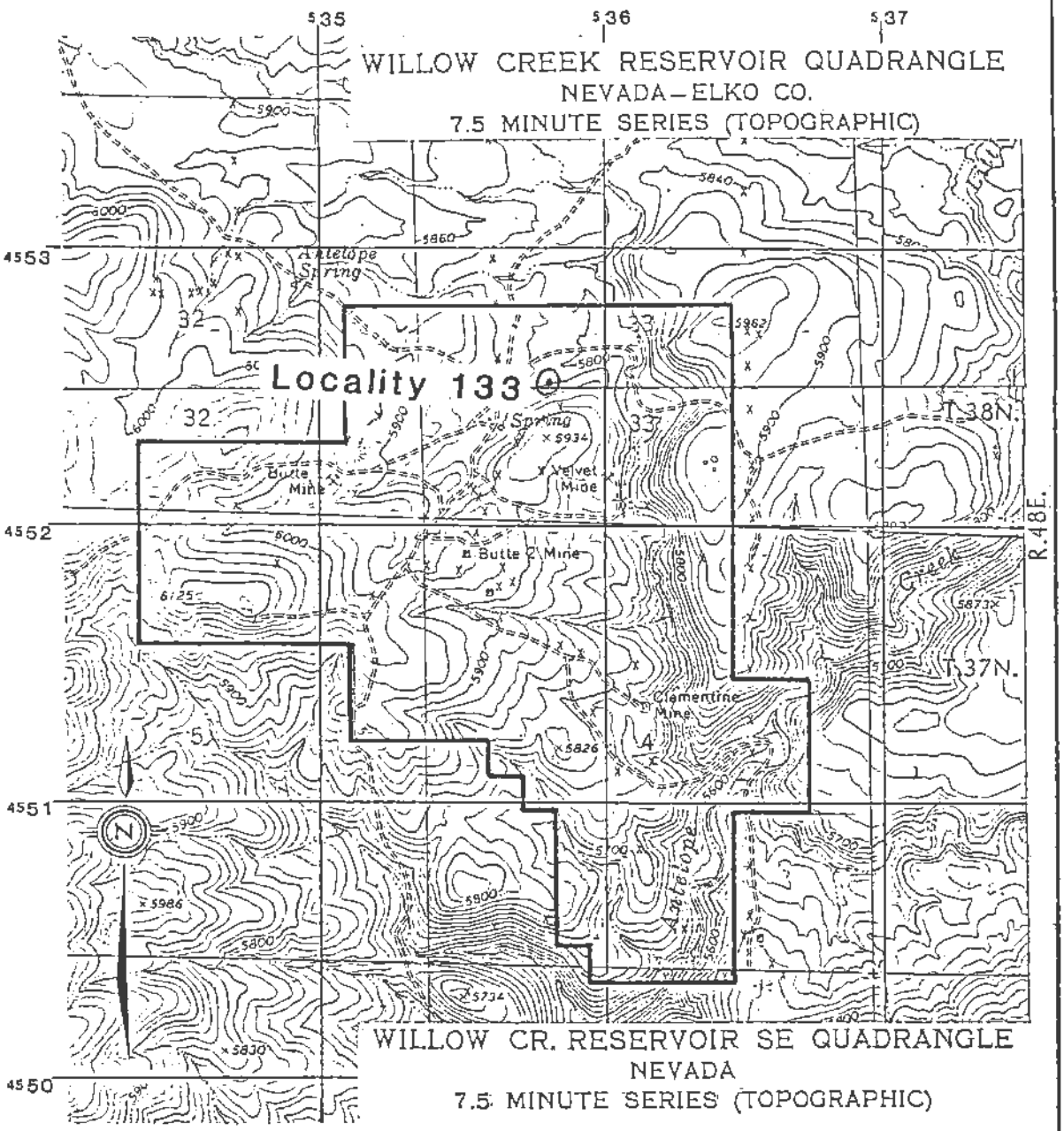
Topographic Data: On low grassy mound, on moderately sloping (9%), north facing slope in western Big Butte Valley.

Quarry Data: No primary opalite source on site.

Description: Grassy mound (feature 57-4) characterized by lithic scatter well mixed in dark grey soil. Artifacts include a knife fragment, bifaces, and debitage with great diversity of material types and reduction stages. May be an old spring mound, or possibly reflects cultural build up.

Site Condition: Some bioturbation, otherwise undisturbed.

Remarks: Will need subsurface tests to determine extent and nature of deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 134 Type: Isolated Quarry Pit

UTM: 535860E/4552440N

Size: pit =5m diameter Max. Area (m^2): 400

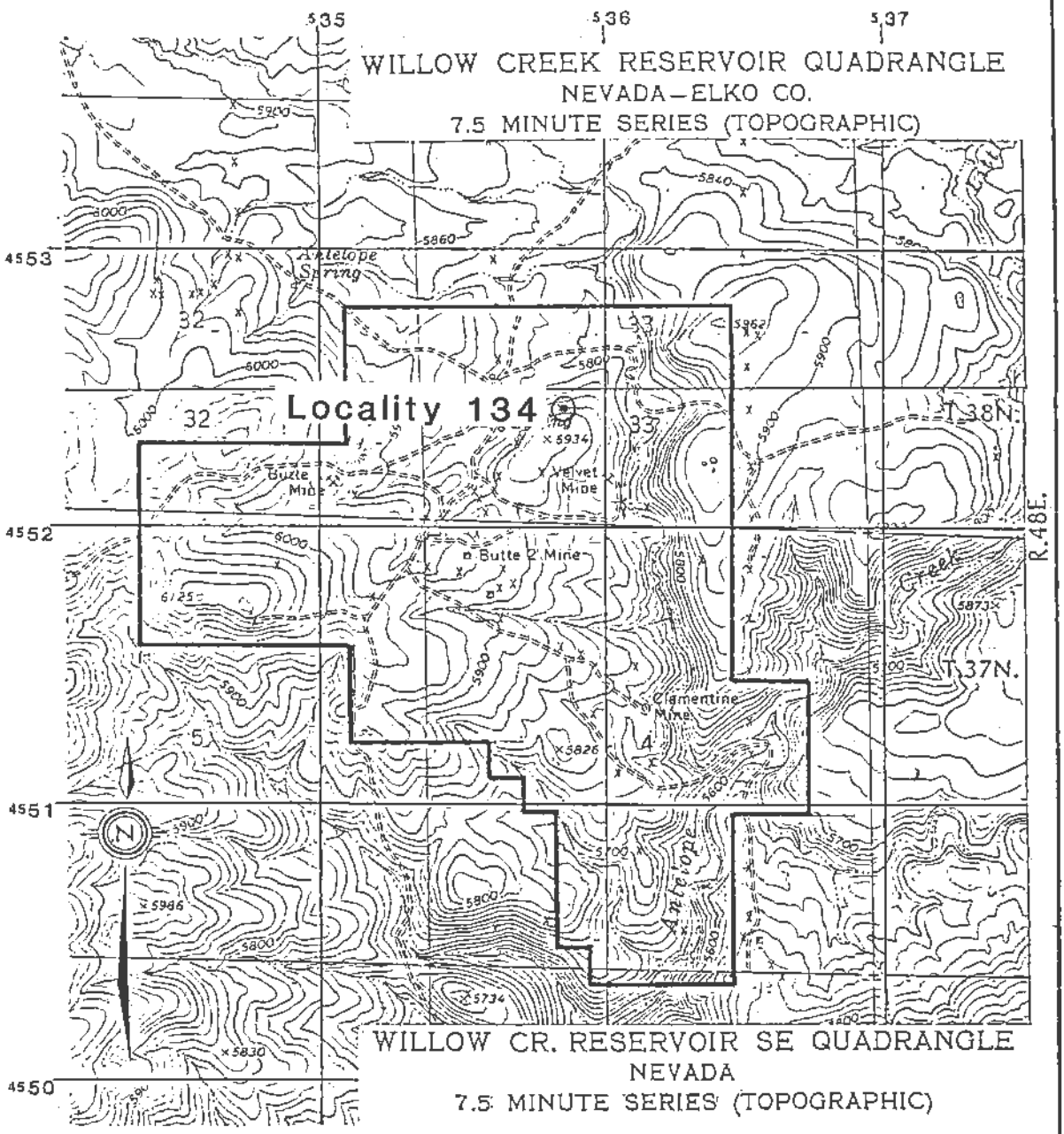
Topographic Data: On moderately steep (20%) north-facing colluvial slope.

Quarry Data: Opalite cobbles in colluvium.

Description: Isolated quarry pit (feature 58-3) in colluvium with thick accumulation of reduction debris surrounding pit for about 20m in diameter.

Site Condition: Apparently undisturbed.

Remarks: Difficult to distinguish prehistoric and historic pit features along this slope.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 135 Type: Large Quarry Pit Complex

UTM: 535800E/4552300N

Size: 180m NS/ 150m EW Max. Area (m^2): 27,000

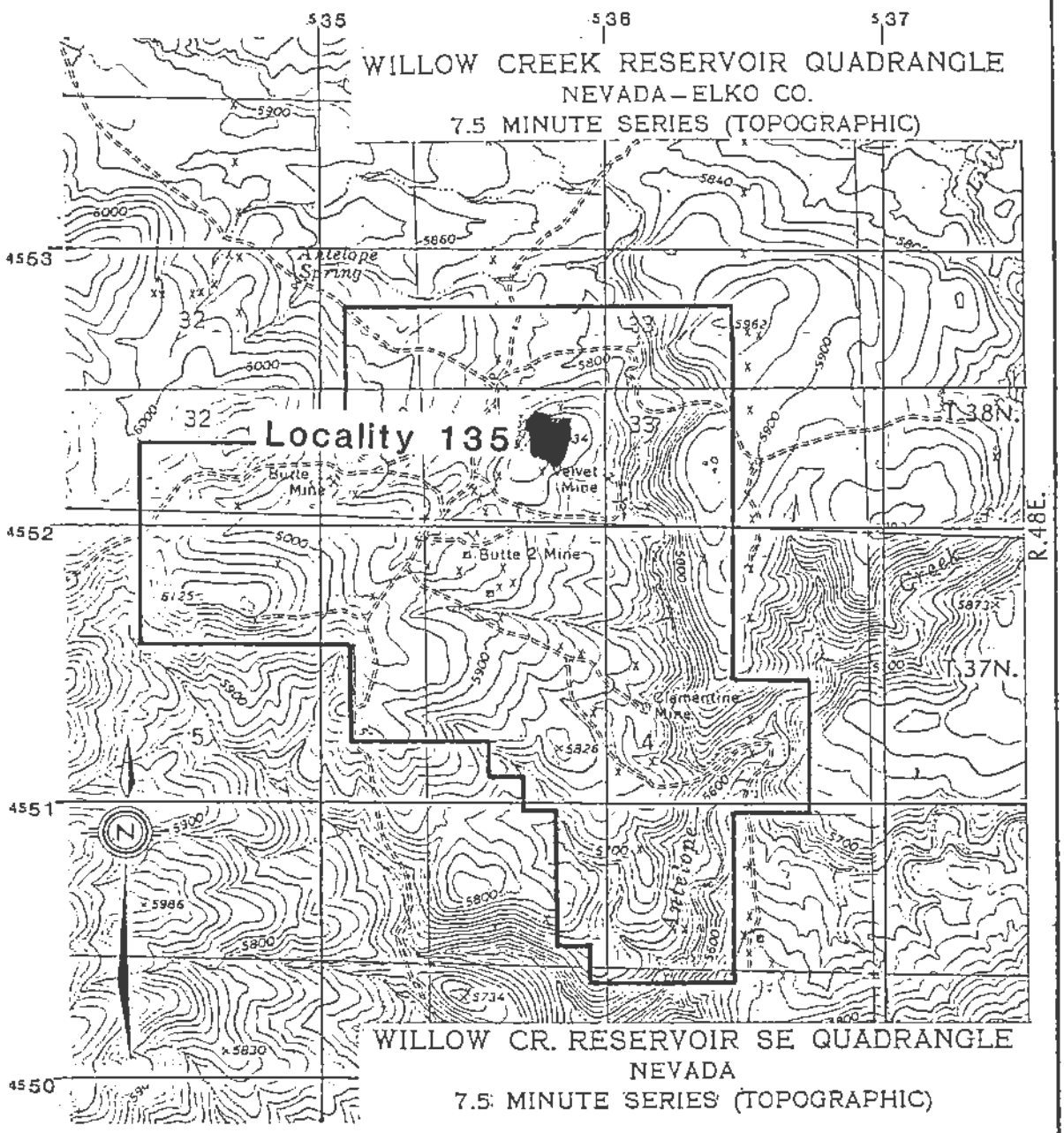
Topographic Data: Top of northeast-trending ridge and upper edge of slopes (7%-25%).

Quarry Data: Cobbles in colluvium; as well as natural talus cobbles.

Description: Large moderate density flake scatter with several pit feature complexes (features 54-3, 54-4, 58-1) in area of intensive prehistoric quarry activities; presently overlain by historic Velvet mining disturbance.

Site Condition: Structure of several prehistoric features remain intact, but general area is much disturbed by historic mining.

Remarks: Intensive prehistoric use area; prehistoric relationships may be confounded by historic disturbance.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 136

Type: Lithic Scatter (Undetermined Type)/ Soil Mound

UTM: 535720E/4552660N

Size: 60m NS/ 20m EW

Max. Area (m^2): 1,200

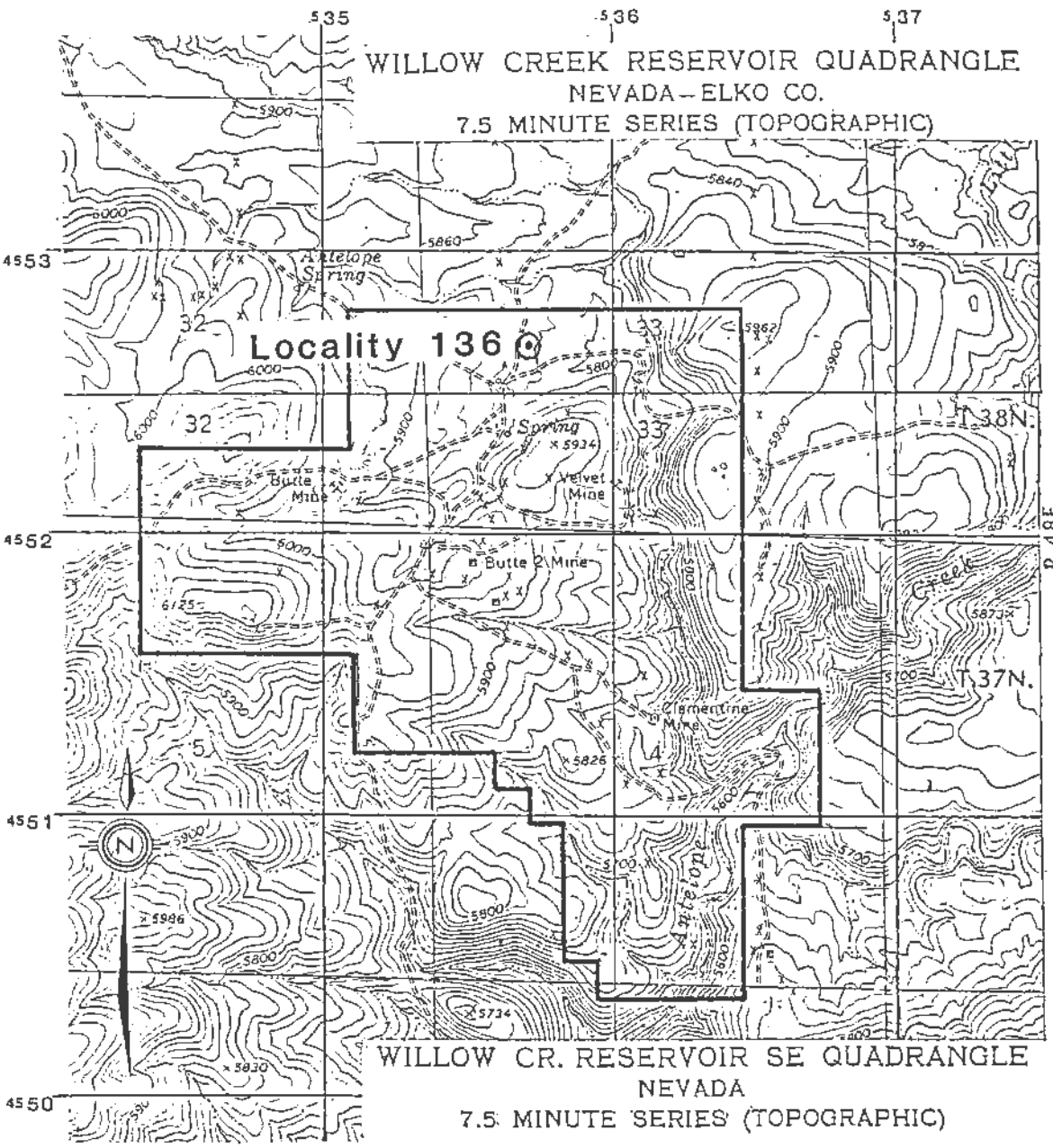
Topographic Data: Grassy soil mound in ephemeral drainage, gently sloping (5%), trending southeast, western Big Butte Valley.

Quarry Data: No on-site opalite source.

Description: Mound with deep, fine-grained soil (54-1); few apparent cultural associations; perhaps an old spring mound. Segregated for attention because of its similarity to other soil mounds with significant cultural associations.

Site Condition: Undisturbed.

Remarks: Use to develop understanding of grassy mounds and deep soil features with Big Sagebrush.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 137 Type: Isolated Artifact

UTM: 535720E/4552600N

Size: N/A Max. Area (m^2): N/A

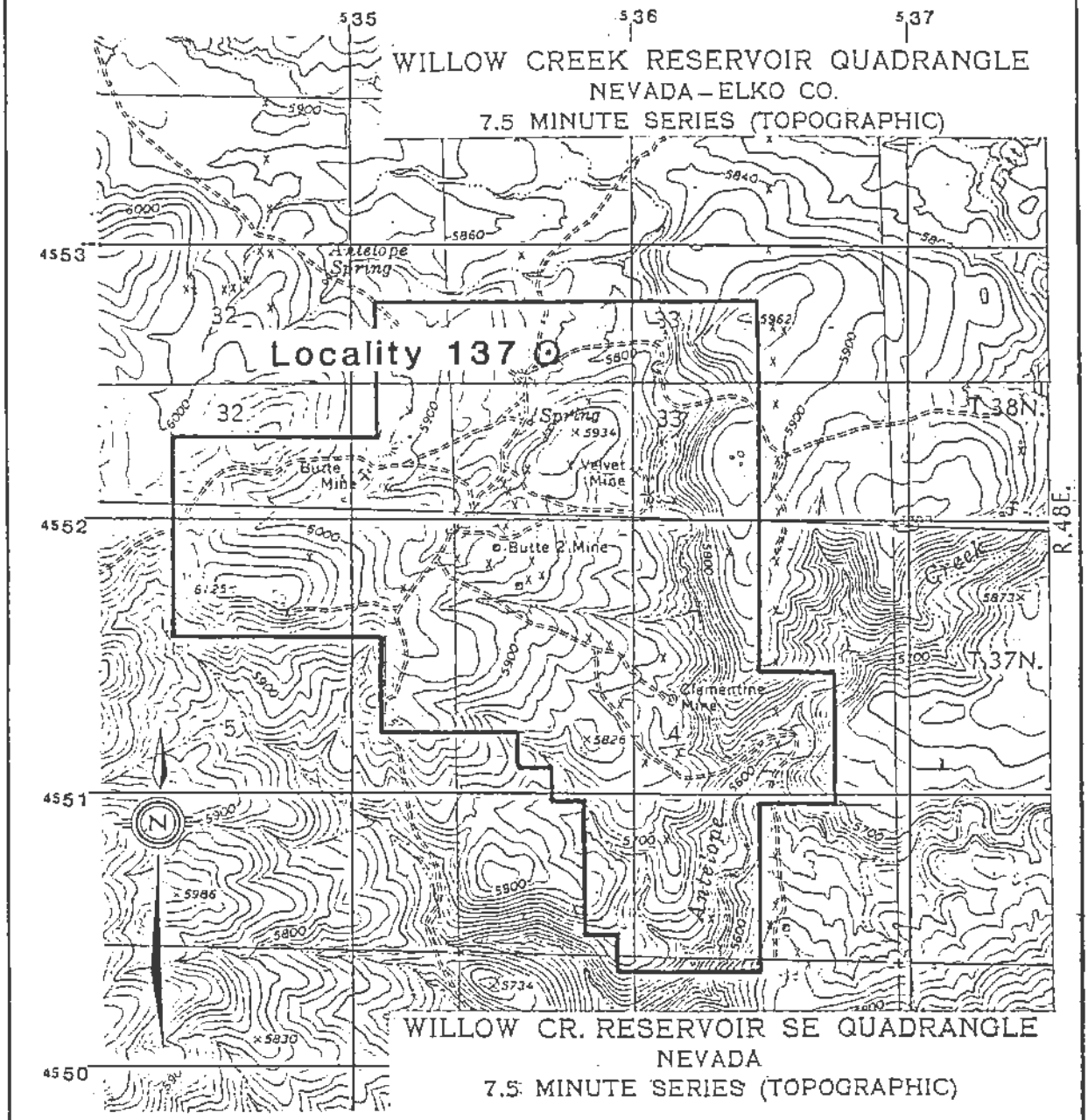
Topographic Data: Gently sloping (5%) undulating terrain, trending southeast, in western Big Butte Valley.

Quarry Data: No on-site opalite source.

Description: Isolated groundstone fragment with light polish.

Site Condition: N/A

Remarks: See possible relationships to open residential site at locality 138.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 138 Type: Large Open Residential/ Soil Mound

UTM: 535660E/4552620N

Size: features 20m x 20m Max. Area (m^2): 21,600

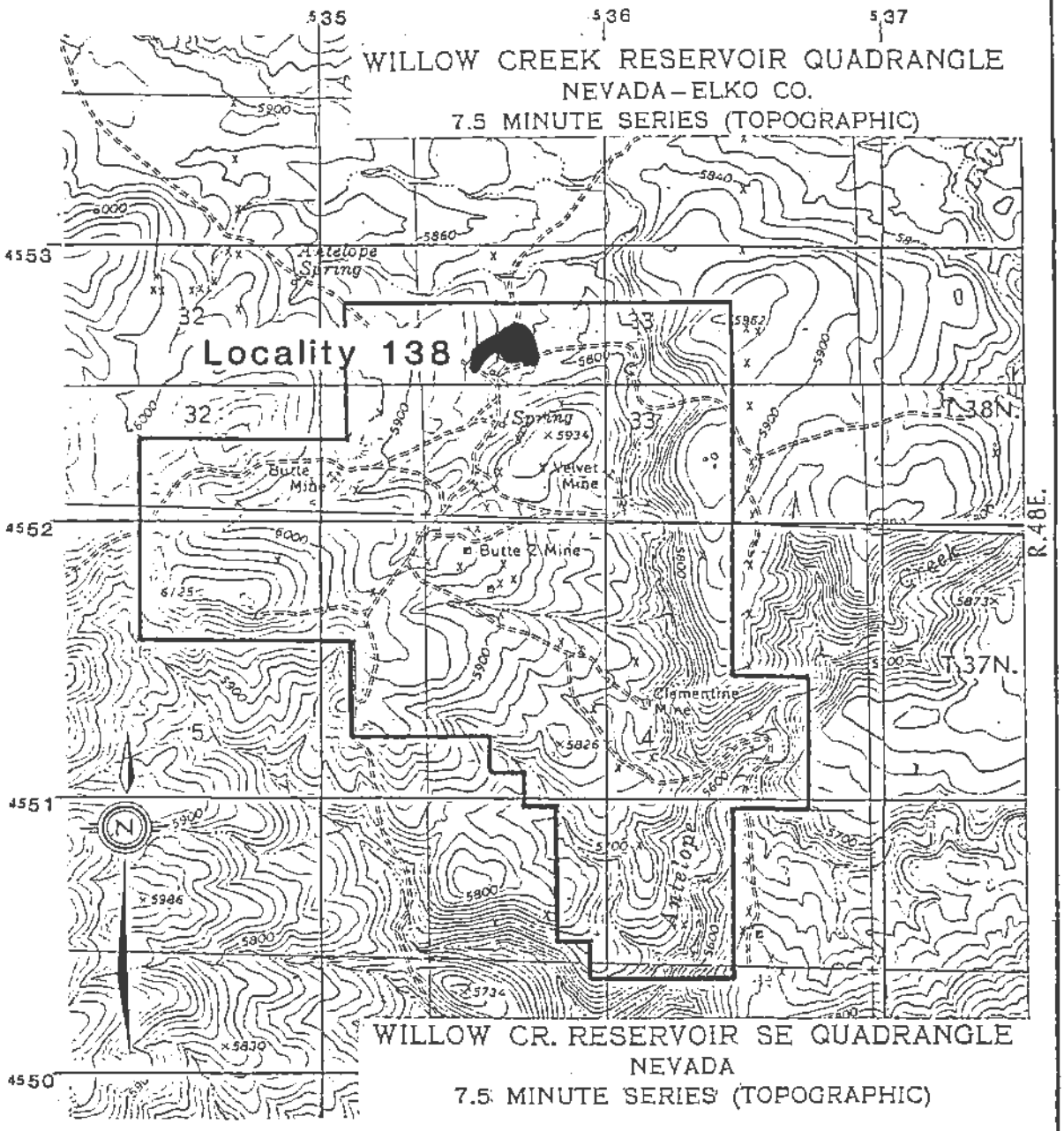
Topographic Data: On gently sloping (5%), east-trending terrain in western Big Butte Valley.

Quarry Data: No good quality opalite source on site, but local opalite pebbles of many colors and kinds apparently used.

Description: Large irregular area with several small campsites (?). Inferred camps include lithic and tool scatters (including both basalt and obsidian flakes), small bifaces and projectile points, and great variety in size and colors of chert and opalite flakes (feature 53-1, 51-4, 50-6). A grassy soil mound (feature 49-4) may contain cultural midden.

Site Condition: Some bioturbation (especially badgers in the soil mound); historic can scatter at feature 51-4.

Remarks: Will need subsurface tests to determine extent and nature of deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 139 Type: Surface Cobble Quarry

UTM: 535460E/4552560N

Size: 150m NS/ 60m EW Max. Area (m^2): 9,000

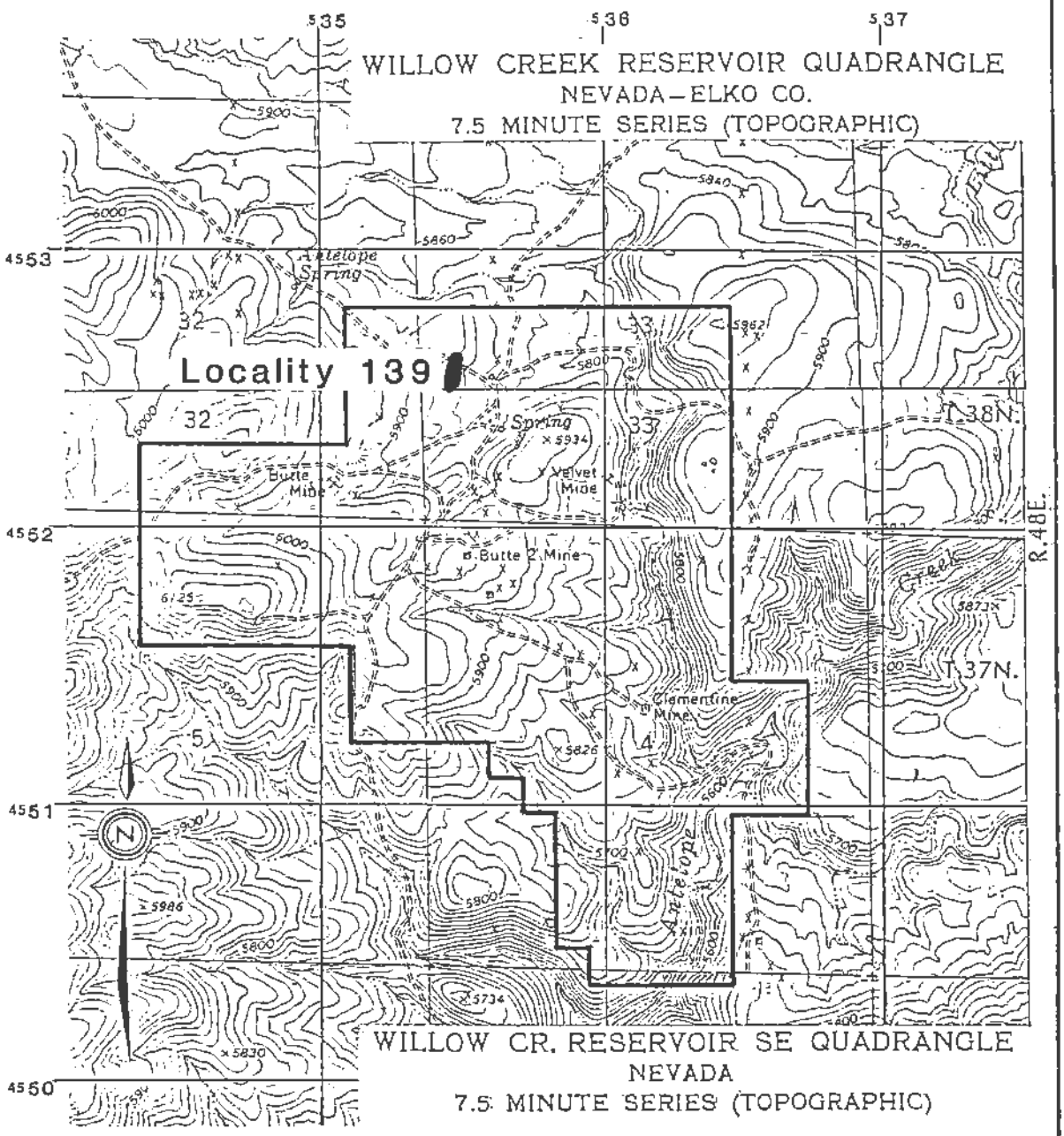
Topographic Data: On gently sloping (5%), east-trending terrain in western Big Butte Valley.

Quarry Data: Poor quality opalite boulders and cobbles on surface.

Description: Large quarry - assay area in cobble-boulder field characterized by assay and natural shatter as well as some distinct reduction stations (feature 46-1).

Site Condition: Some historic disturbance, but not significant impacts.

Remarks: Not well characterized at present.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mill Ridge

Locality No.: 140 Type: Isolated Artifact

UTM: 535520E/4552700N

Size: 10 x 15 cm Max. Area (m^2): N/A

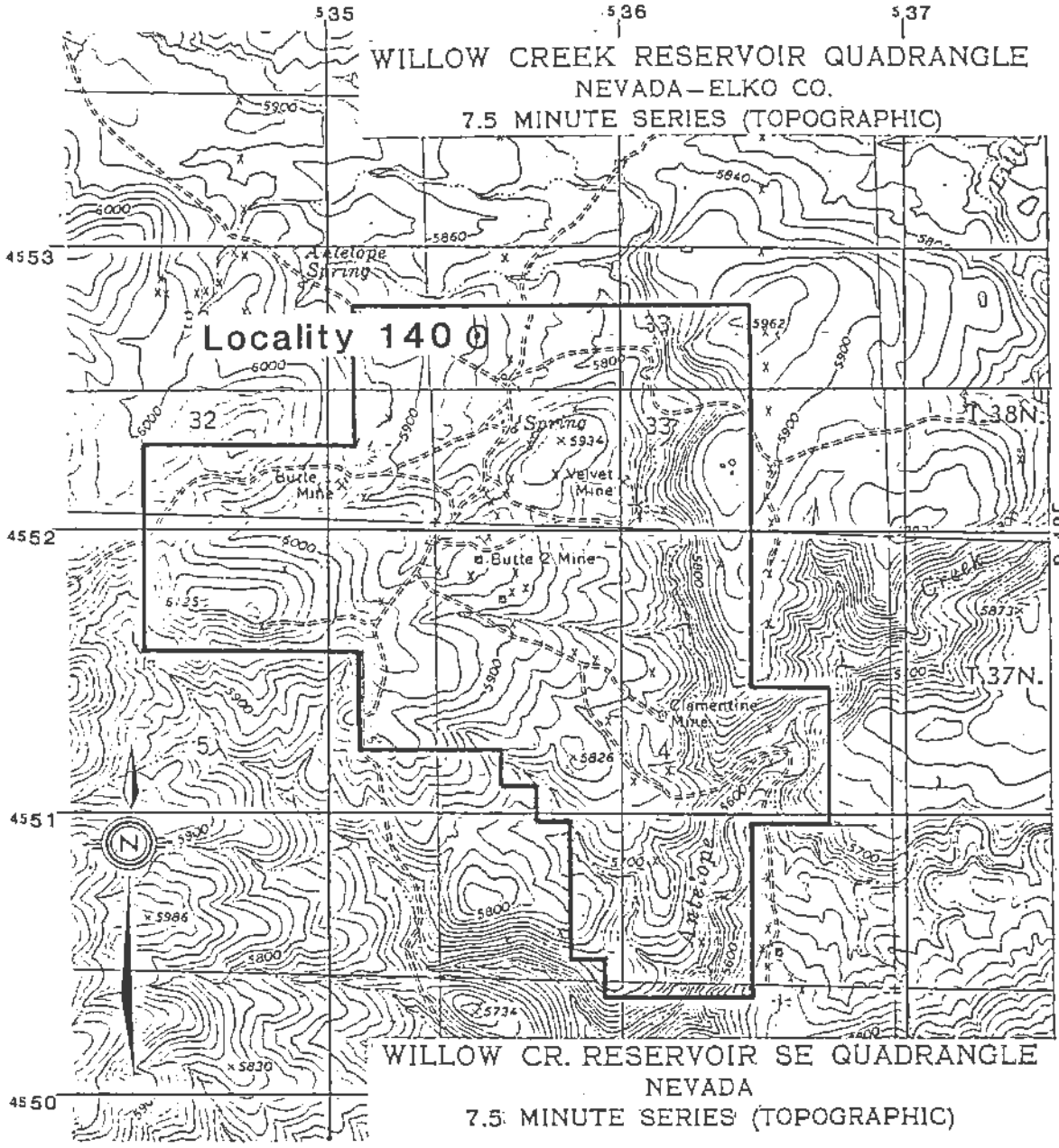
Topographic Data: On strongly sloping (13%), east-facing ridge slope in western Big Butte Valley.

Quarry Data: Thinly scattered, poor quality opalite boulders and cobbles.

Description: Isolated groundstone artifact, tabular, concave grinding surface.

Site Condition: Apparently undisturbed.

Remarks: Several inferred residential sites are located in western Big Butte Valley.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mill Ridge

Locality No.: 141 Type: Isolated Quarry Pit

UTM: 535520E/4552660N

Size: 120m NS/ 30m EW Max. Area (m^2): 3,600

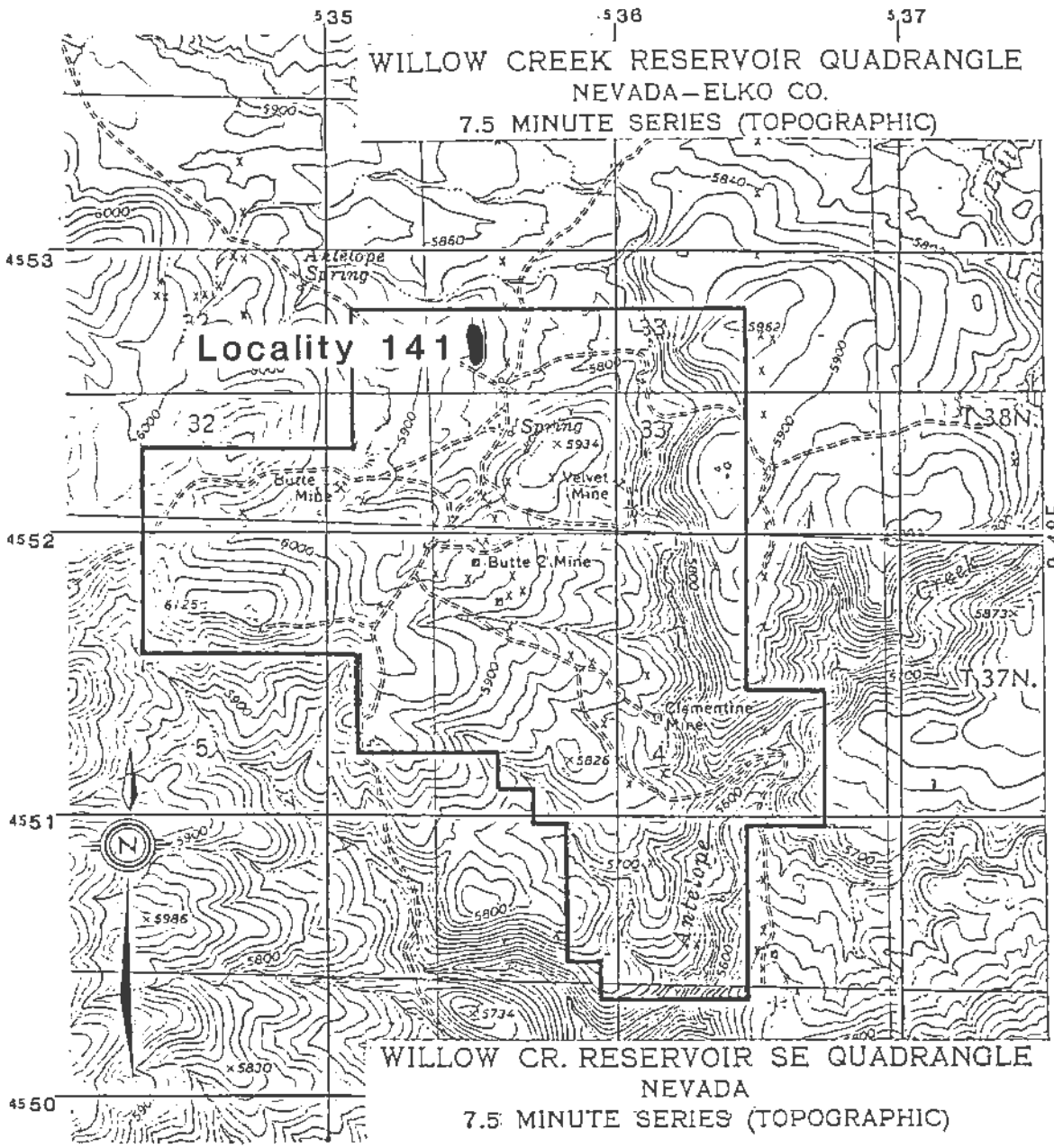
Topographic Data: On upper edge of knoll and along strongly sloping (10%), east-facing slope, western Big Butte Valley.

Quarry Data: Not Indicated.

Description: Isolated quarry pit (6m x 3m x 1.2m [deep]) in light to moderate density lithic scatter with numerous bifaces.

Site Condition: Apparently undisturbed.

Remarks: Needs further field assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mill Ridge

Locality No.: 142 Type: Surface Cobble Quarry

UTM: 535340E/4552620N

Size: 45m NS/ 35m EW Max. Area (m^2): 1,575

Topographic Data: Top and gentle (5%) slopes of northeast-trending ridge, western Big Butte Valley.

Quarry Data: Variable quality source with lots of poor quality cobbles and boulders on surface.

Description: Component of a large, ill-defined cobble-boulder field complex composed of discrete, shallow quarry pits (features 42-12A and 42-12B), small loci of concentrated reduction debris (42-12), and conspicuous scattered assay flakes and shatter.

Site Condition: Eroded, but otherwise undisturbed.

Remarks: Related to Localities 143 and 144, all in continuous light density scatter, likely relating to the same near-surface bedrock formation.

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mill Ridge

Locality No.: 142 Type: Surface Cobble Quarry

UTM: 535340E/4552620N

Size: 45m NS/ 35m EW Max. Area (m^2): 1,575

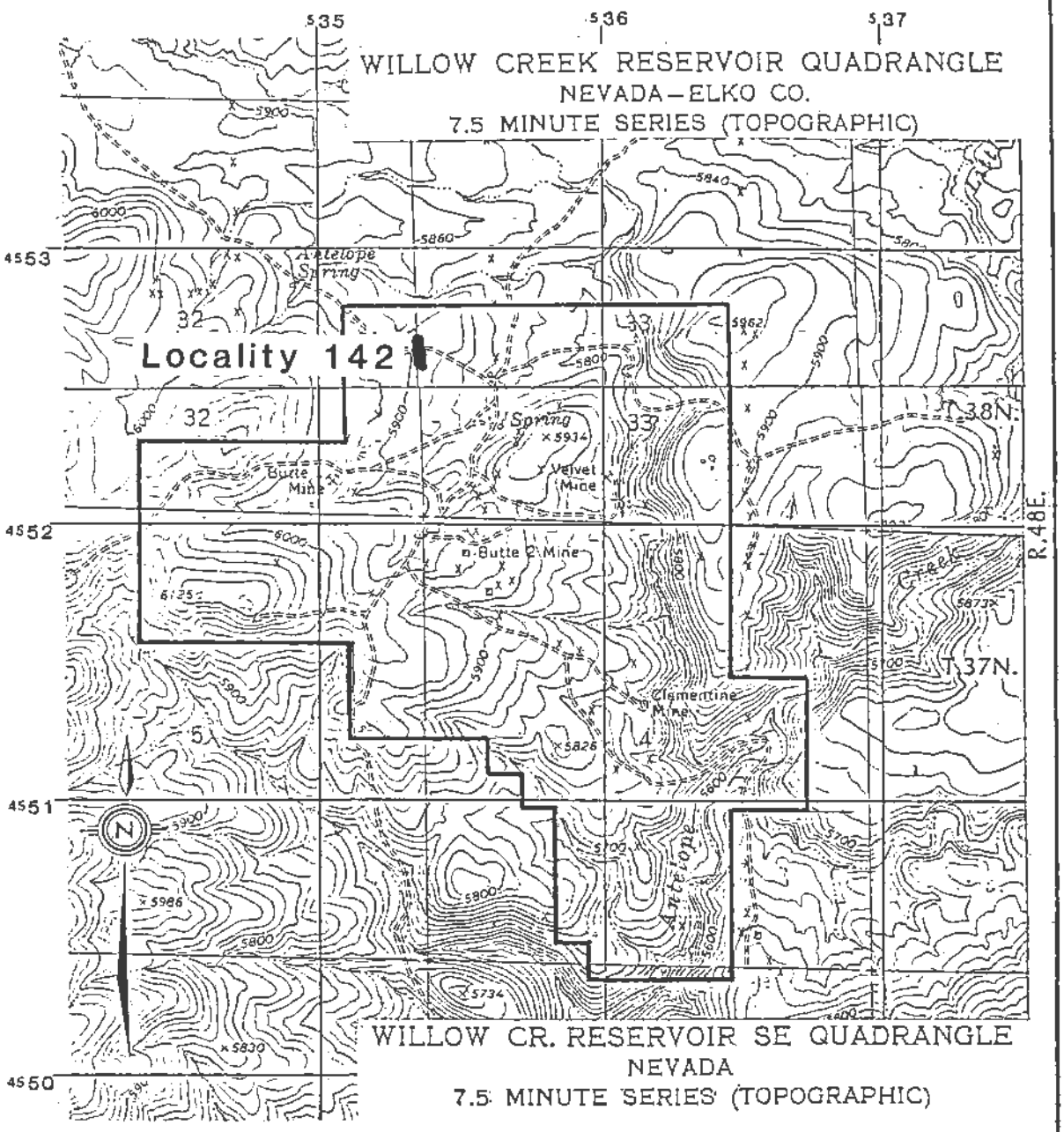
Topographic Data: Top and gentle (5%) slopes of northeast-trending ridge, western Big Butte Valley.

Quarry Data: Variable quality source with lots of poor quality cobbles and boulders on surface.

Description: Component of a large, ill-defined cobble-boulder field complex composed of discrete, shallow quarry pits (features 42-12A and 42-12B), small loci of concentrated reduction debris (42-12), and conspicuous scattered assay flakes and shatter.

Site Condition: Eroded, but otherwise undisturbed.

Remarks: Related to Localities 143 and 144, all in continuous light density scatter, likely relating to the same near-surface bedrock formation.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mill Ridge

Locality No.: 143 Type: Surface Cobble Quarry

UTM: 535280E/4552600N

Size: 15m NS/ 15m EW Max. Area (m^2): 225

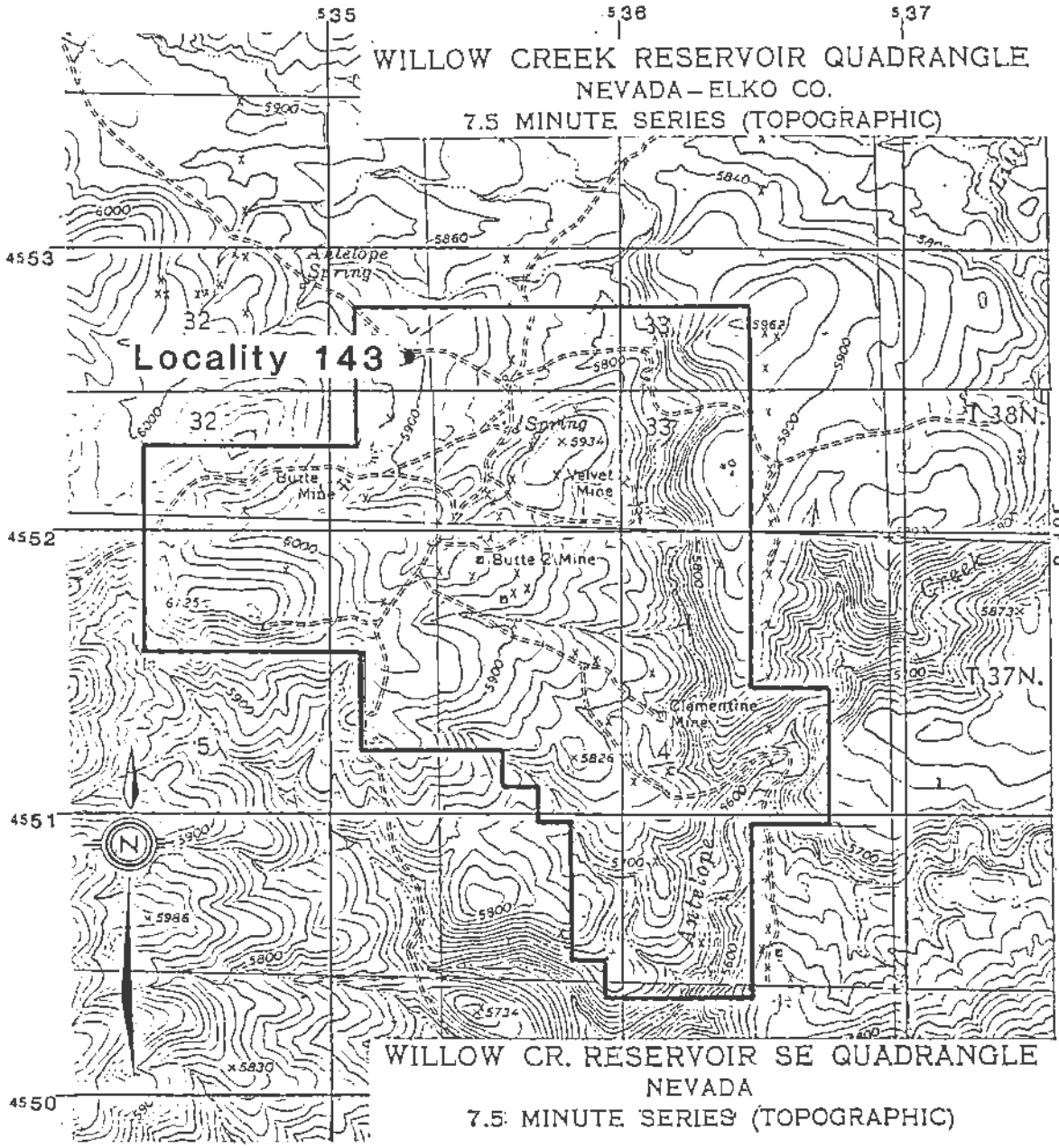
Topographic Data: Top of northeast-trending ridge, western Big Butte Valley.

Quarry Data: Variable quality source with lots of poor quality cobbles and boulders on surface.

Description: Component of a large, ill-defined cobble-boulder field complex; Locality (feature 40-2) consists of a light to moderate density reduction scatter of white and pink opalite.

Site Condition: Undisturbed.

Remarks: Related to localities 142 and 144, all in continuous light density scatter, likely exploiting the same near-surface bedrock formation.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 144 Type: Surface Cobble Quarry

UTM: 535300E/4552460N

Size: 100m x 45m Max. Area (m^2): 4,500

Topographic Data: East slopes of northeast-trending ridge, moderately sloping (6%), western Big Butte Valley.

Quarry Data: Variable quality source with lots of poor quality cobbles and boulders on surface; multicolored materials.

Description: Component of a large, ill-defined cobble-boulder field complex; comprised of a pit complex (feature 40-3) and localized cobble reduction (feature 39-1); features are associated with moderate density flake scatters.

Site Condition: Undisturbed.

Remarks: Related to Localities 142 and 143, all in continuous light density scatter, likely exploiting the same near-surface bedrock formation.

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mound Draw

Locality No.: 145 Type: Large Open Residential/ Soil Mound

UTM: 535180 E/4552680N

Size: 170m x 60m Max. Area (m^2): 10,200

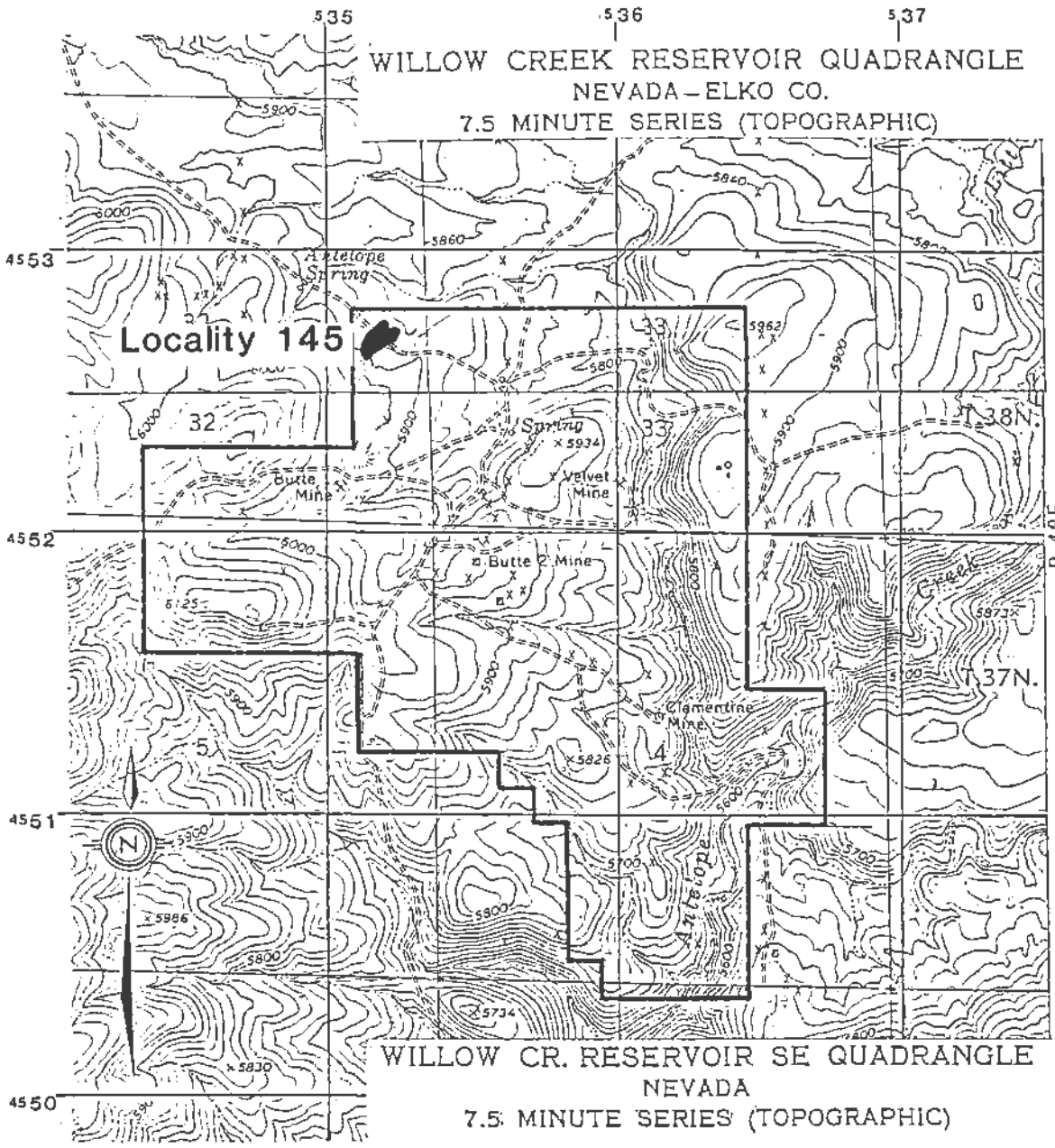
Topographic Data: Grassy mounds on low, linear (northeast-trending) ridge features edging an ephemeral drainage, western Big Butte Valley.

Quarry Data: No on-site source.

Description: Three separate soil mounds, rising about 1 meter above surrounding terrain (features 34-4, 37-1, 38-1). Big Sage and grasses signal deeper soils that have potential for subsurface cultural deposits. Only a light flake scatter is visible on the surfaces of these features, with most materials accumulated along their eroded edges. The deep, dark colored soils are similar to those near Tosawihi spring. Perhaps these features represent old spring mounds.

Site Condition: Bioturbation.

Remarks: Compare to similar enigmatic features in the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mill Ridge

Locality No.: 146 Type: Surface Cobble Quarry

UTM: 535240E/4552400N

Size: 10m NS/ 30m EW Max. Area (m^2): 300

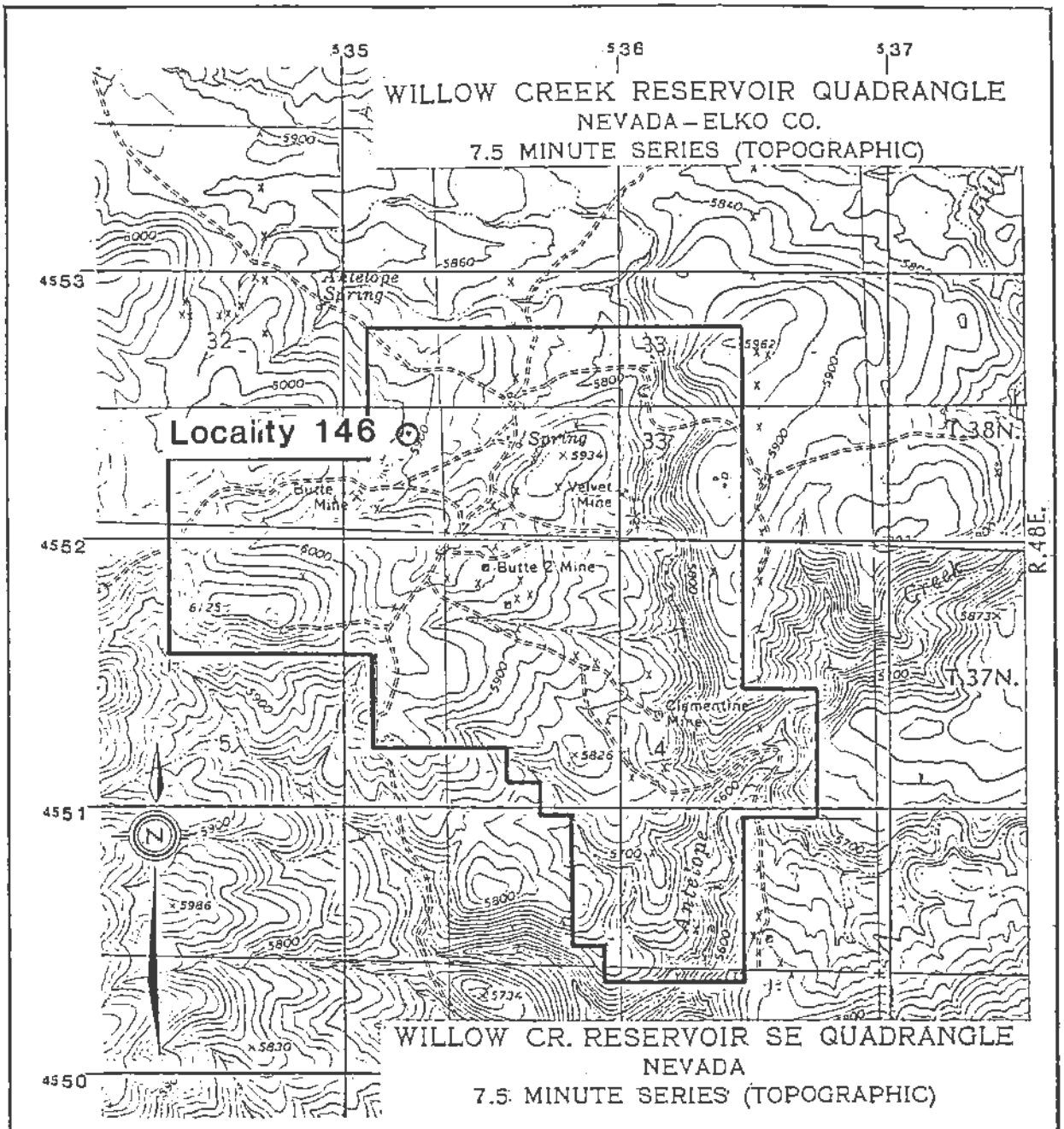
Topographic Data: Bench at break in slope on northeast-trending ridge, western Big Butte Valley.

Quarry Data: Variable quality source with lots of poor quality cobbles and boulders on surface; multicolored materials (pink, purple, red, mustard).

Description: A small cobble-boulder field quarry (feature 36-3); may be related to nearby complex (localities 142-144).

Site Condition: Undisturbed.

Remarks: See nearby localities 142-144.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 147 Type: Surface Cobble Quarry

UTM: 535360E/4552440N

Size: 30m NS/ 45m EW Max. Area (m^2): 1,350

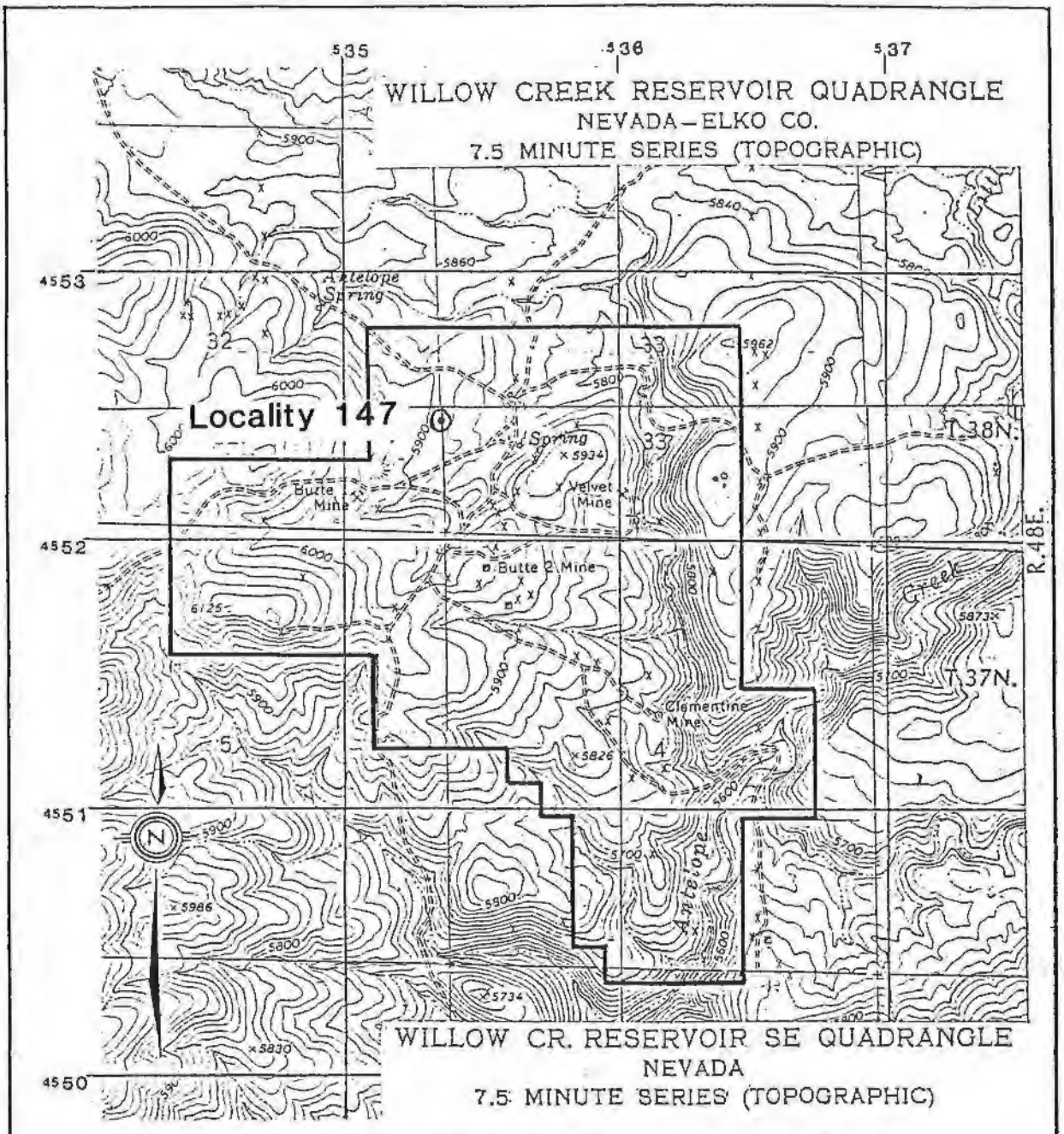
Topographic Data: Gentle sloping (5%), undulating terrain, lower component northeast trending ridge, western Big Butte Valley.

Quarry Data: Variable quality source with sparse scatter of poor quality cobbles and boulders on surface.

Description: A small cobble-boulder field quarry (feature 42-11); cobbles are shattered and likely assayed; no systematic core or biface reduction evident in the light density scatter.

Site Condition: Undisturbed.

Remarks: See nearby localities 148-150.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 148 Type: Small Cobble Assay Station

UTM: 535360E/4552340N

Size: 10m x 10m Max. Area (m^2): 100

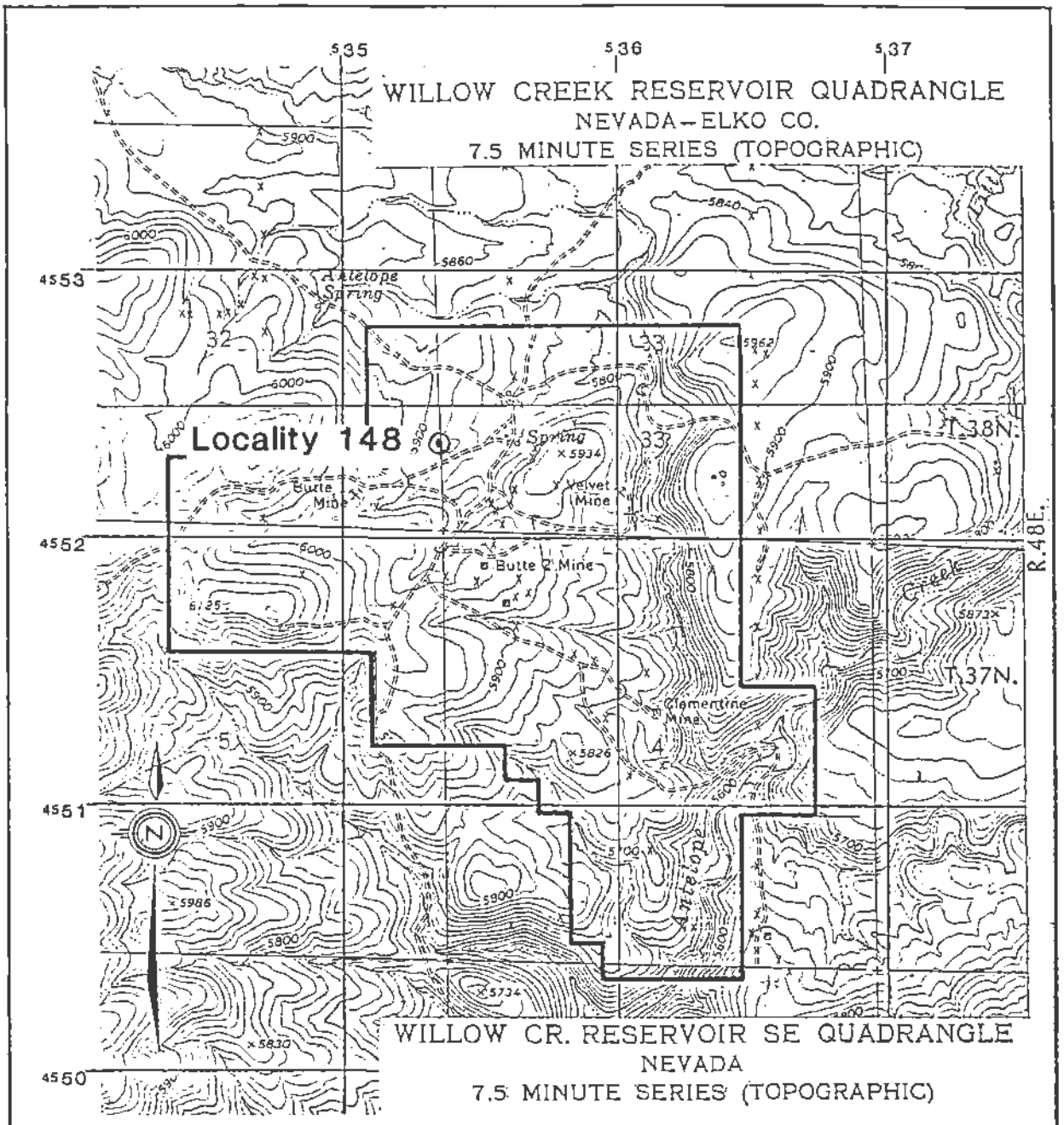
Topographic Data: Flat top of low knoll overlooking Tosawihi Spring, western Big Butte Valley.

Quarry Data: Poor quality cobbles on surface.

Description: Small area where local cobbles were assayed (feature 42-9). A moderate density flake scatter surrounds localities 147-150.

Site Condition: Undisturbed.

Remarks:



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 149 Type: Surface Cobble Quarry

UTM: 535320E/4552260N

Size: 75m x 45m Max. Area (m^2): 3,375

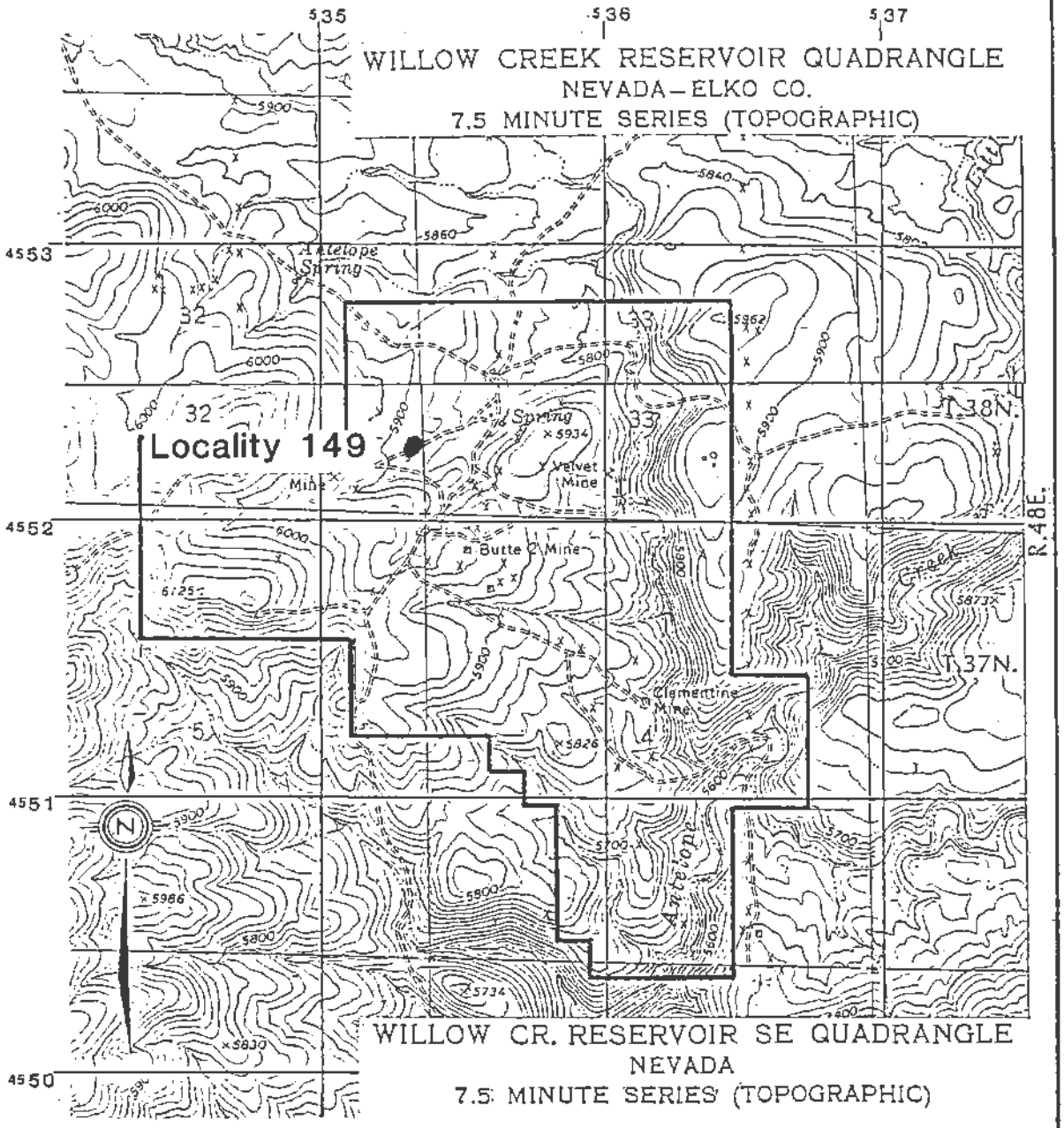
Topographic Data: Nearly flat (2%), east-trending bench, overlooking Tosawihi Spring, western Big Butte Valley.

Quarry Data: Poor quality cobbles on surface.

Description: Cobble field with scattered assay flakes and shatter and numerous small reduction stations (features 42-9 and 43-4).

Site Condition: Adjacent historic disturbance; no significant on-site disturbance.

Remarks: See nearby Localities 148, 150;



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Alluvial Flats

Locality No.: 150 Type: Quarry Pit Complex

UTM: 535480E/4552400N

Size: 15m x 25m Max. Area (m^2): 375

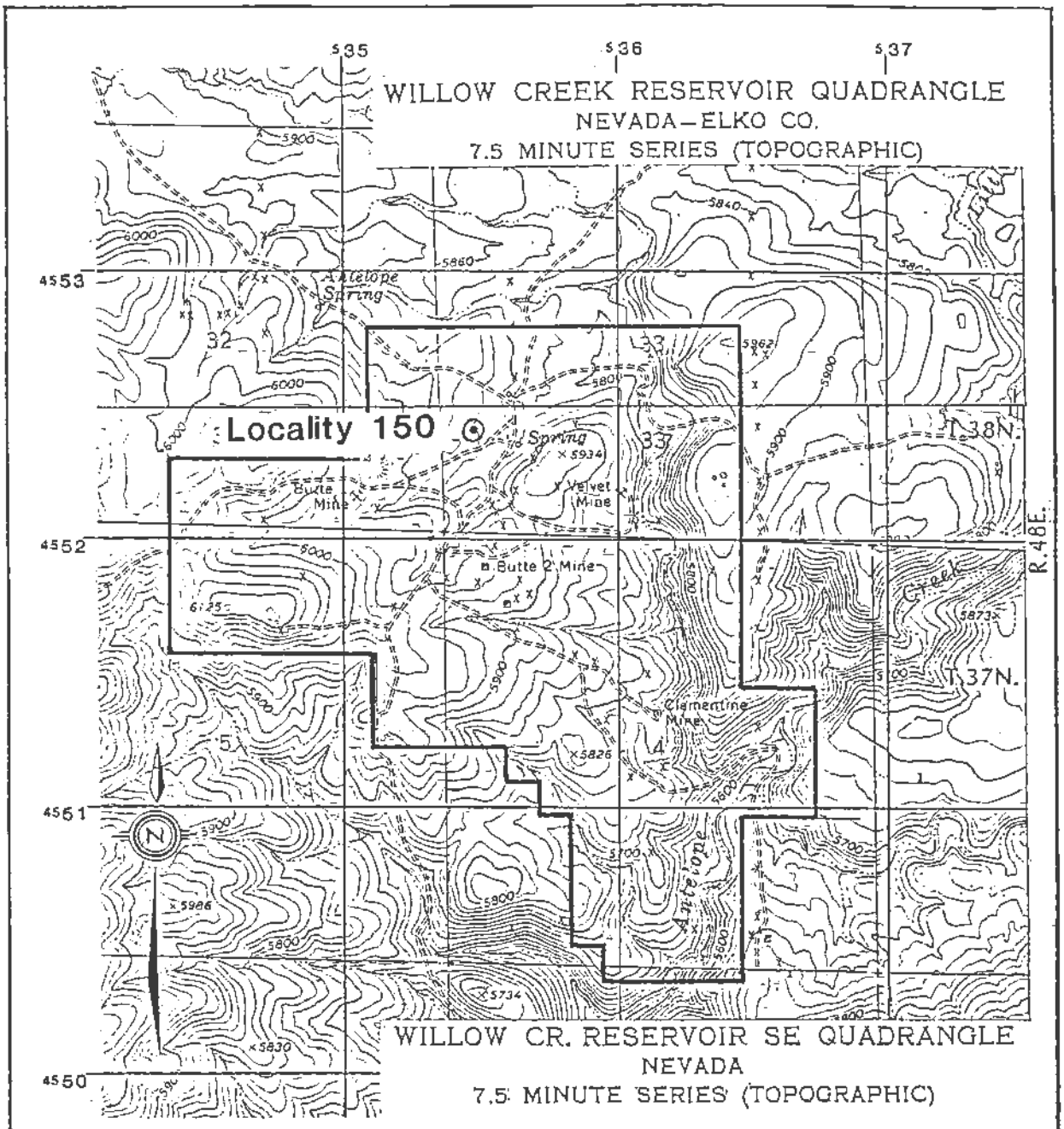
Topographic Data: Moderately sloping (7%), northeast-trending ridge, overlooking Tosawihi Spring, western Big Butte Valley.

Quarry Data: Shallow colluvium at base bedrock outcrop.

Description: Small complex of four quarry pits (feature 45-2) in a moderate density scatter; pits were excavated into colluvium downslope from a low bedrock exposure.

Site Condition: Undisturbed.

Remarks: See nearby localities 148-149; all potentially are linked by moderate density flake scatter.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: South Tosawihi Spring

Locality No.: 151 Type: Large Open Residential

UTM: 535600E/4552380N

Size: 150m x 120m Max. Area (m^2): 18,000

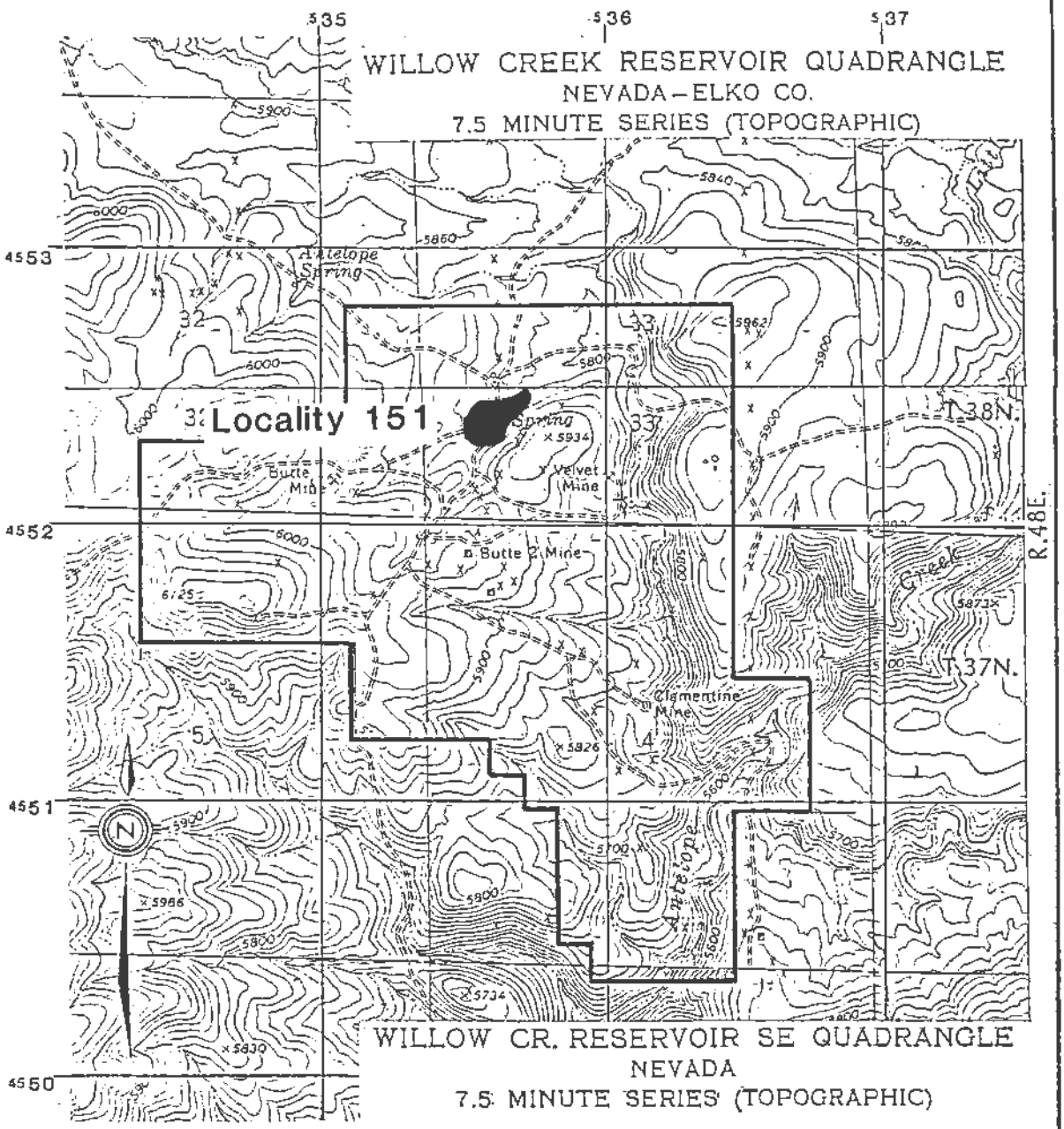
Topographic Data: Flats along edge ephemeral drainage, gentle undulating (4%) slopes surrounding Tosawihi Spring.

Quarry Data: No on-site source.

Description: Moderate density flake scatter consisting of both small and large secondary flakes of many different colored materials (features 46-2 and 47-2); no cores noted, but bifaces range from Stage I to Stage III. One mano and several fire-affected rocks noted near edge of vandal pit; at least 60 cm depth indicated in sidewalls of vandal excavation. Artifacts suggest a palimpsest of quarry reduction and residential uses surrounding a perennial spring.

Site Condition: Historic debris and cabin foundation; one vandal hole. Extent of historic impacts on prehistoric locality will need to be assessed by testing, but large portions seem intact.

Remarks:



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 152 Type: Quarry Pit Complex

UTM: 535520E/4552200N

Size: 105m x 45m Max. Area (m^2): 4,725

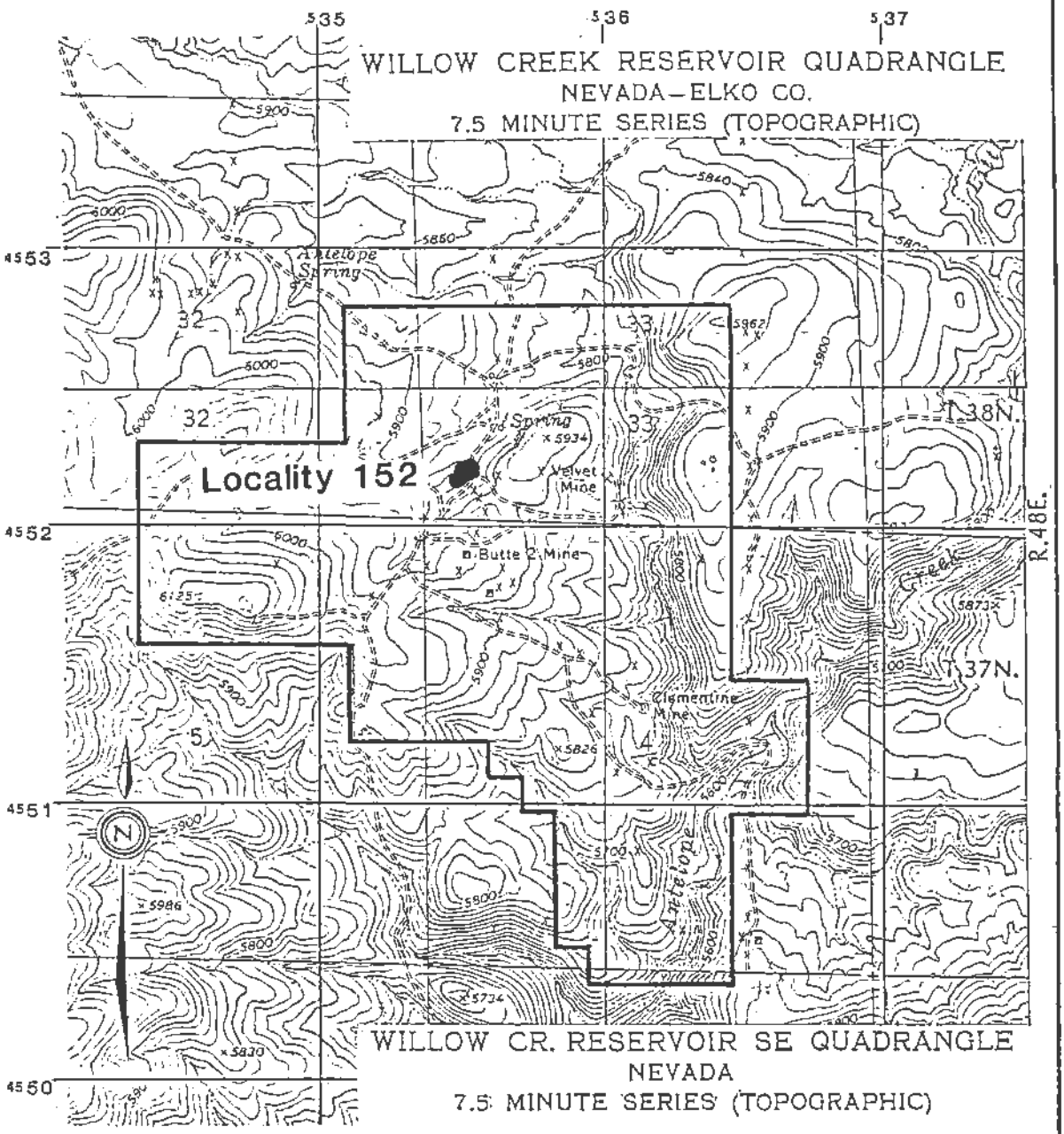
Topographic Data: On top of small isolated knoll and along moderately steep (25%), northwest-facing ridge slopes overlooking Tosawihi Spring.

Quarry Data: Good quality cobbles in colluvium; colors from pink to white.

Description: Large quarry pit complex above Tosawihi Spring; three pit complexes were recorded in a moderate to heavy density flake scatter (features 45-3, 45-4, 46-3).

Site Condition: Some nearby historic pit disturbance, but this has no significant effect on prehistoric remains.

Remarks: Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 153 Type: Isolated Artifact

UTM: 535520E/4552100N

Size: 15cm x 15cm Max. Area (m^2): N/A

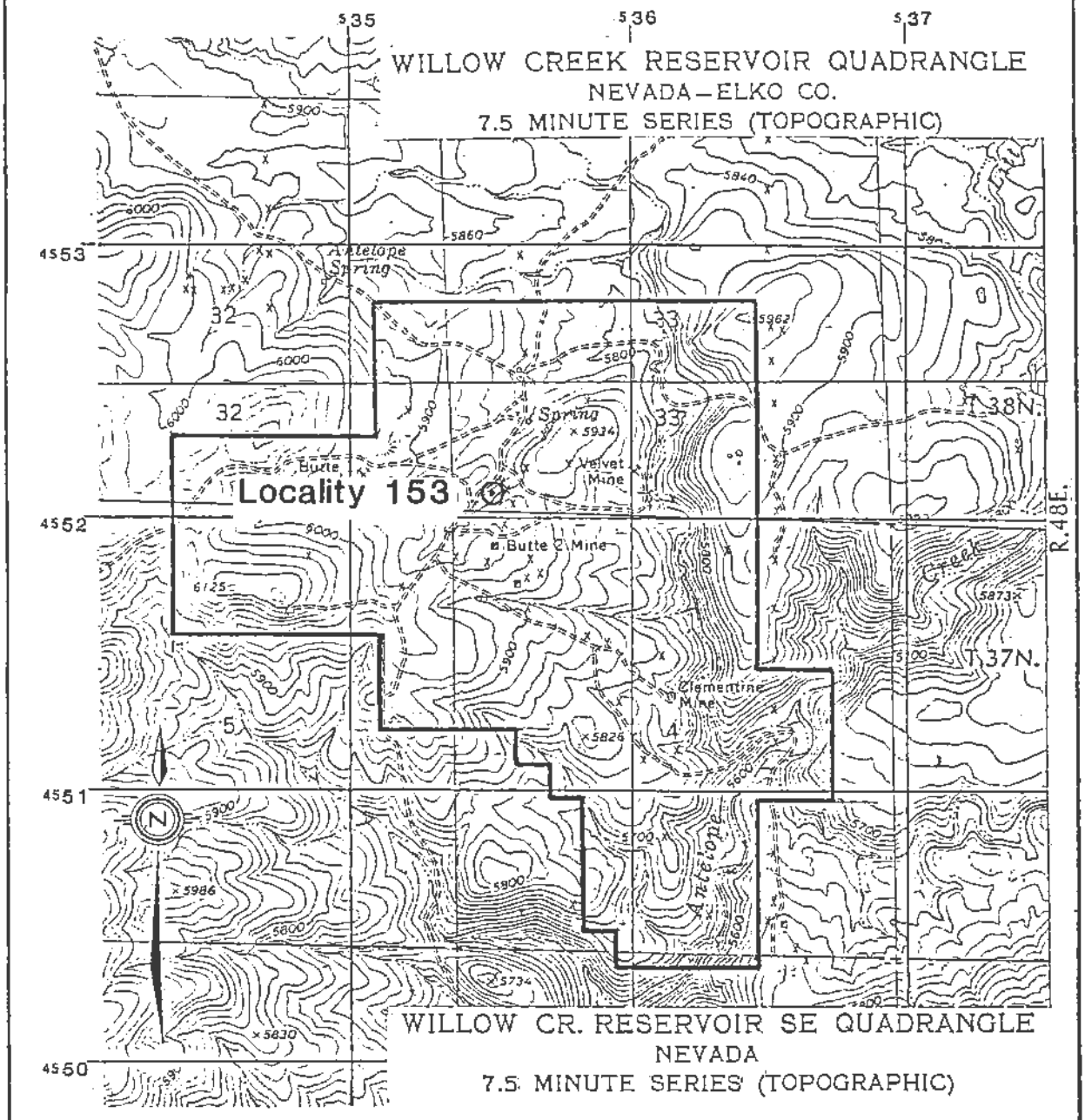
Topographic Data: On moderately steep (25%), northwest-facing ridge slope overlooking Tosawihi Spring.

Quarry Data: N/A

Description: Isolated groundstone artifact, metate fragment, slightly concave grinding surface (feature 47-4).

Site Condition: N/A

Remarks: Groundstone is rare in the Tosawihi Quarry District, but several isolates (cf. Locality 154) and others associated with quarry pits (cf. Locality 152) were found on the slopes overlooking Tosawihi Spring.



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Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 154 Type: Isolated Artifact

UTM: 535580E/4552200N

Size: not given Max. Area (m^2): N/A

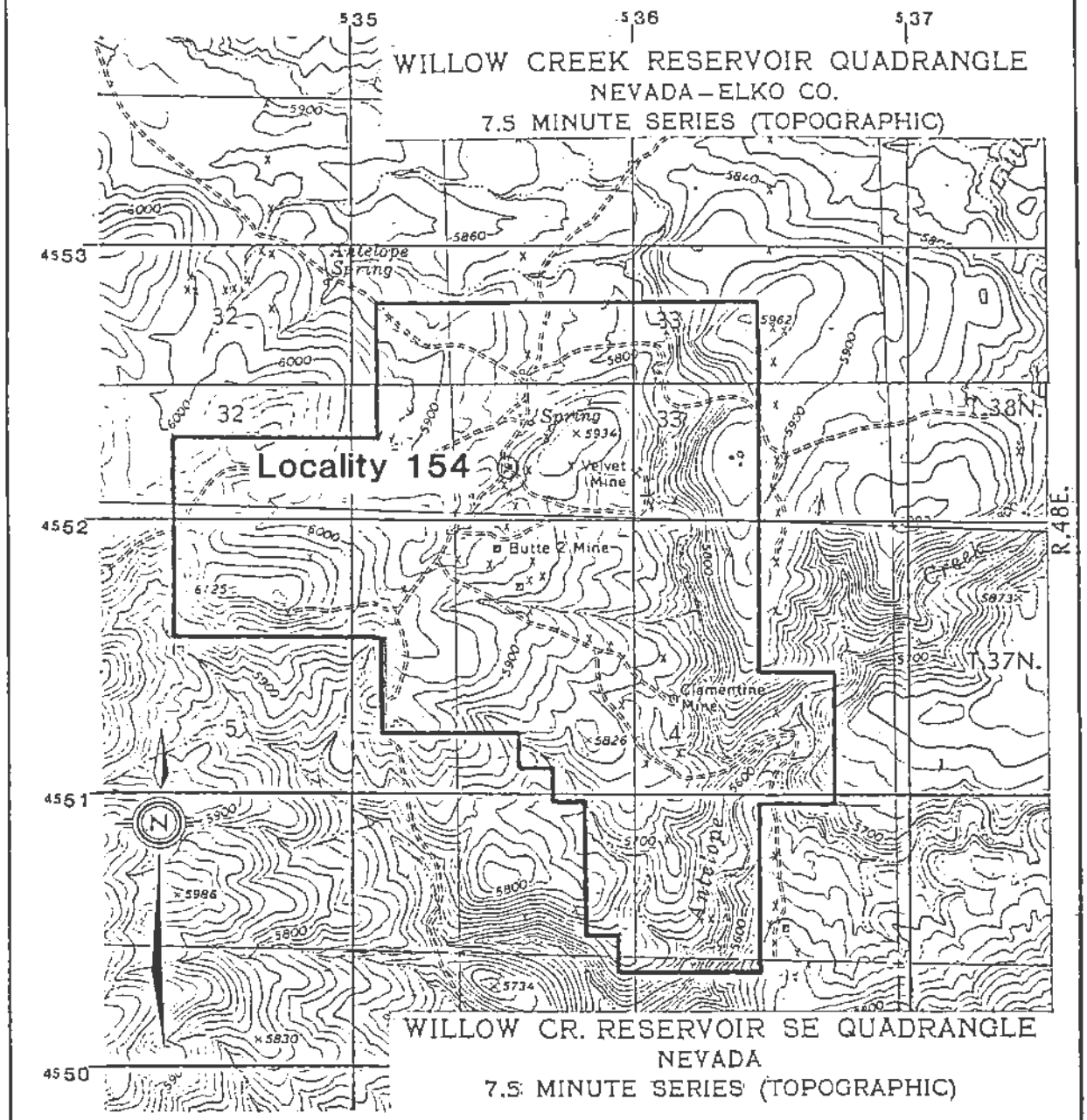
Topographic Data: On moderately steep (25%), northwest-facing ridge slope overlooking Tosawihi Spring.

Quarry Data: N/A

Description: Isolated groundstone artifact, metate fragment, concave grinding surface with incised grooves (feature 48-2).

Site Condition: N/A

Remarks: Groundstone is rare in the Tosawihi Quarry District, but several isolates (cf. Locality 153) and others associated with quarry pits (cf. Locality 152) were found on the slopes overlooking Tosawihi Spring.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 155 Type: Quarry Pit Complex

UTM: 535640E/4552320N

Size: 30m NS/55m EW Max. Area (m^2): 1,650

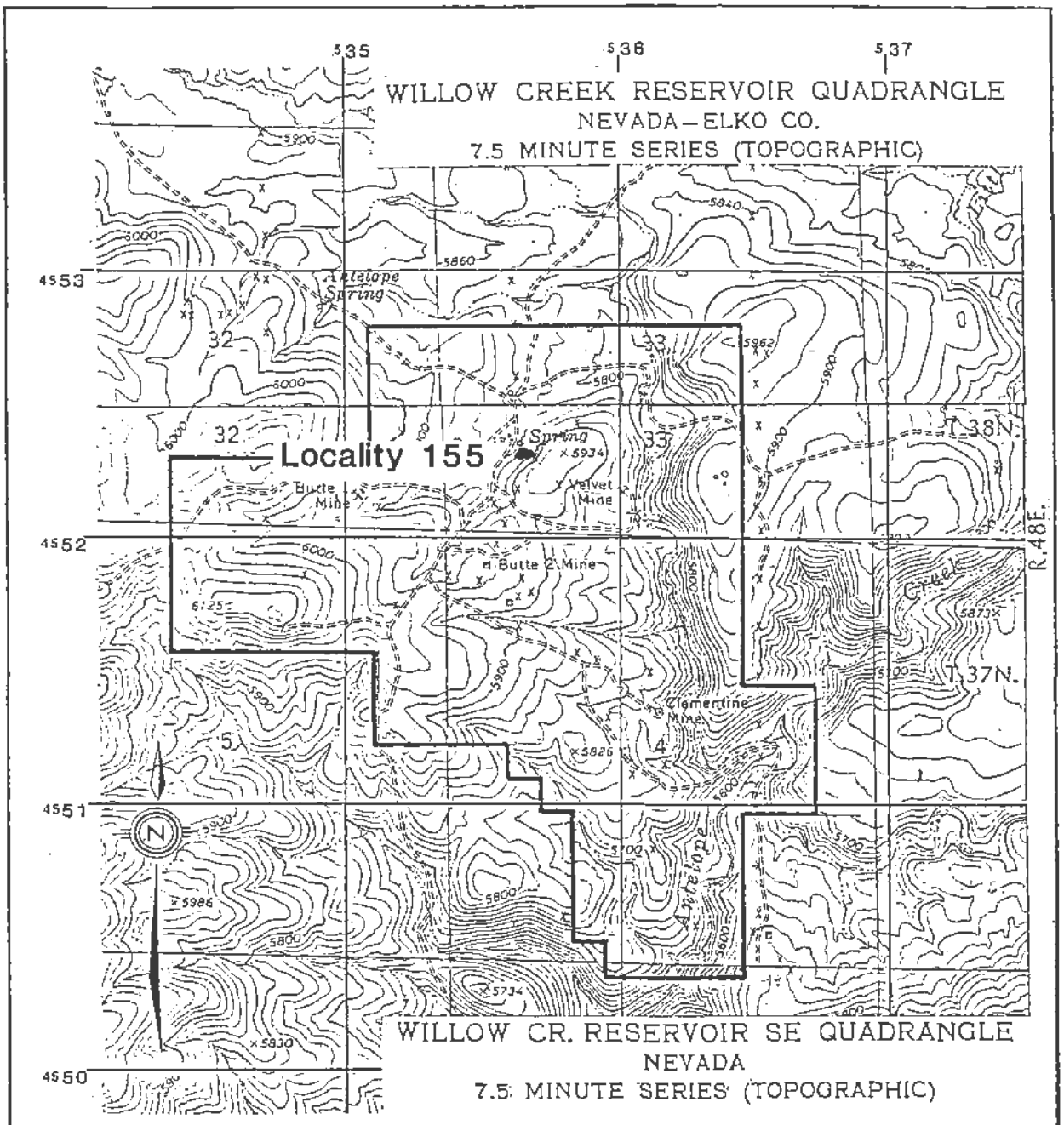
Topographic Data: On moderately steep (25%), northwest-facing ridge slope overlooking Tosawihi Spring.

Quarry Data: Cobbles in colluvium.

Description: Series of small quarry pits (feature 50-3) in dense reduction scatter; along slope above Tosawihi Spring. An isolated pit (3m x 3m) located nearby has only a light scatter of materials associated (feature 51-3).

Site Condition: Historic explorations in vicinity, but quarry complex is undisturbed.

Remarks: May be related to localities 152-154; all located on slope above Tosawihi Spring.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 156

Type: Boulder Field Quarry/ Pit Complex

UTM: 535220E/4552300N

Size: 10m x 20m

Max. Area (m^2): 200

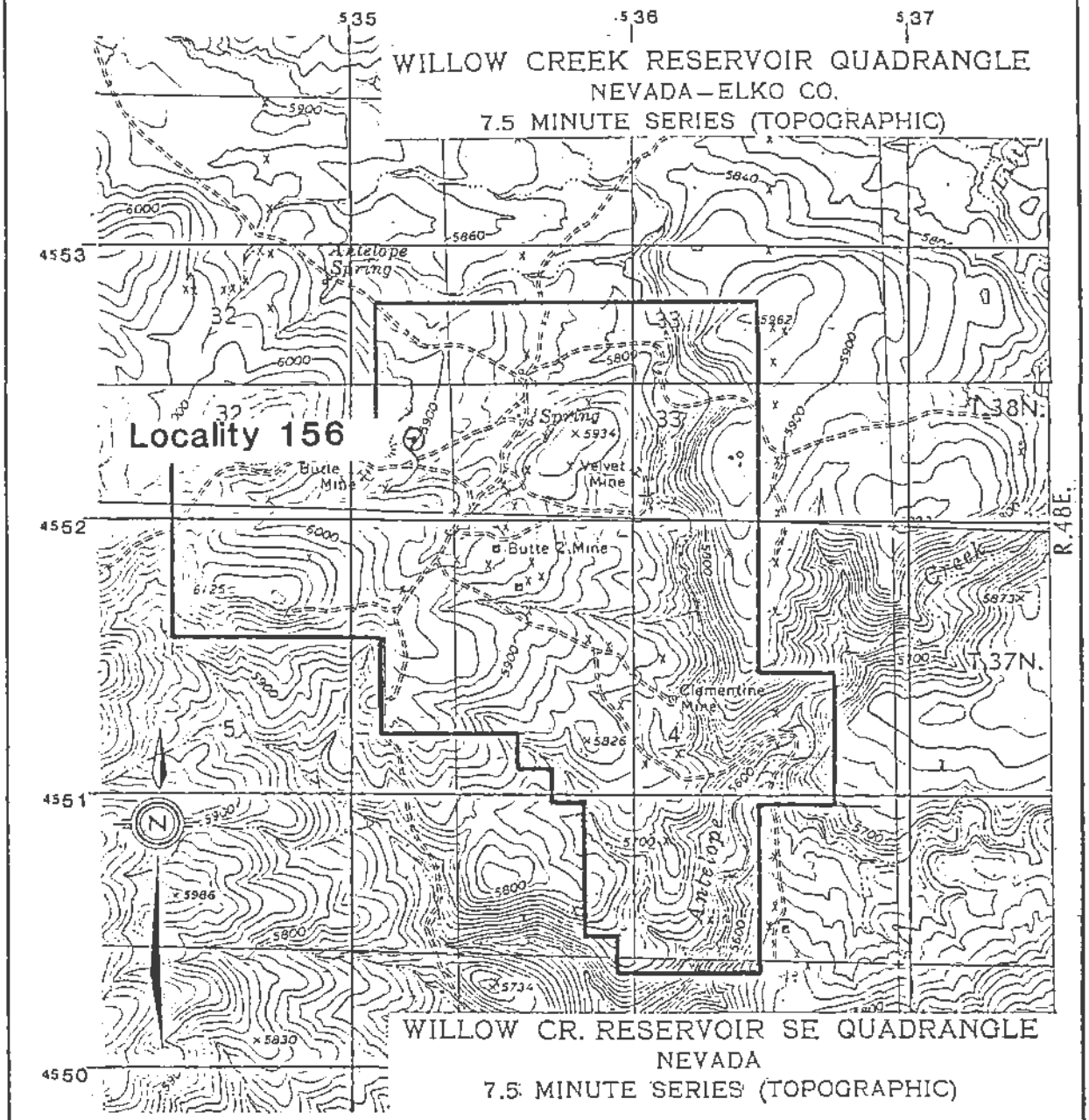
Topographic Data: On strongly sloping (10%), east-facing ridge slope.

Quarry Data: Boulders on surface; near-surface bedrock.

Description: Moderate to heavy density quarry reduction flake scatter surrounding two small pits (2m diameter, 20cm deep); artifacts include cores and bifaces and basalt hammerstone (feature 35-2).

Site Condition: Adjacent historic Butte I Mine, but no on-site disturbance noted.

Remarks: See relationships to prehistoric quarry localities around edge of Butte I Mine; localities 156-160 apparently reflect intensive prehistoric quarrying along weathered bedrock edging a small knoll; center of the knoll was the focus of the historic Butte I Mine (severely disturbed).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

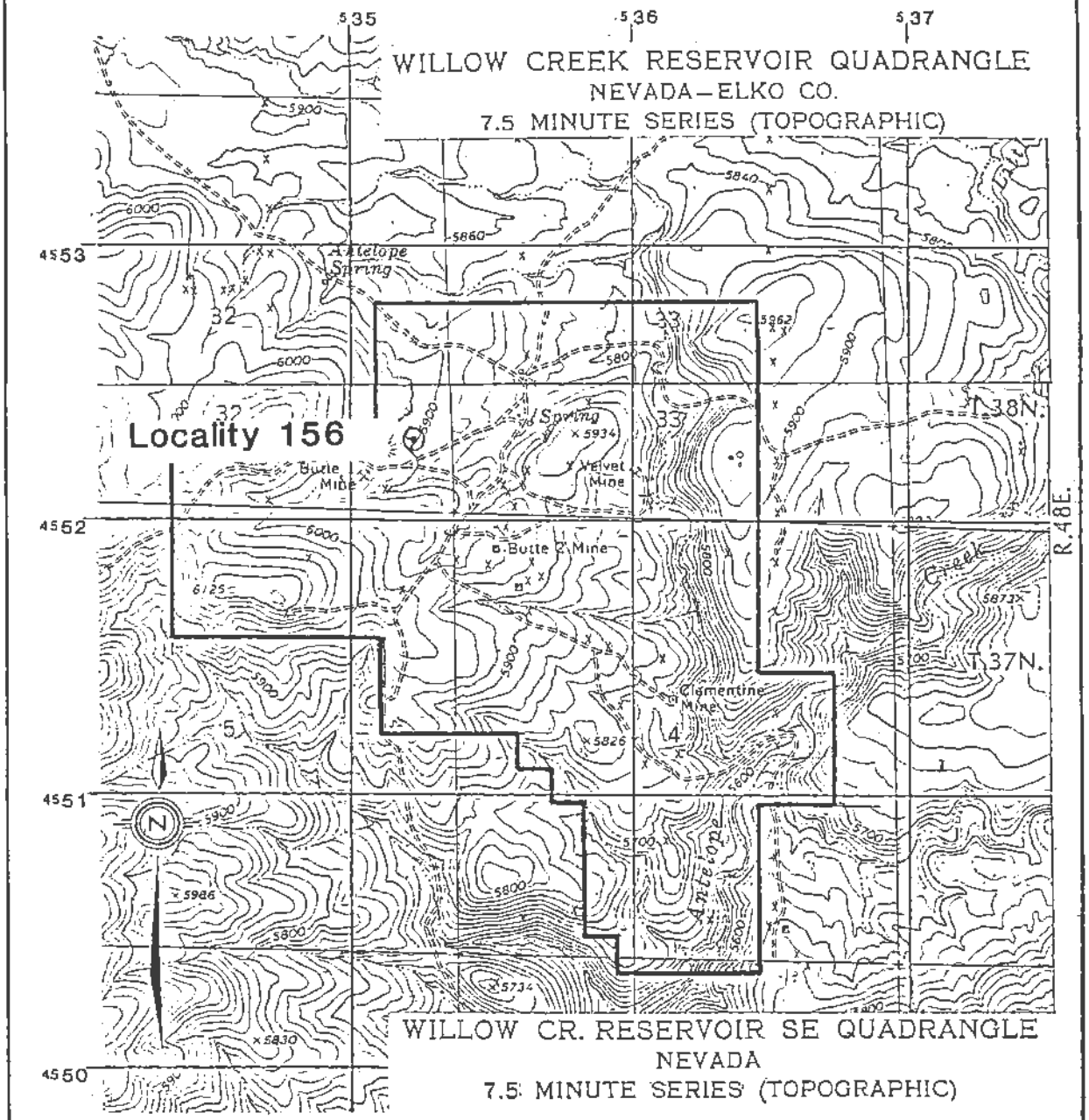
SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 157 Type: Small Outcrop Quarry

UTM: 535180E/4552240N

Size: 15m x 5m Max. Area (m^2): 75

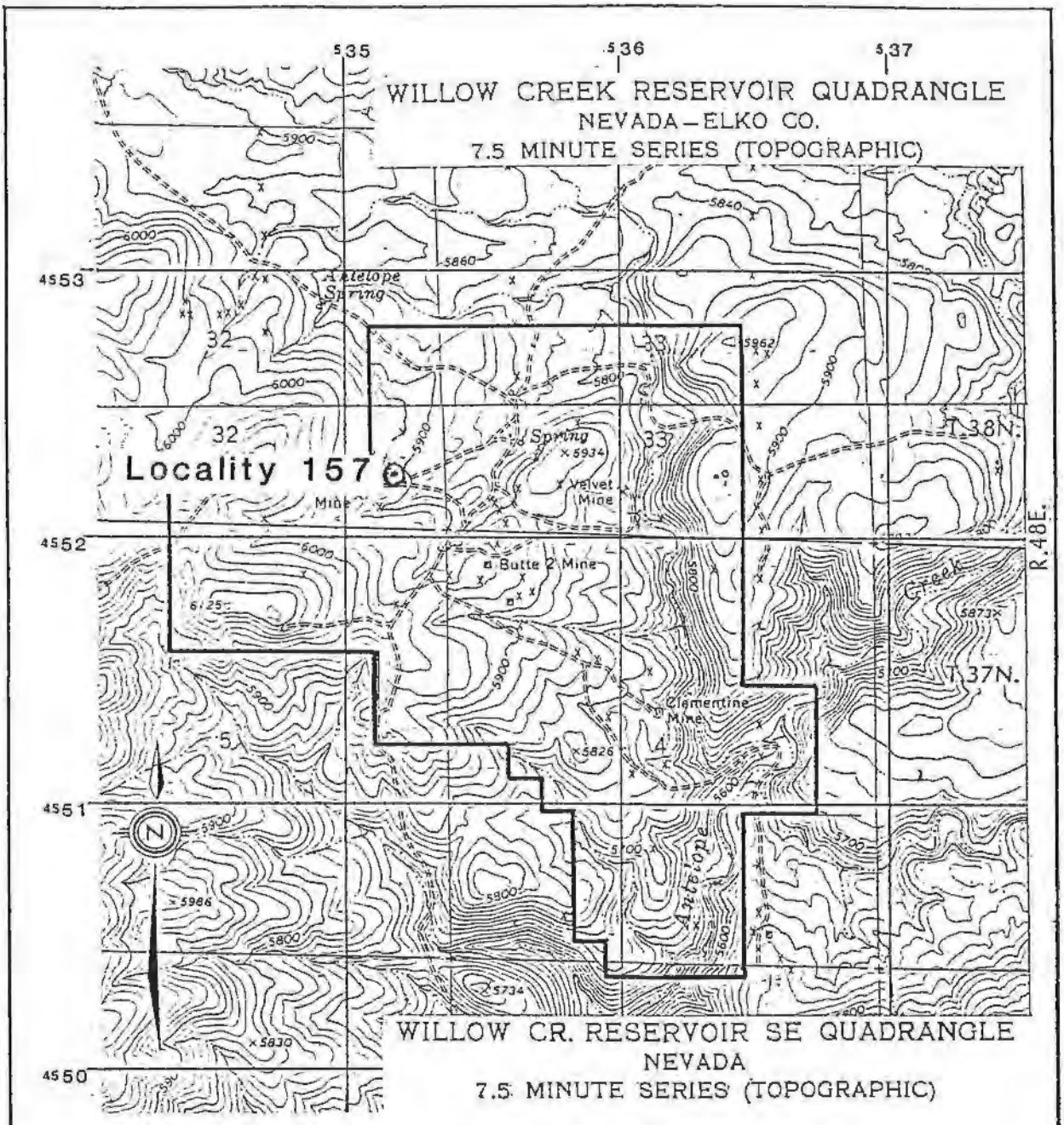
Topographic Data: On strongly sloping (10%), northeast-facing knoll slope.

Quarry Data: Outcrop exposed in side of knoll; poor quality toolstone.

Description: Moderate to heavy density scatter of reduction debris, including some weathering debris, but scatter also includes cores and bifaces (feature 35-1). Deeper soil below base of outcrop is stained dark with charcoal (could relate to recent wildfire).

Site Condition: Adjacent historic Butte I Mine, but no on-site disturbance noted.

Remarks: See relationships to prehistoric quarry localities around edge of Butte I Mine; localities 156-160 apparently reflect intensive prehistoric quarrying along weathered bedrock edging a small knoll; center of the knoll was the focus of the historic Butte I Mine (severely disturbed). Deeper soil may yield subsurface cultural deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 158 Type: Isolated Artifact

UTM: 535180E/4552220N

Size: N/A Max. Area (m^2): N/A

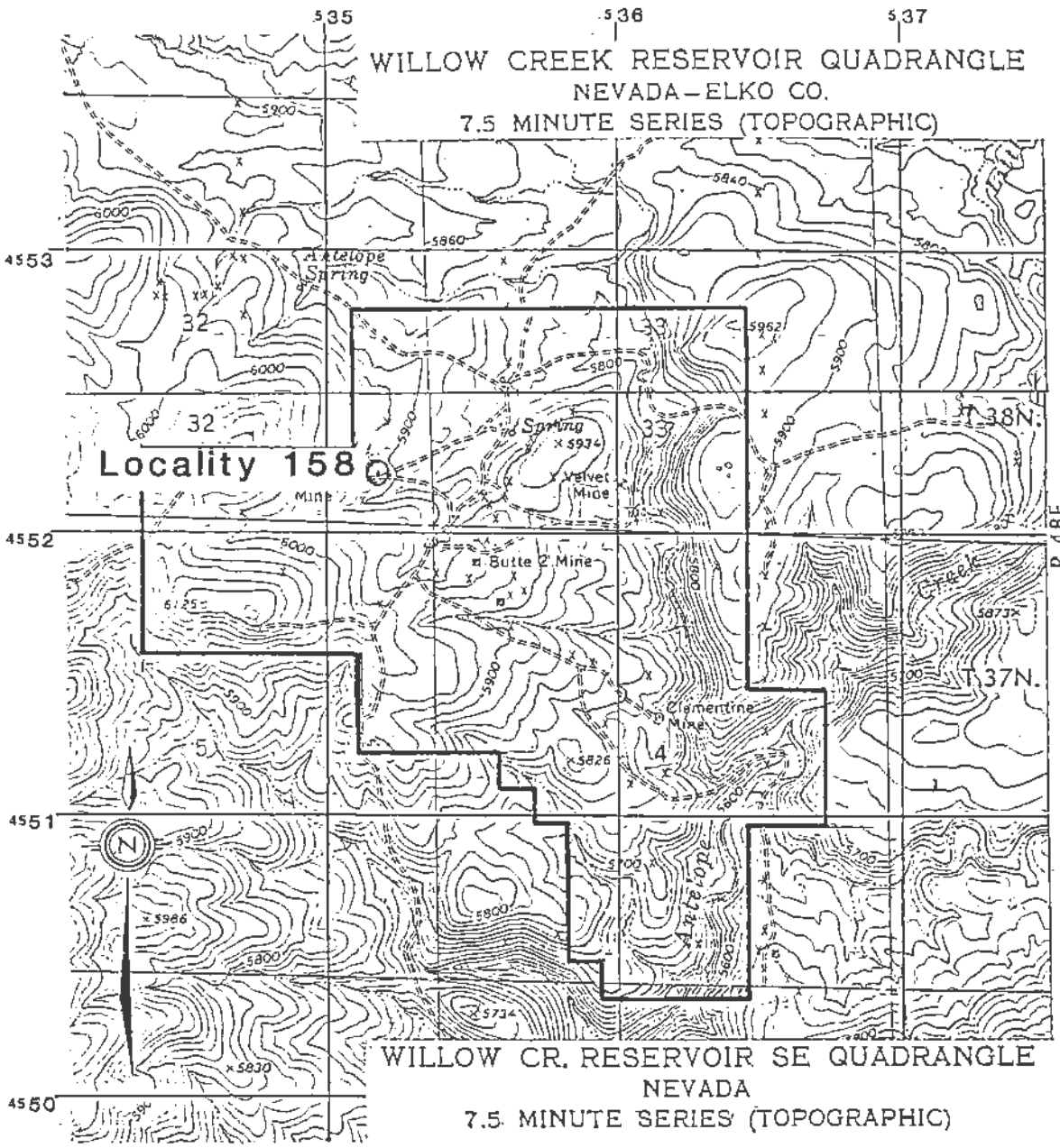
Topographic Data: Small flat on strongly sloping (10%), northeast-facing knoll slope.

Quarry Data: N/A

Description: Isolated obsidian, Desert Side-notched projectile point (collected) (feature 35-4).

Site Condition: In roadcut.

Remarks: Possibly related to quarries ringing Butte I Mine (see localities 156-160).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 159 Type: Quarry Pit Complex

UTM: 535200E/4552160N

Size: 45m NS/ 150m EW Max. Area (m^2): 6,750

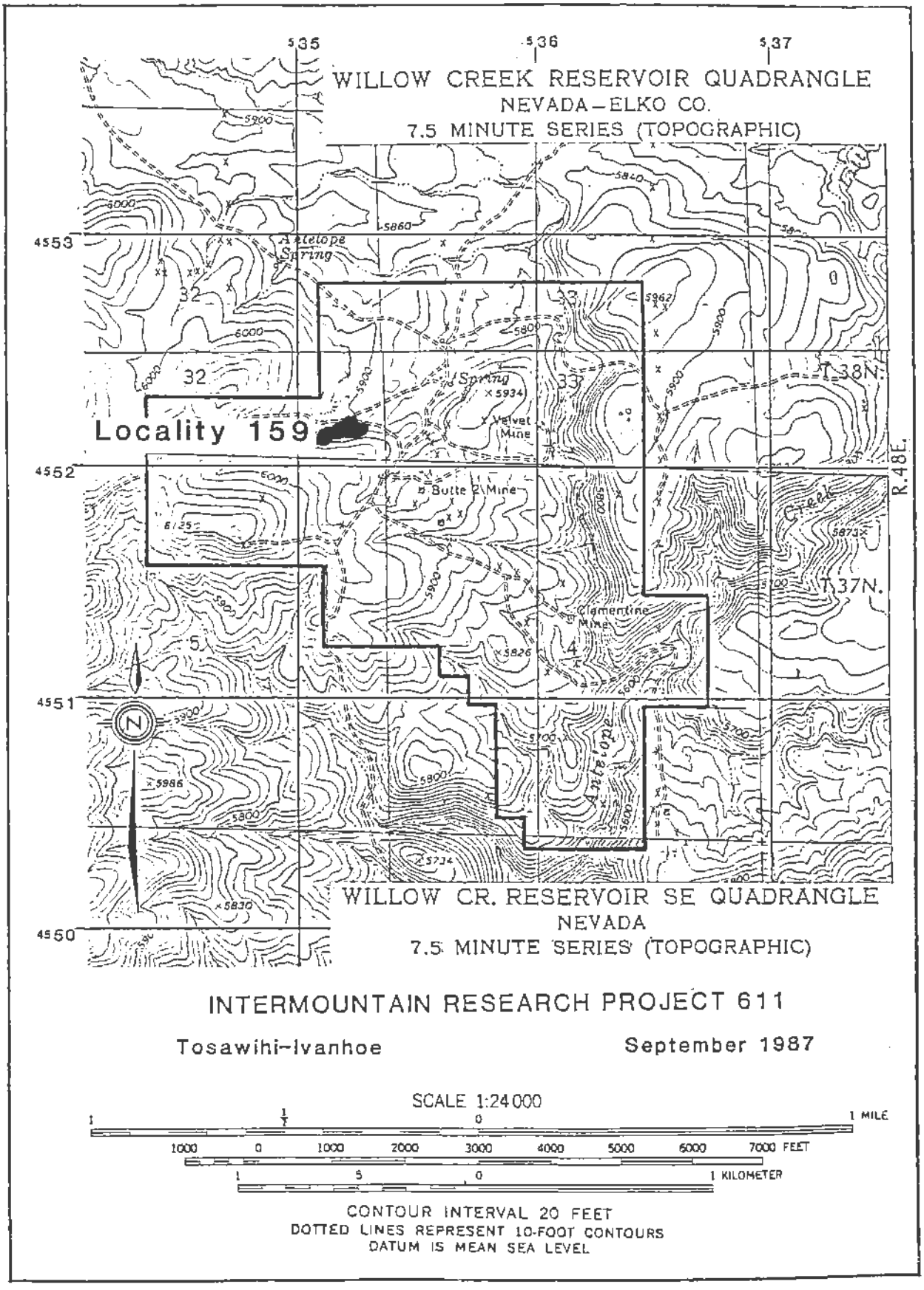
Topographic Data: On strongly sloping (10%), northeast-facing knoll slope.

Quarry Data: Outcrop exposed in side of knoll.

Description: Complex of 8 quarry pits in a moderate to heavy density reduction scatter, including cores, bifaces, and small basalt hammerstones (feature 35-7). An area of intensive bedrock ledge reductions (feature 36-1) is located below pits (lower on slope). To the east, near the base of the drainage, a light density flake scatter is associated with a grassy, soil mound (38-4) and very irregular, pitted ground.

Site Condition: Adjacent to historic Butte I Mine; pits in the feature 35-7 complex may be historic excavations over intensively quarried prehistoric reduction debris.

Remarks: See relationships to prehistoric quarry localities around edge of Butte I Mine; localities 156-160 apparently reflect intensive prehistoric quarrying along weathered bedrock edging a small knoll; center of the knoll was the focus of the historic Butte I Mine (severely disturbed). Deeper soil may yield subsurface cultural deposits.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 160

Type: Bedrock Ledge/ Quarry Pit Complex

UTM: 535040E/4552140N

Size: 45m NS/ 120m EW

Max. Area (m^2): 5,400

Topographic Data: On strongly sloping (12%), south-facing knoll slope.

Quarry Data: Bedrock ledge outcrop exposed in side of knoll.

Description: Complex of 13 quarry pits in a heavy density reduction scatter; few bifaces noted, but numerous cores and irregular chunks (feature 30-3); a nearby isolated pit was designated feature 32-5 (partially overlain by mine dump). A large, well made biface (grey chert), apparently isolated, was designated feature 32-7.

Site Condition: Adjacent historic Butte I Mine; several pits in the feature 30-3 complex are thought to be of historic or recent origin, but the density of prehistoric materials surrounding the excavation makes assessment difficult.

Remarks: See relationships to prehistoric quarry localities around edge of Butte I Mine; localities 156-160 apparently reflect intensive prehistoric quarrying along weathered bedrock edging a small knoll; center of the knoll was the focus of the historic Butte I Mine (severely disturbed). Deeper soil may yield subsurface cultural deposits.

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 161 Type: Quarry Pit Complex

UTM: 535380E/4552060N

Size: 60m NS/30m EW Max. Area (m^2): 1,800

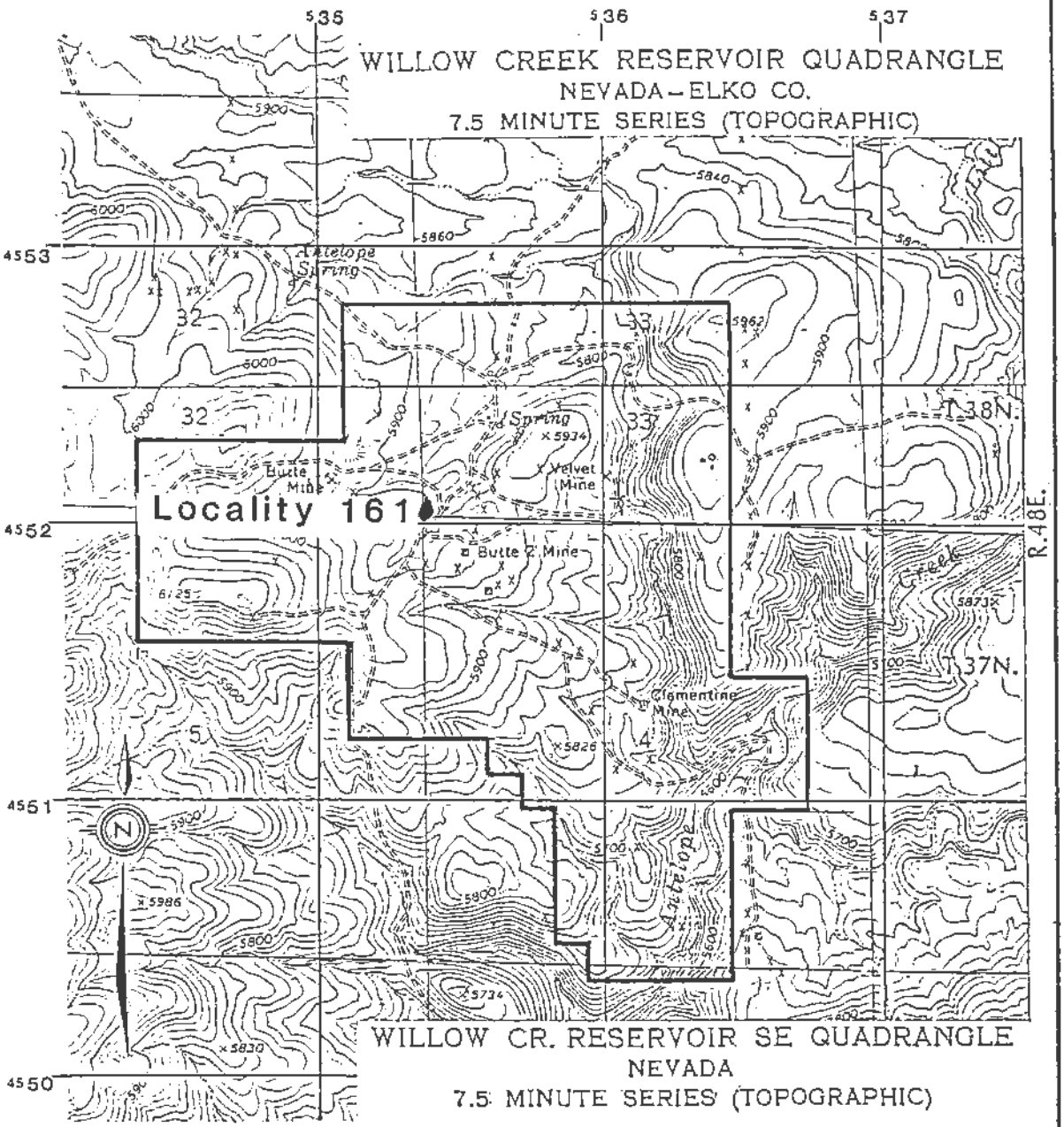
Topographic Data: Top and east-facing (12%) slopes of small knob on north-east trending ridge.

Quarry Data: Cobbles in colluvium.

Description: Quarry pit complex composed of one 5 pit cluster (feature 42-6) and one isolated pit (feature 42-7); all enclosed within light density flake scatter.

Site Condition: Numerous historic explorations in vicinity, but prehistoric features are apparently undisturbed.

Remarks: Needs further field assessment.



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Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 162 Type: Small Outcrop Quarry/ Pit Complex

UTM: 535260E/4552000N

Size: 9m x 12m Max. Area (m^2): 108

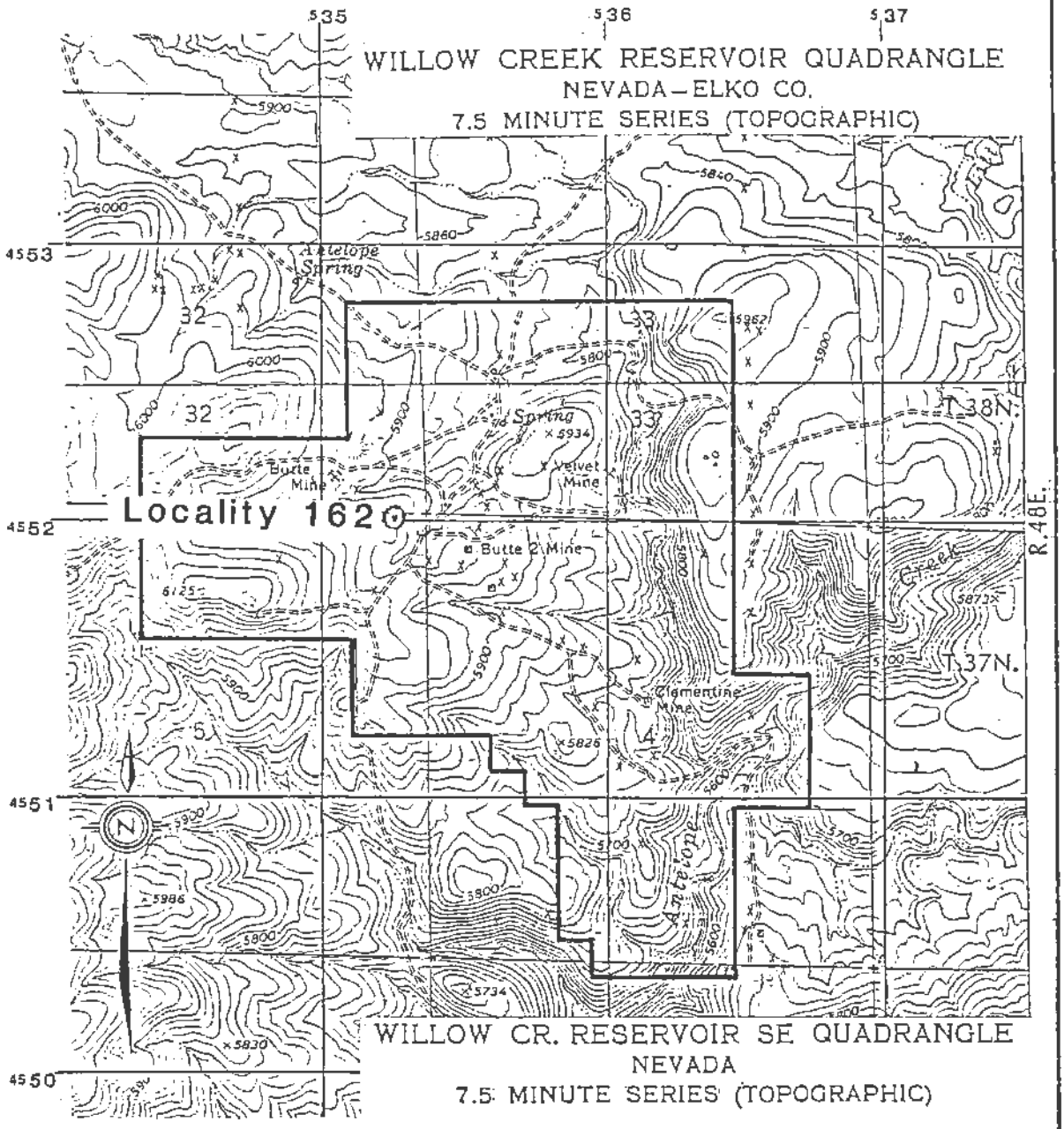
Topographic Data: Bench on low knob, along northeast trending ridge.

Quarry Data: Small bedrock outcrop; cobbles in colluvium at base feature.

Description: Small outcrop quarry with two pits (37-6). Primary reduction flakes and shatter are the most abundant items associated with quarry features, but a few bifaces were also noted.

Site Condition: Apparently undisturbed.

Remarks: Needs further assessment of toolstone source and quality.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 163 Type: Small Outcrop Quarry/ Pit Complex

UTM: 535280E/4552080N

Size: 20m x 20m Max. Area (m^2): 400

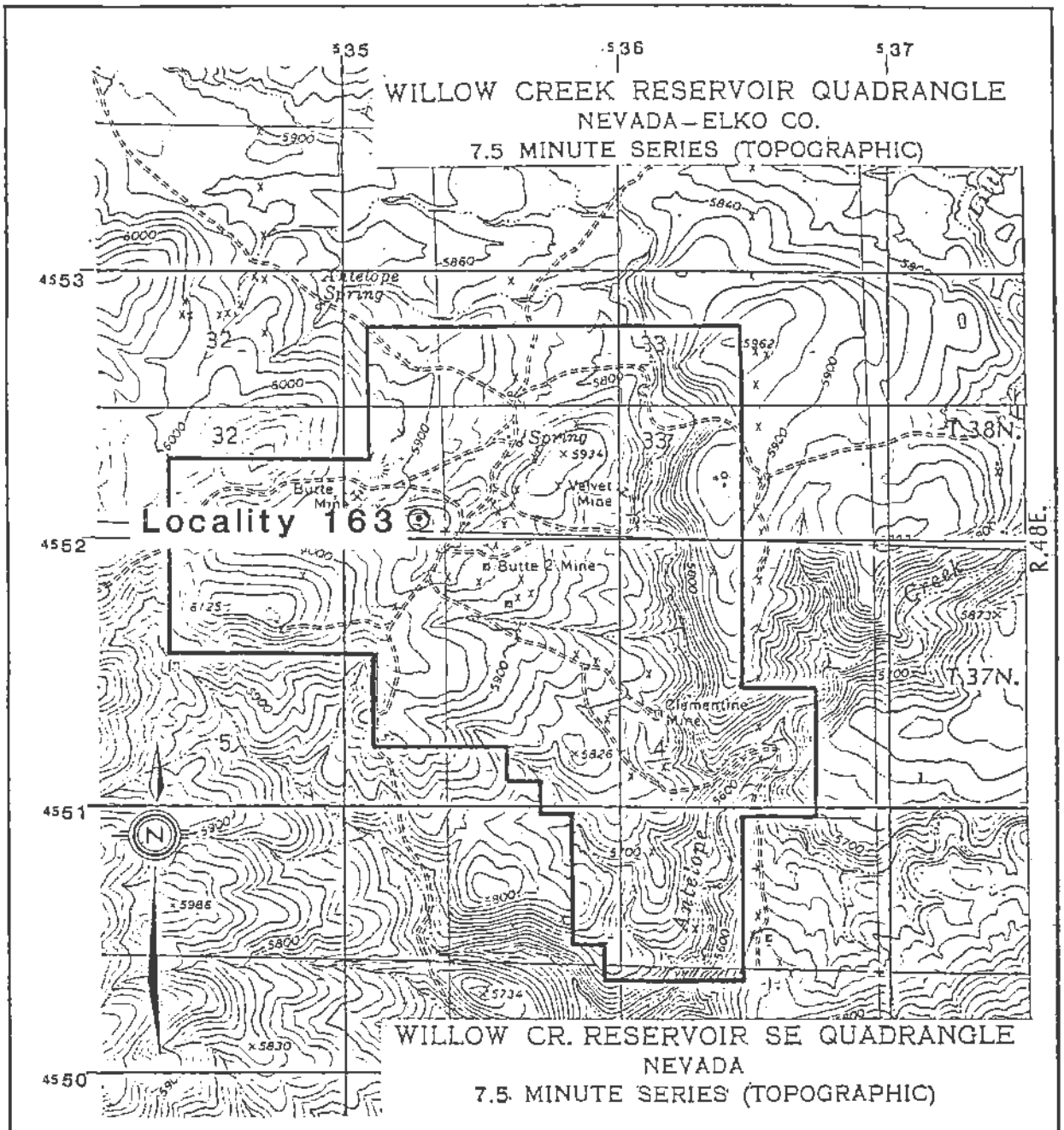
Topographic Data: North edge bench on low knob, along northeast trending ridge.

Quarry Data: Poor quality cobbles; white, transluscent, and pink-banded.

Description: Small complex of 4 pits in a moderate density flake scatter (feature 36-5). Seems to be poor quality toolstone overall.

Site Condition: Apparently undisturbed.

Remarks: Apparently related to locality 162.



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 164 (Prospect Shelter) Type: Rockshelter (Undetermined Type)

UTM: 536180E/4550900N

Size: 4m wide/ 1m deep/3m high Max. Area (m^2): 25

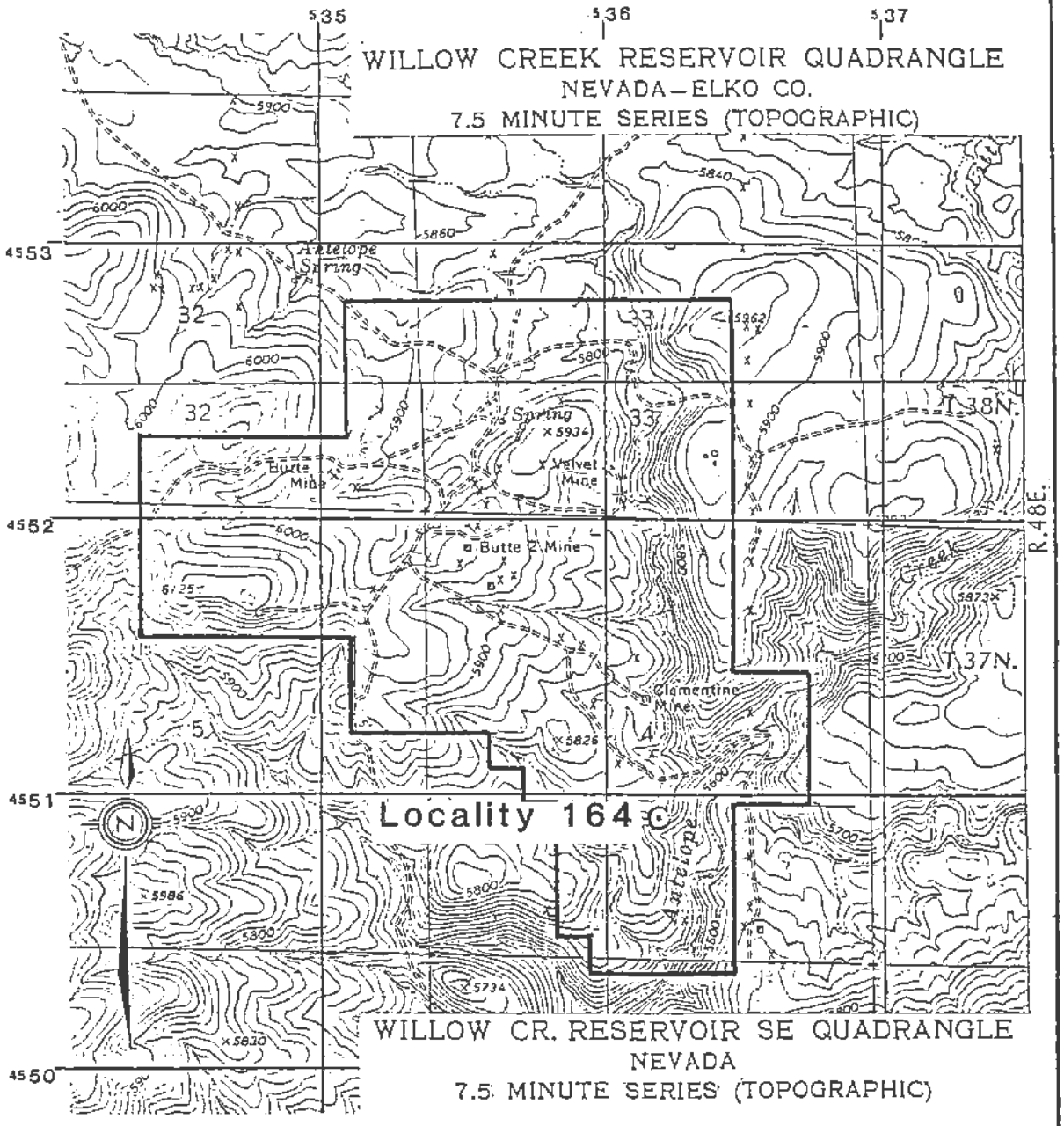
Topographic Data: Bedrock ledge outcrop at break in slope on south-facing ridge; strongly sloping (10%) to moderately steep (25%).

Quarry Data: Bedrock ledge outcrop is not knappable material, but good quality cobbles and boulders were quarried from the colluvium overlying the ledge.

Description: A small rockshelter (feature 68-13) located at the base of a two meter high outcrop is filled with secondary flakes and other undifferentiated reduction materials. A historic pit in the shelter indicates cultural materials here extend to a depth of at least 1 meter.

Site Condition: About 50% of rockshelter deposits remain undisturbed.

Remarks: The miner's hole should be faced up to look at the sidewalls; needs further assessment.



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 165 Type: Lithic Scatter (Undetermined Type)

UTM: 5350800E/4552000N

Size: 20m x 20m Max. Area (m^2): 400

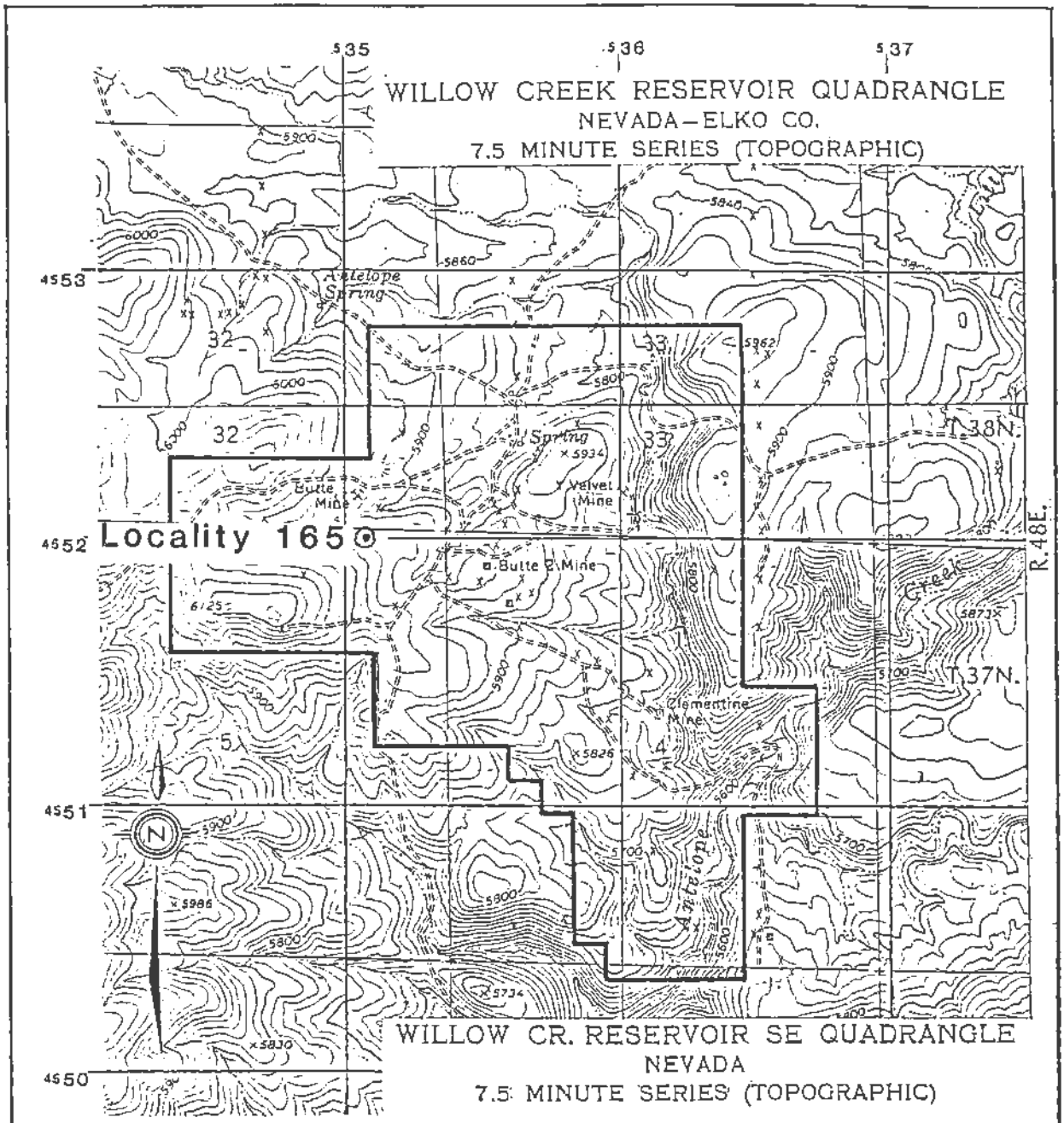
Topographic Data: On strongly sloping (12%), north-facing slope of long ridge.

Quarry Data: Unknown.

Description: Locality defined from density plots; a small moderate density scatter with no features recorded.

Site Condition: Unknown.

Remarks: Needs field assessment to determine significance (if any) of this density plot.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 166

Type: Lithic Scatter (Undetermined Type)

UTM: 535020E/4542020N

Size: 75m x 45m

Max. Area (m^2): 3,375

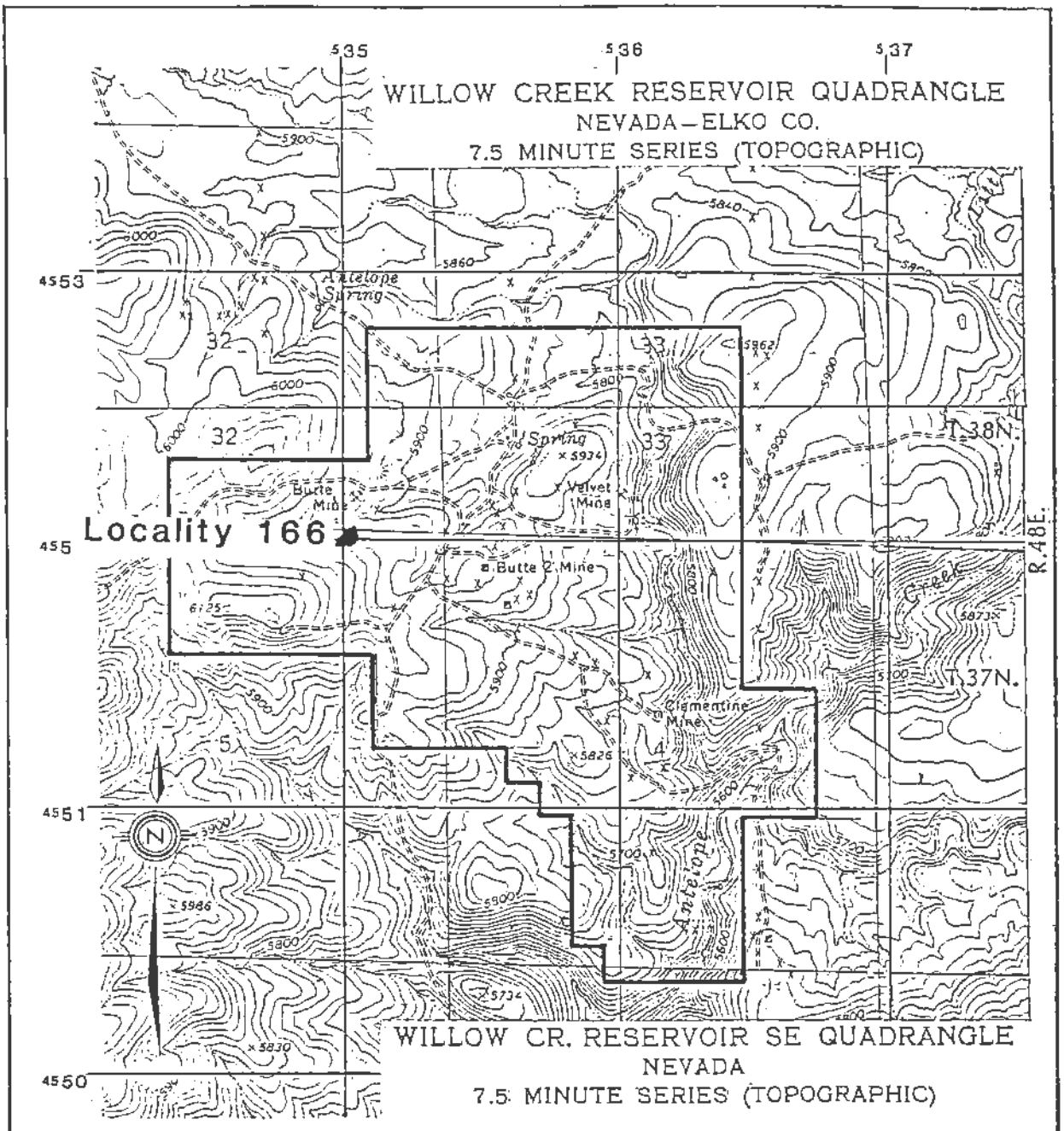
Topographic Data: On strongly sloping (12%), north-facing slope of long ridge.

Quarry Data: Unknown.

Description: Locality defined from density plots; characterized only as an enigmatic moderate density scatter with no features recorded.

Site Condition: Unknown.

Remarks: Needs field assessment to determine significance (if any) of this density plot.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 167 Type: Isolated Quarry Pit

UTM: 534960E/4552160N

Size: pit=4m x 4m Max. Area (m^2): 200

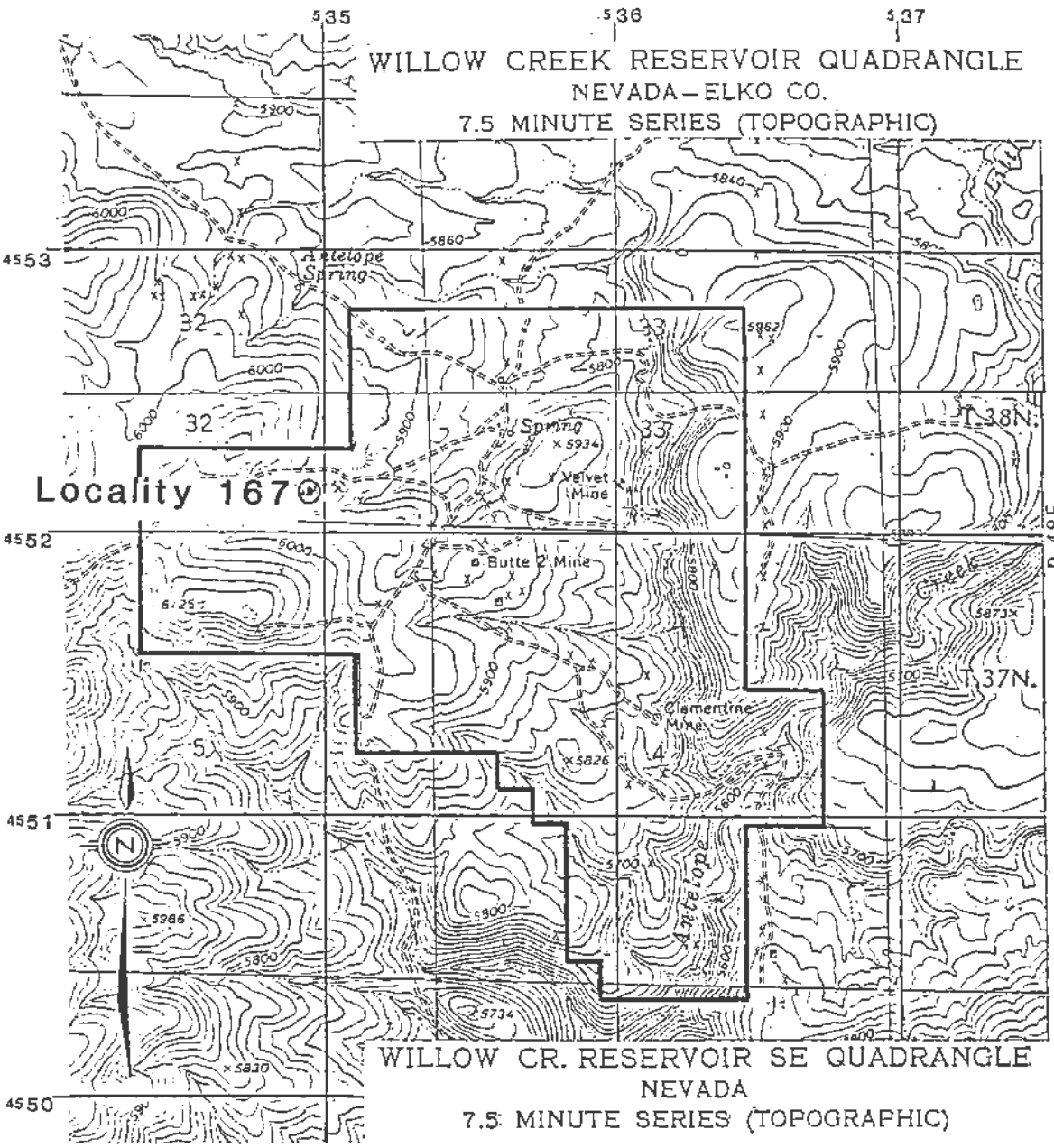
Topographic Data: Along break in slope on south side knoll overlooking ephemeral drainage.

Quarry Data: Cobbles in colluvium; white.

Description: Isolated quarry pit (feature 27-7); surrounding pit is a light to moderate density flake scatter; many flakes are quite large (white opalite); bifaces also are associated.

Site Condition: Adjacent Butte I Mine and intensively disturbed area, but pit seems intact.

Remarks: Likely related to other quarry localities edging Butte I (cf. localities 159-160).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 168 Type: Small Reduction Station

UTM: 534880E/4552180N

Size: 15m x 15m Max. Area (m^2): 225

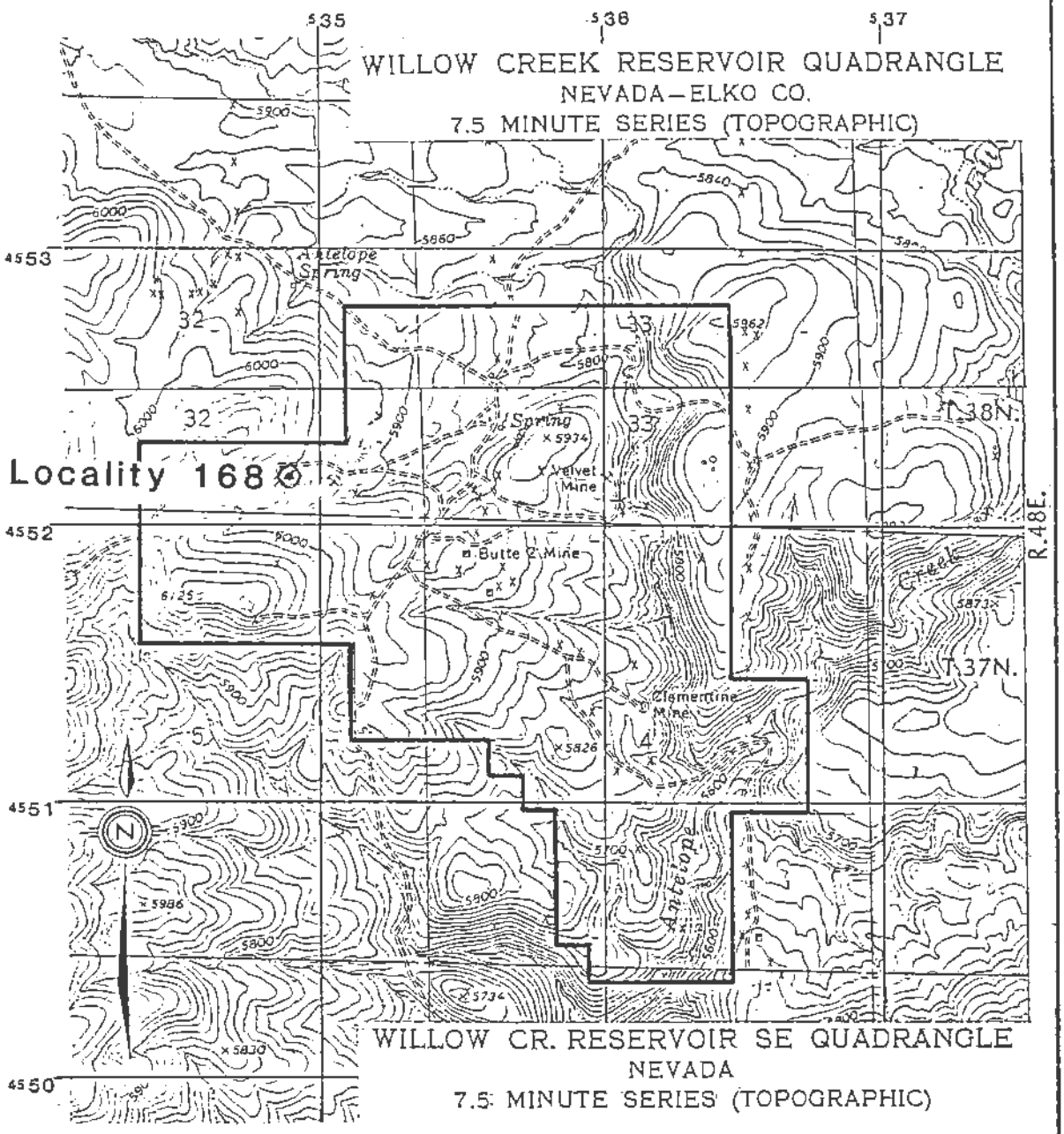
Topographic Data: Small bench on strongly sloping (10%), south-facing ridge slope.

Quarry Data: No on-site source.

Description: Discrete reduction area with dense concentration of secondary and biface thinning flakes of many different colors (feature 26-10); no bifaces noted.

Site Condition: Undisturbed.

Remarks: Why the thick accumulation of flakes from so many different cores and/or bifaces in such a small area?



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 169

Type: Quarry Pit Complex/ Grassy Mound

UTM: 534900E/4551940N

Size: 90m NS/45m EW

Max. Area (m^2): 4,050

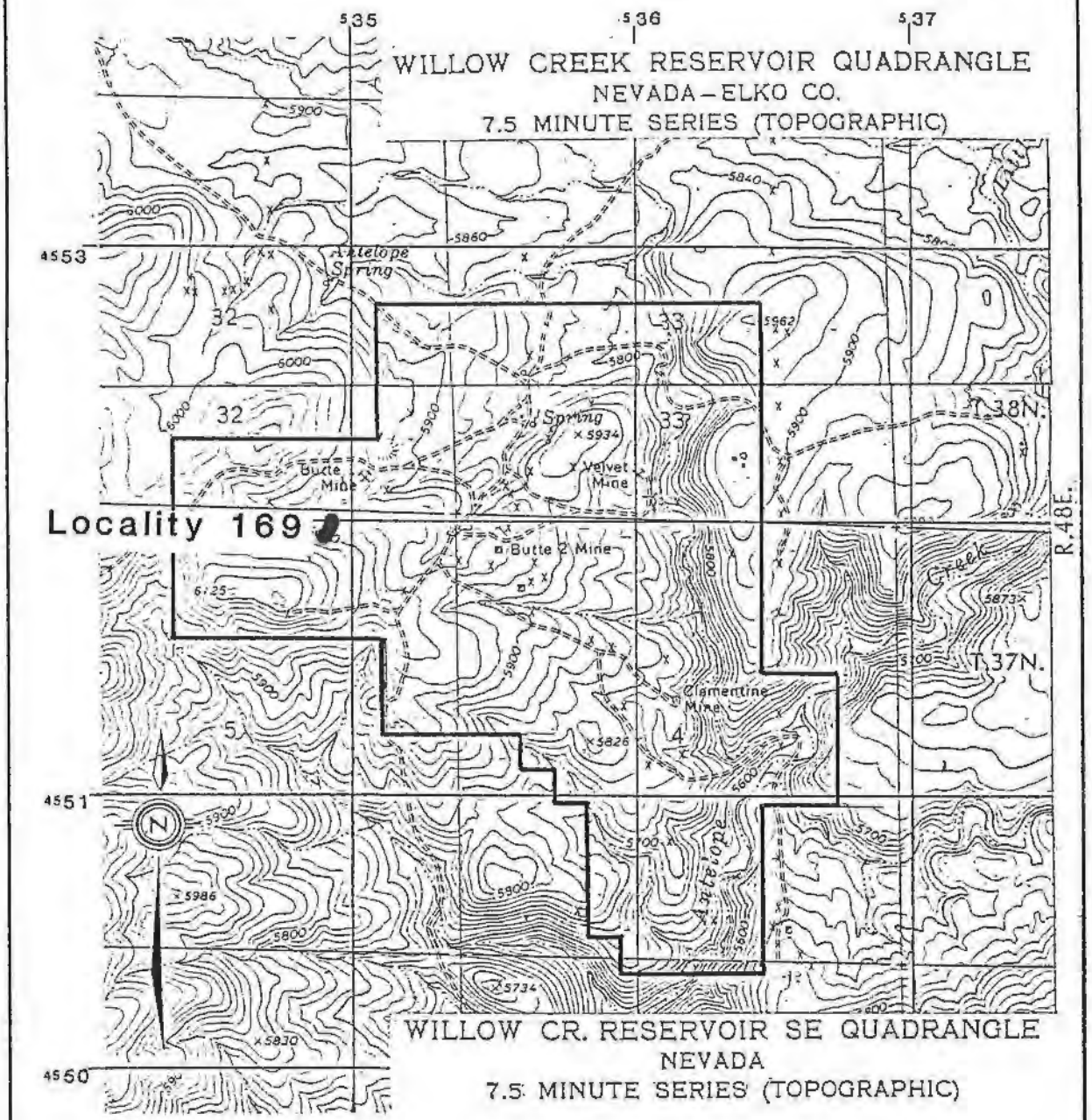
Topographic Data: On strongly sloping (14%), north-facing slope of ridge.

Quarry Data: Variable quality cobbles in colluvium.

Description: Quarry activities reflect a wide range of available materials. Feature 25-2 is a series of incipient pits into a distinctive red opalite; associated materials include bifaces and biface thinning flakes. Feature 26-8 is an isolated pit (4 m in diameter) in dense flake scatter. Feature 26-7 is a complex of six shallow pits, with very little associated reduction debitage (probably historic); associated materials consist of chunky pieces with few good flakes and no bifaces (refer to H-16). A deeper soil feature, "grassy mound, " was recorded as feature 26-6; many different material colors are found on the mound.

Site Condition: Apparently undisturbed.

Remarks: Compare to locality 170 where prehistoric pits yield low returns per extraction cost.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 170 Type: Quarry Pit Complex

UTM: 534800E/4552100N

Size: 30m NS/ 100m EW Max. Area (m^2): 3,000

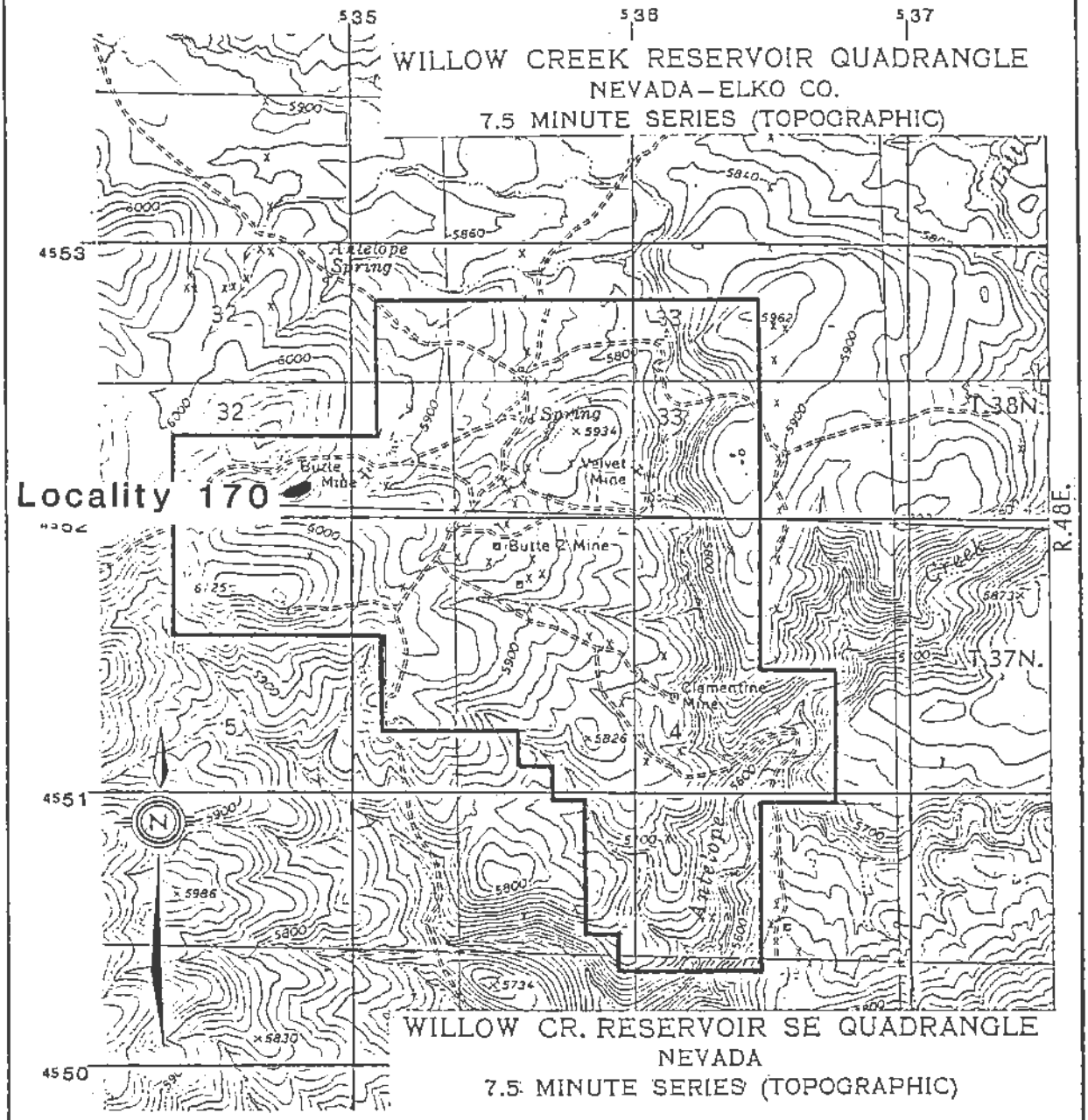
Topographic Data: On strongly sloping (14%), south-facing slope of ridge.

Quarry Data: Variable quality cobbles in colluvium; many nonsilicified cobbles constitute residue; colors include white, blue-grey, and light yellow banded chert.

Description: An interesting series of pits in the colluvium (feature 24-3) because of the low numbers of associated flakes and reduction debitage and the numbers of scattered nonsilicified (powdery) materials removed from the quarry pits.

Site Condition: Apparently undisturbed.

Remarks: An interesting feature to explore toolstone economics.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mary's Ridge

Locality No.: 171 Type: Outcrop Quarry Complex

UTM: 534780E/4552260N

Size: 215m x 75m Max. Area (m^2): 16,125

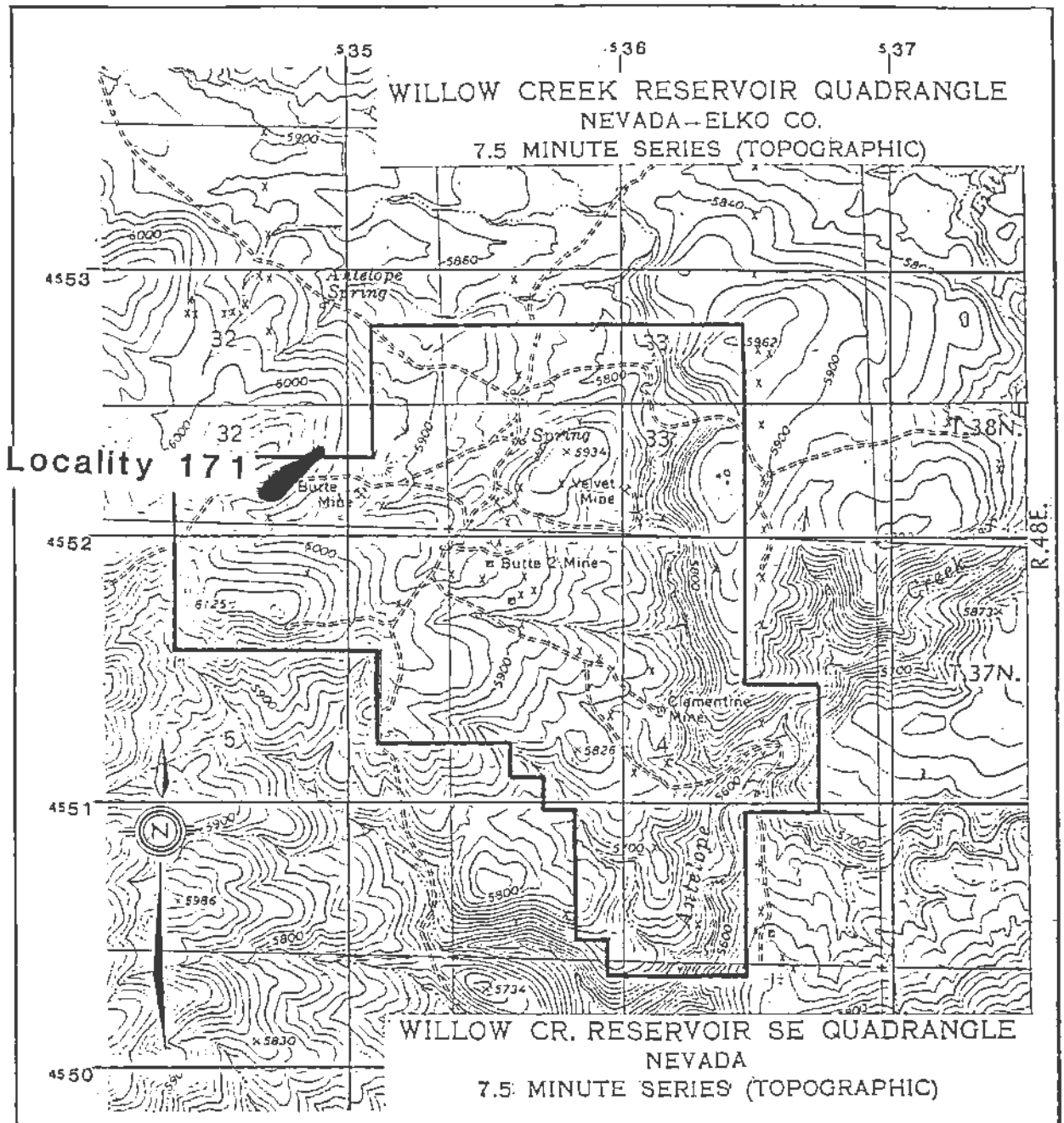
Topographic Data: Bedrock outcrop at break in slope (10%-25%) on southeast-facing ridge slope.

Quarry Data: Bedrock ledge outcrop of generally poor to mediocre quality opalite; colors vary from white to yellowish; vugs and crystalline inclusions common.

Description: Large bedrock ledge quarry, with many battered surfaces; numerous small pit features were identified. There are many cobbles and cores and extensive shatter, with fewer bifaces and controlled thinning flakes than at many nearby quarries (cf. Locality 181). Both rhyolite and basalt hammerstones were noted. Recorded features include 19-1, 19-2, 20-4, 20-5, 21-1, 22-3, 22-4, 23-1, 23-2, 24-1, 24-2, and 25-3.

Site Condition: Some road and historic pit disturbance, but condition of site is good overall.

Remarks: Good example of large area, poor quality source exploitation.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mary's Ridge

Locality No.: 172 Type: Small Reduction Station

UTM: 534780E/4552160N

Size: 2m x 2m Max. Area (m^2): 4

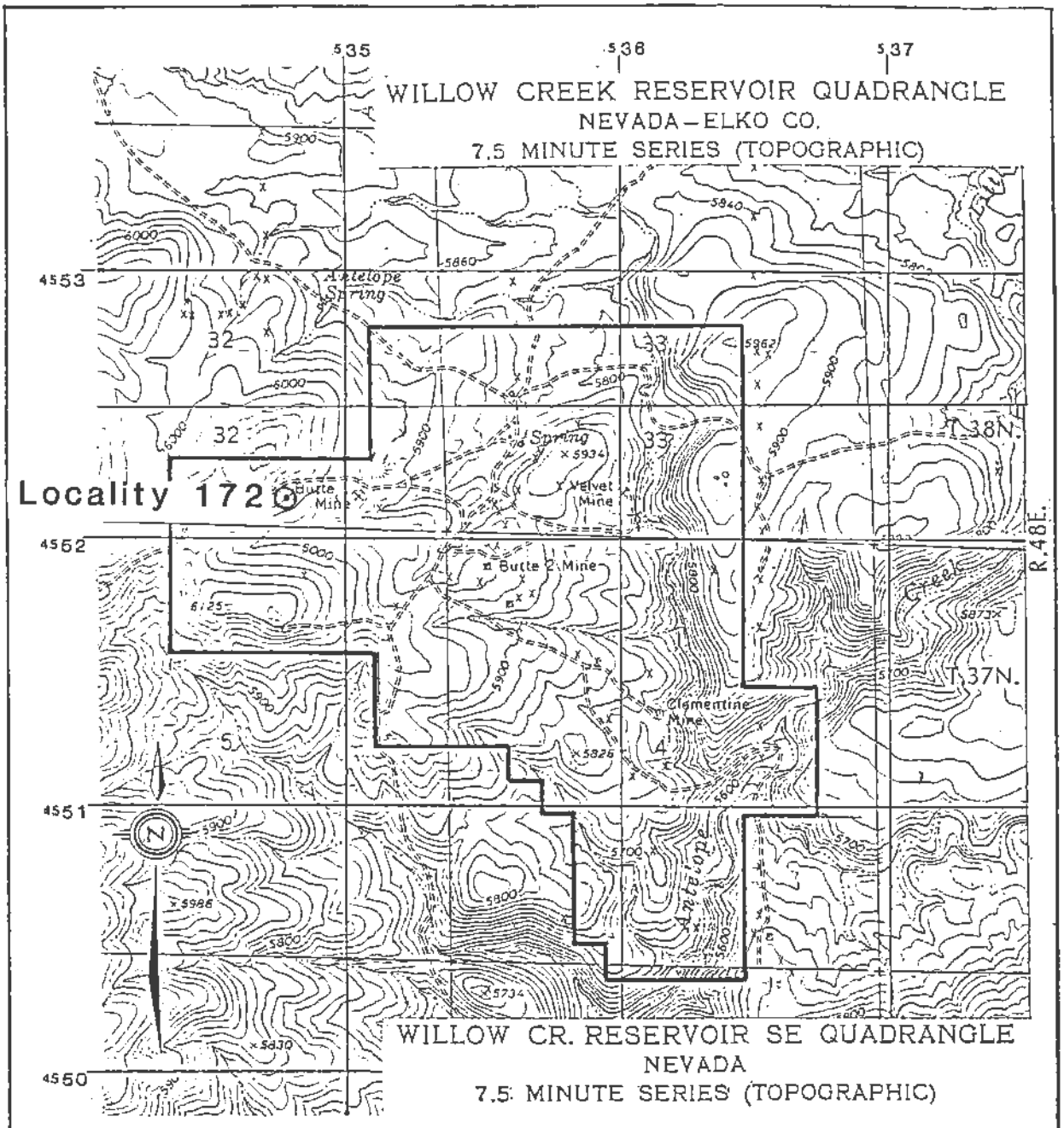
Topographic Data: Small bench along break in slope (13-25%) on southeast-facing ridge slope.

Quarry Data: No on-site source (but large quarry nearby at Locality 171).

Description: Small, discrete reduction scatter of white opalite flakes, cores, one large biface fragment, and large biface thinning flakes (feature 23-3).

Site Condition: Undisturbed.

Remarks: May be related to quarry at nearby Locality 171.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mary's Ridge

Locality No.: 173 Type: Small Reduction Station

UTM: 534720E/4552300N

Size: 10m x 10m Max. Area (m^2): 100

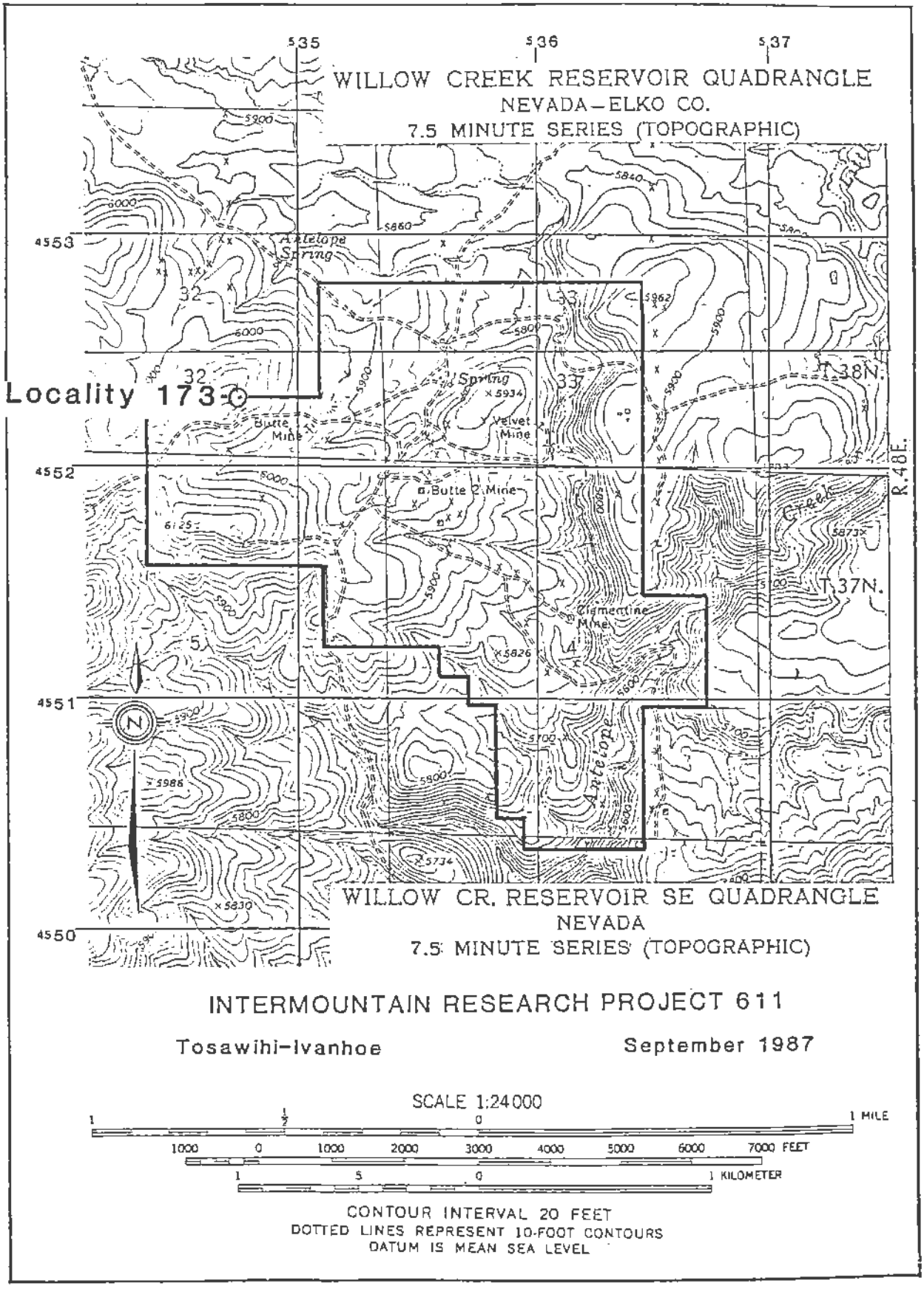
Topographic Data: Located on moderately steep (16%), southeast-facing ridge slope.

Quarry Data: No on-site source; near quarry Locality 171.

Description: Discrete reduction station comprised of dense scatter of flakes, with abundant biface thinning flakes and bifaces (feature 22-1).

Site Condition: Undisturbed.

Remarks: Opalite may be derived from nearby quarry Locality 171.



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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mary's Ridge

Locality No.: 174 Type: Small Reduction Station

UTM: 534740E/4552280N

Size: 10m x 10m Max. Area (m^2): 100

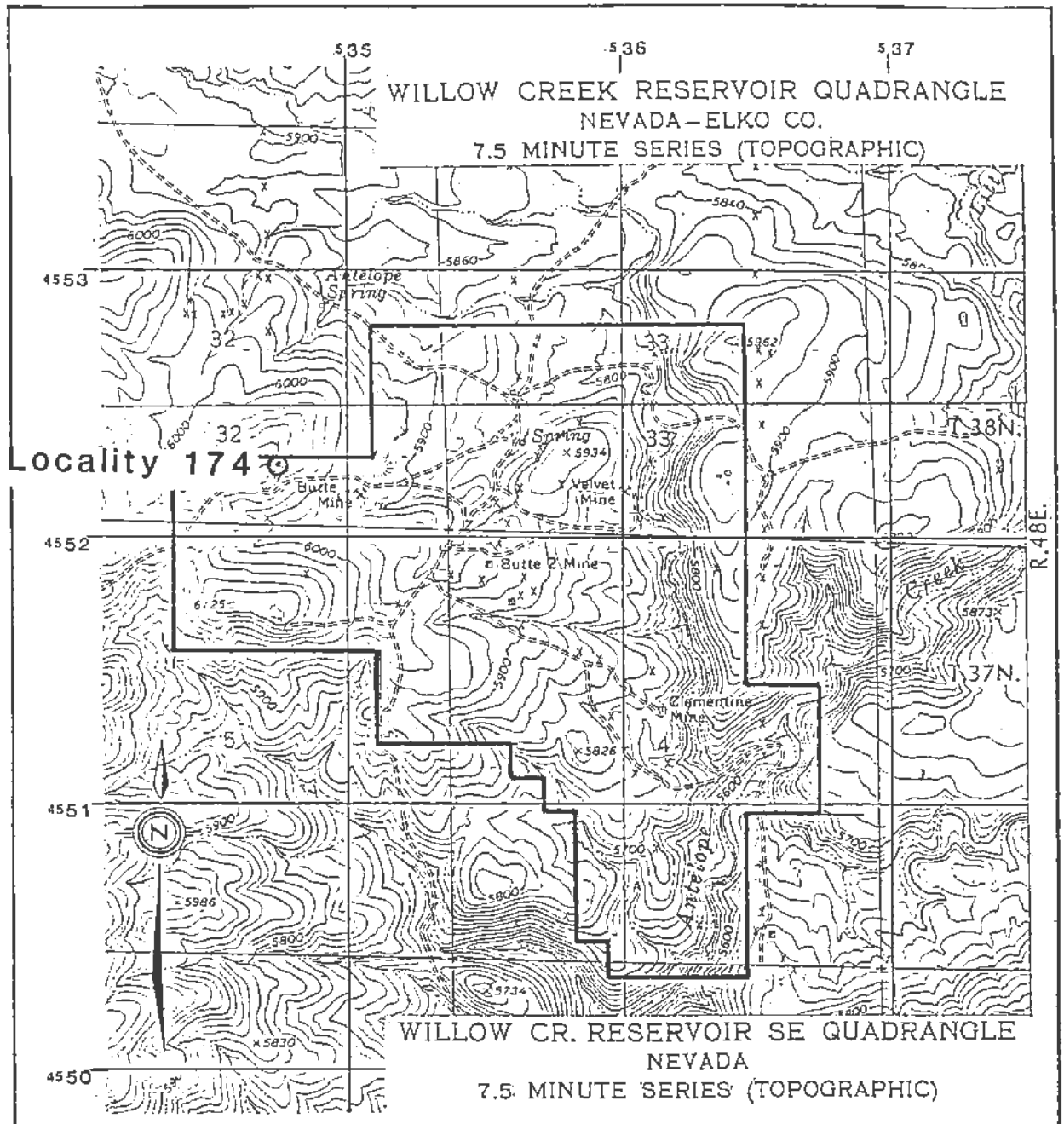
Topographic Data: Located above bedrock ledge on moderately steep (16%) southeast-facing ridge slope.

Quarry Data: No on-site source; near quarry Locality 171.

Description: Discrete reduction station comprised of dense scatter of flakes, with abundant biface thinning flakes (feature 22-2).

Site Condition: Undisturbed.

Remarks: Opalite may be derived from nearby quarry locality 171.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Mary's Ridge

Locality No.: 175 Type: Small Cobble-Assay Station

UTM: 534620E/4552220N

Size: 10m NS/ 10m EW Max. Area (m^2): 100

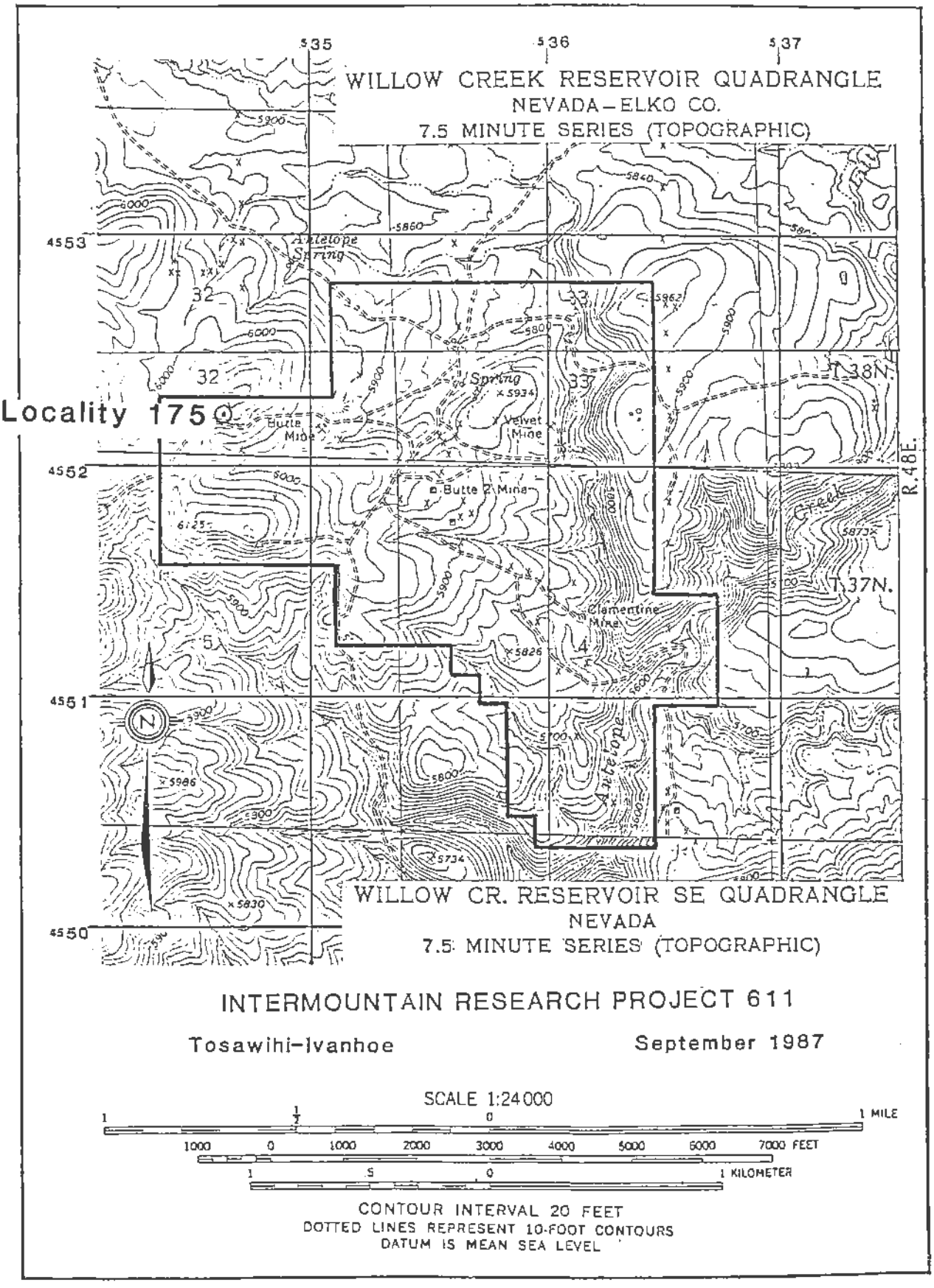
Topographic Data: At break in slope (6%-15%) near ridge top, facing south.

Quarry Data: Poor quality cobbles on surface; variegated colors.

Description: Small cobble quarry with abundant shatter and irregular chunks and small amounts of controlled flakes (feature 18-3).

Site Condition: Undisturbed.

Remarks: Seems to be primarily an assay station.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Spring Canyon

Locality No.: 176 Type: Isolated Quarry Pit

UTM: 534820E/4552960N

Size: 90m NS/ 60m EW Max. Area (m^2): 5,400

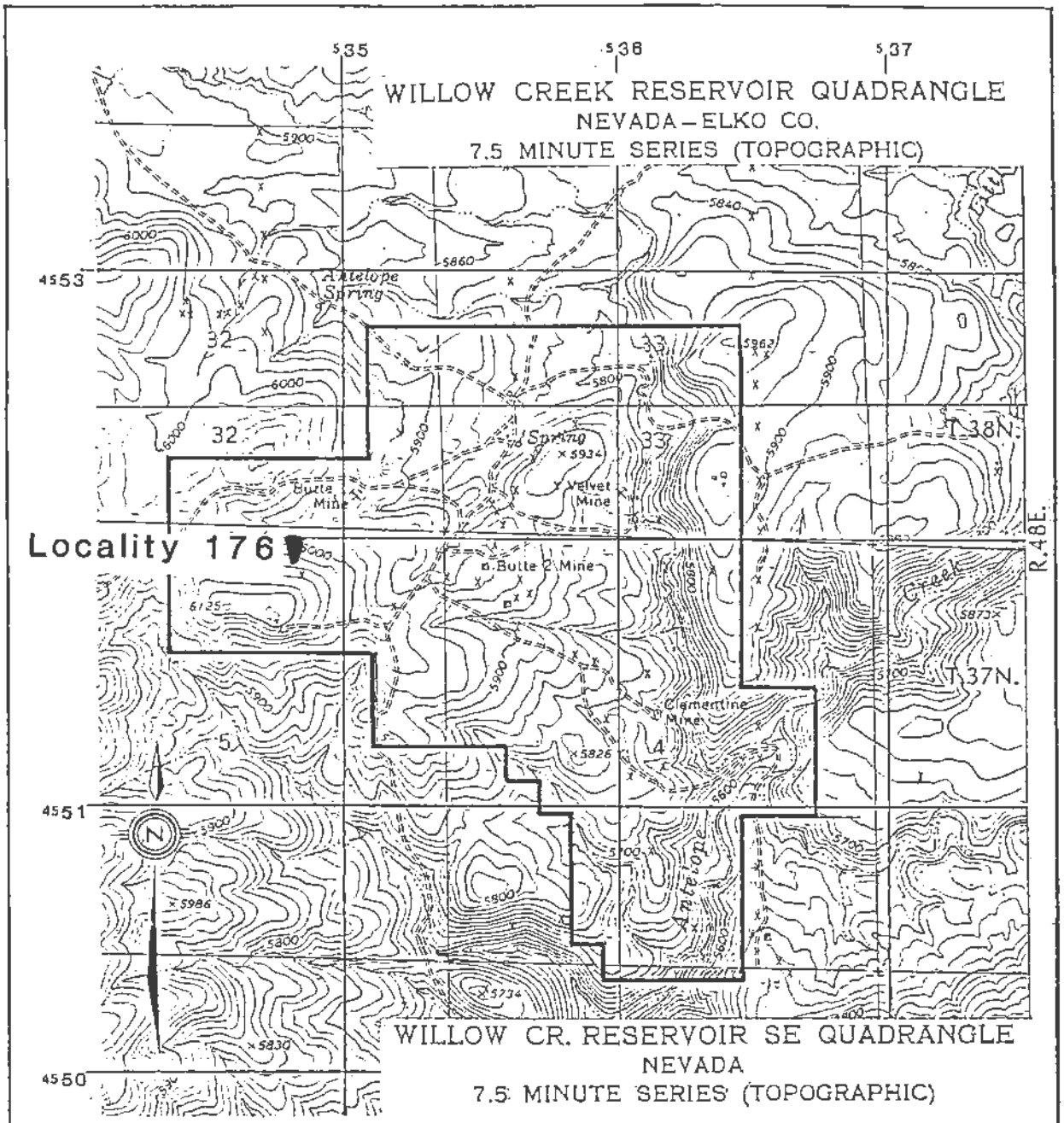
Topographic Data: On moderately steep, north-facing ridge slope.

Quarry Data: Boulders and cobbles in colluvium; high quality toolstone.

Description: Large quarry pit and dense scatter of reduction flakes in 15 meter diameter area (feature 22-5) with large cone-shaped moderate density scatter cascading downslope to north.

Site Condition: Undisturbed (except for some natural movement on slope).

Remarks: Example of a single, intensively quarried pit feature with a large, but contained, flake scatter. If the moderate to dense flake scatter surrounding pit is the residue from excavation and reduction, then we must assume that a very large amount of material was excavated from the pit (likely extending well below present base of pit) (similar examples may be localities 100 and 104).



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 177 Type: Quarry Pit Complex/ Groundstone

UTM: 535540E/4552220N

Size: 60m x 60m Max. Area (m^2): 3,600

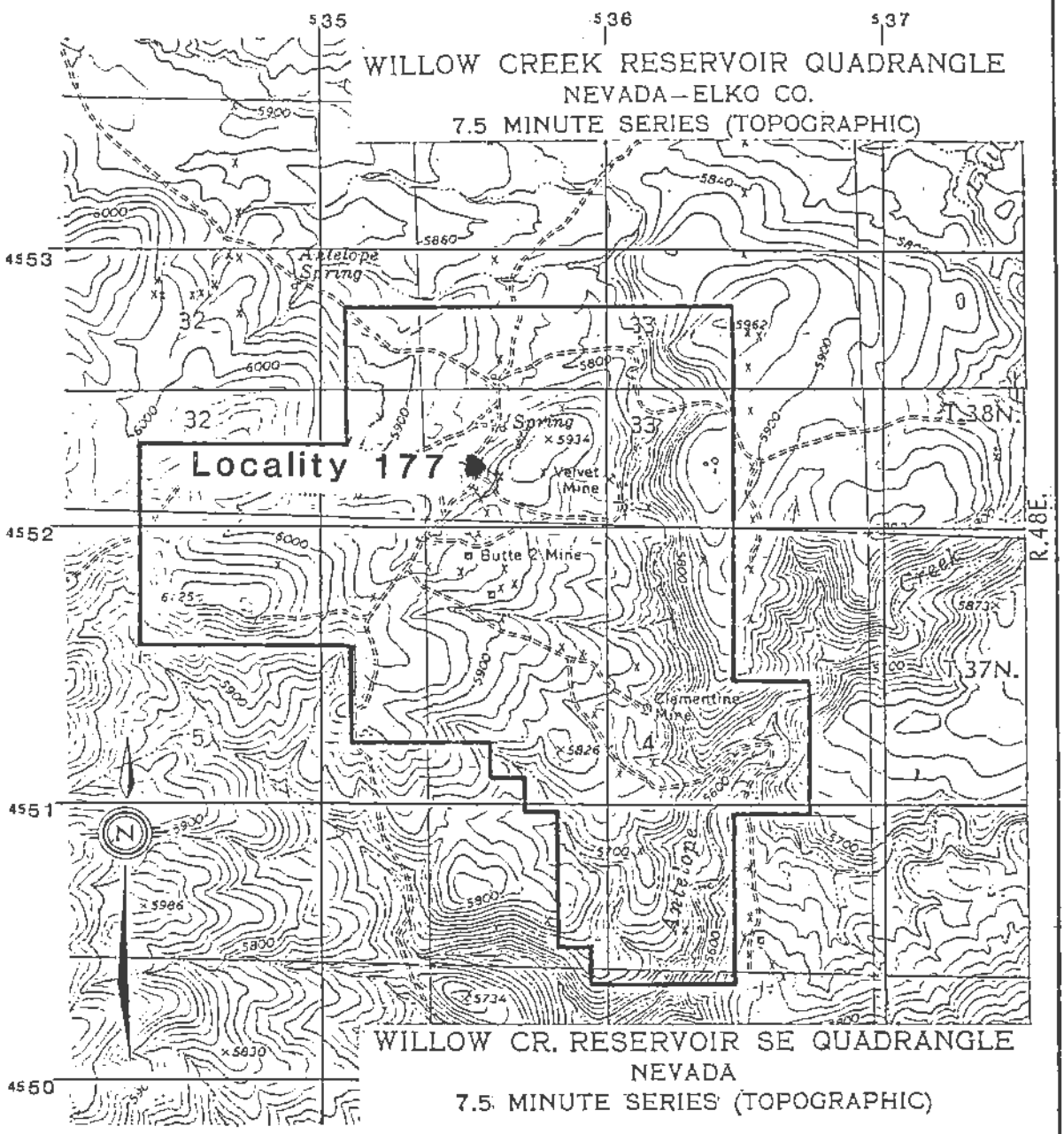
Topographic Data: Moderately steep (25%), northwest-facing ridge slopes overlooking Tosawihi Spring.

Quarry Data: Good quality cobbles in colluvium; colors from pink to white.

Description: Complex of two quarry pits (feature 48-1) in a moderate to heavy density flake scatter overlooking Tosawihi Spring. Two metates (one with incised grooves) were found in the quarry pits. An obsidian Elko Series projectile point, designated Locality 219, was collected near the west edge of pit complex.

Site Condition: Some nearby historic pit disturbance, but this has not effected prehistoric remains.

Remarks: The association of groundstone with quarry pit complexes is rare elsewhere in the District (see also isolated groundstone localities 153 and 154); perhaps seed grinding tools are related to use of nearby Tosawihi Spring.



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Deer Pass

Locality No.: 178 Type: Reduction Station Complex

UTM: 534380E/4551900N

Size: 90m NS/ 45m EW Max. Area (m^2): 4,050

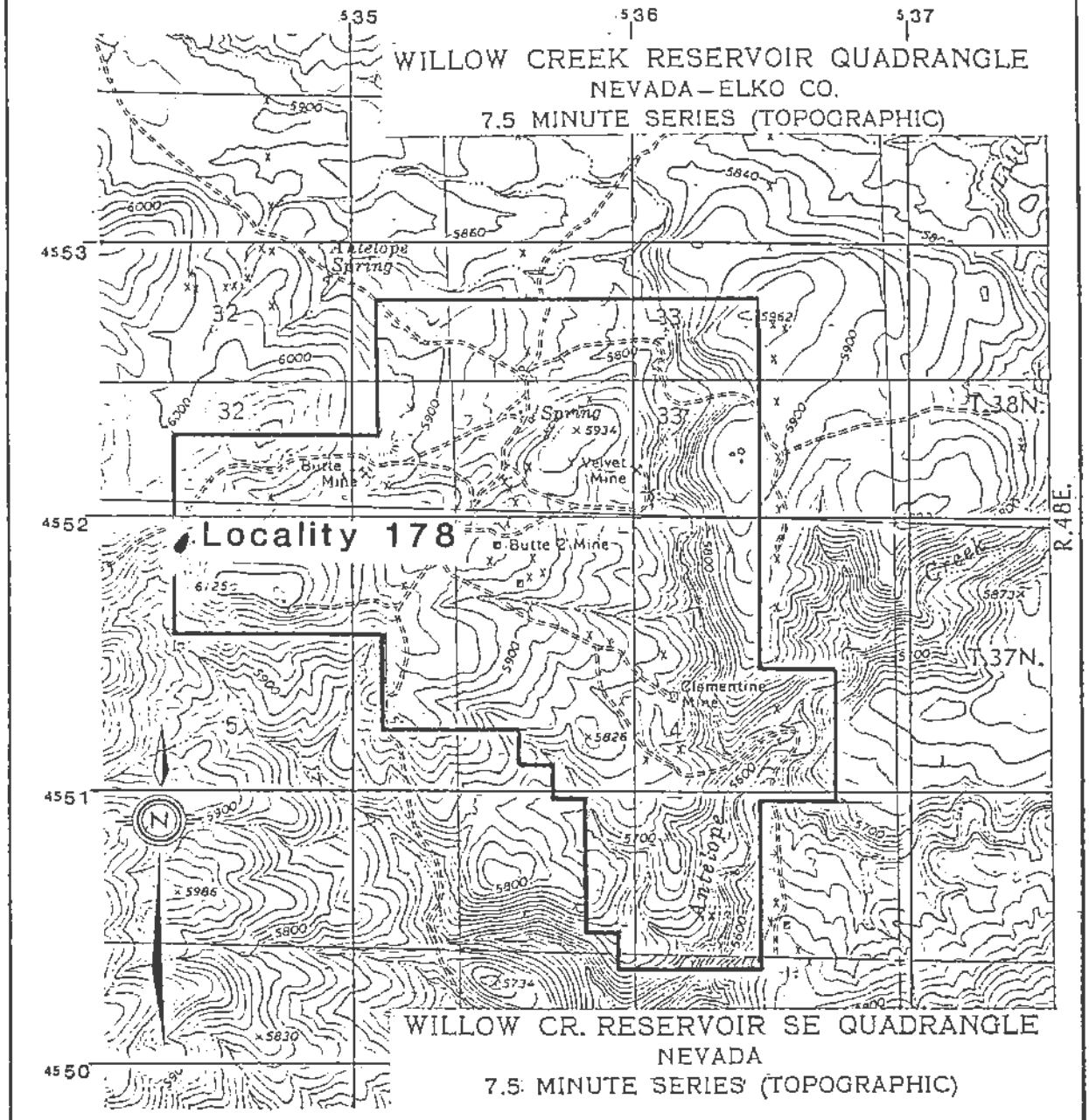
Topographic Data: Top of small knoll, gently sloping (5%) to the south.

Quarry Data: No on-site source.

Description: Complex of several discrete flaking stations comprised of light scatters of secondary flakes and several biface fragments; a large "stemmed" biface was noted here (feature 9-1).

Site Condition: Pristine.

Remarks: Very good example of discrete reduction stations located on the west side of the Tosawihi Quarry District, well outside the quarry zone (see similar localities 179-181).



INTERMOUNTAIN RESEARCH PROJECT 611

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September 1987

SCALE 1:24000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Deer Pass

Locality No.: 179 Type: Small Reduction Station

UTM: 534440E/4551820N

Size: 5m x 5m Max. Area (m^2): 25

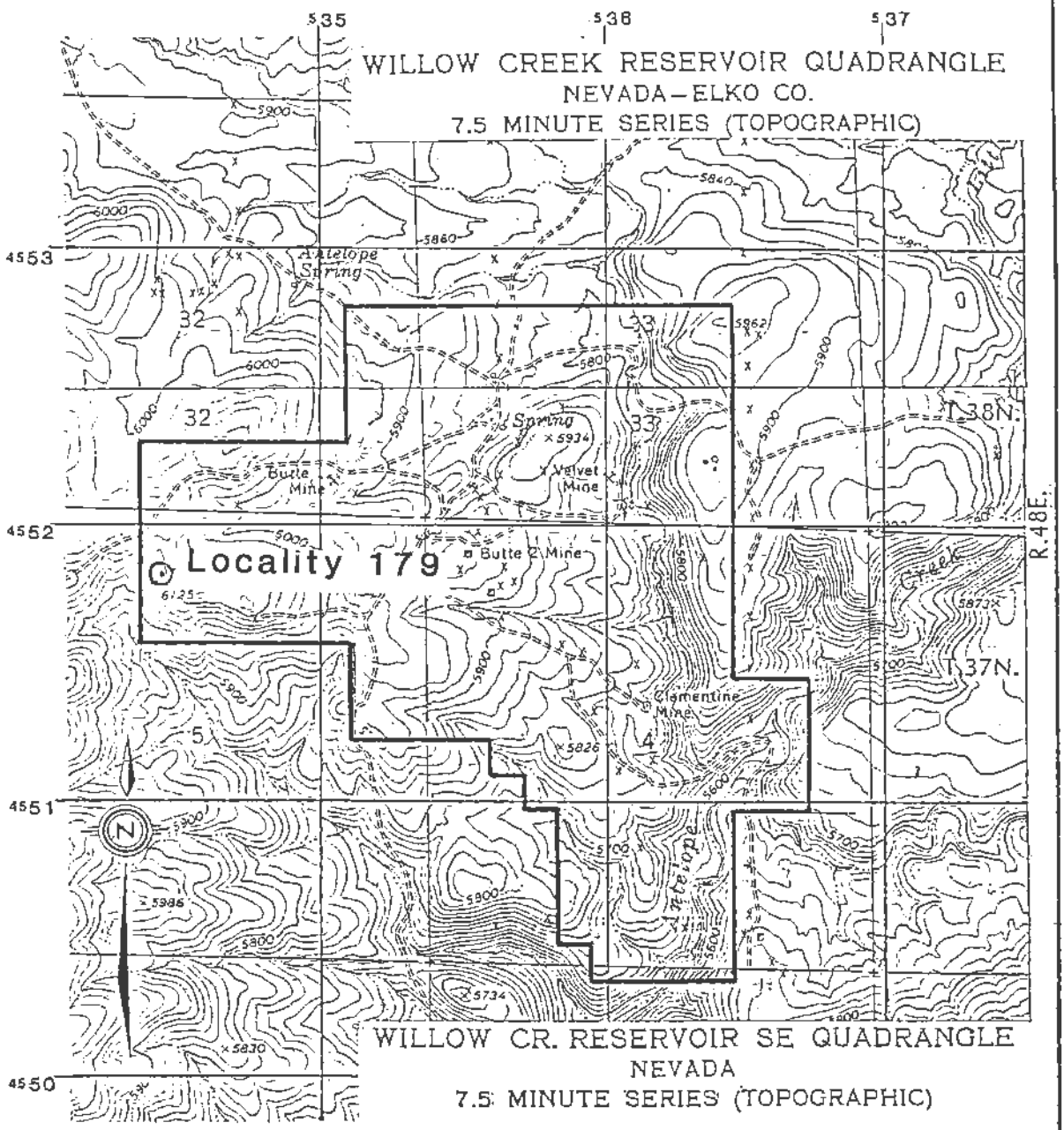
Topographic Data: West edge of small saddle, overlooking moderately steep (20%) slope.

Quarry Data: No on-site source.

Description: Small reduction station comprised of about 100 white and red opalite flakes (feature 12-1).

Site Condition: Pristine.

Remarks: See similar stations at localities 178, 180, 181.



INTERMOUNTAIN RESEARCH PROJECT 611

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September 1987

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 180 Type: Reduction Station Complex

UTM: 534520E/4551640N

Size: 40m NS / 25m EW Max. Area (m^2): 1,000

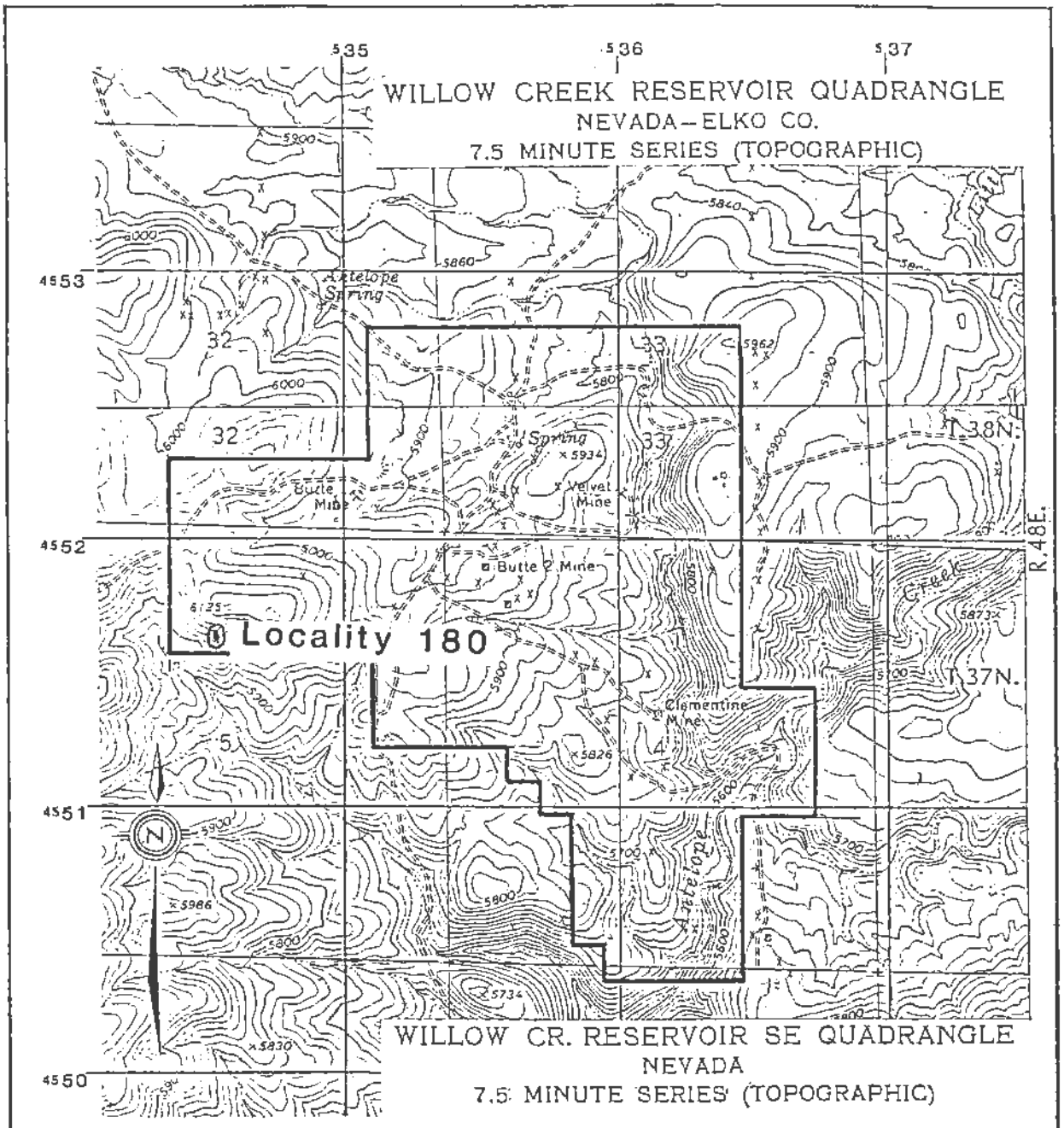
Topographic Data: Top of small ridge protrusion on strongly sloping (10%), south-facing ridge slope.

Quarry Data: No on-site source.

Description: Series of discrete reduction stations, each with ca. 500 white opalite flakes and 2 obsidian flakes; located in red soil zone outside opalite quarry zone (feature 14-1).

Site Condition: Pristine.

Remarks: See similar reduction stations at localities 178, 179, 181; the presence of a few obsidian flakes in each scatter is interesting.



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SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 181 Type: Small Reduction Station

UTM: 534540E/4551770N

Size: 10m x 2m Max. Area (m^2): 20

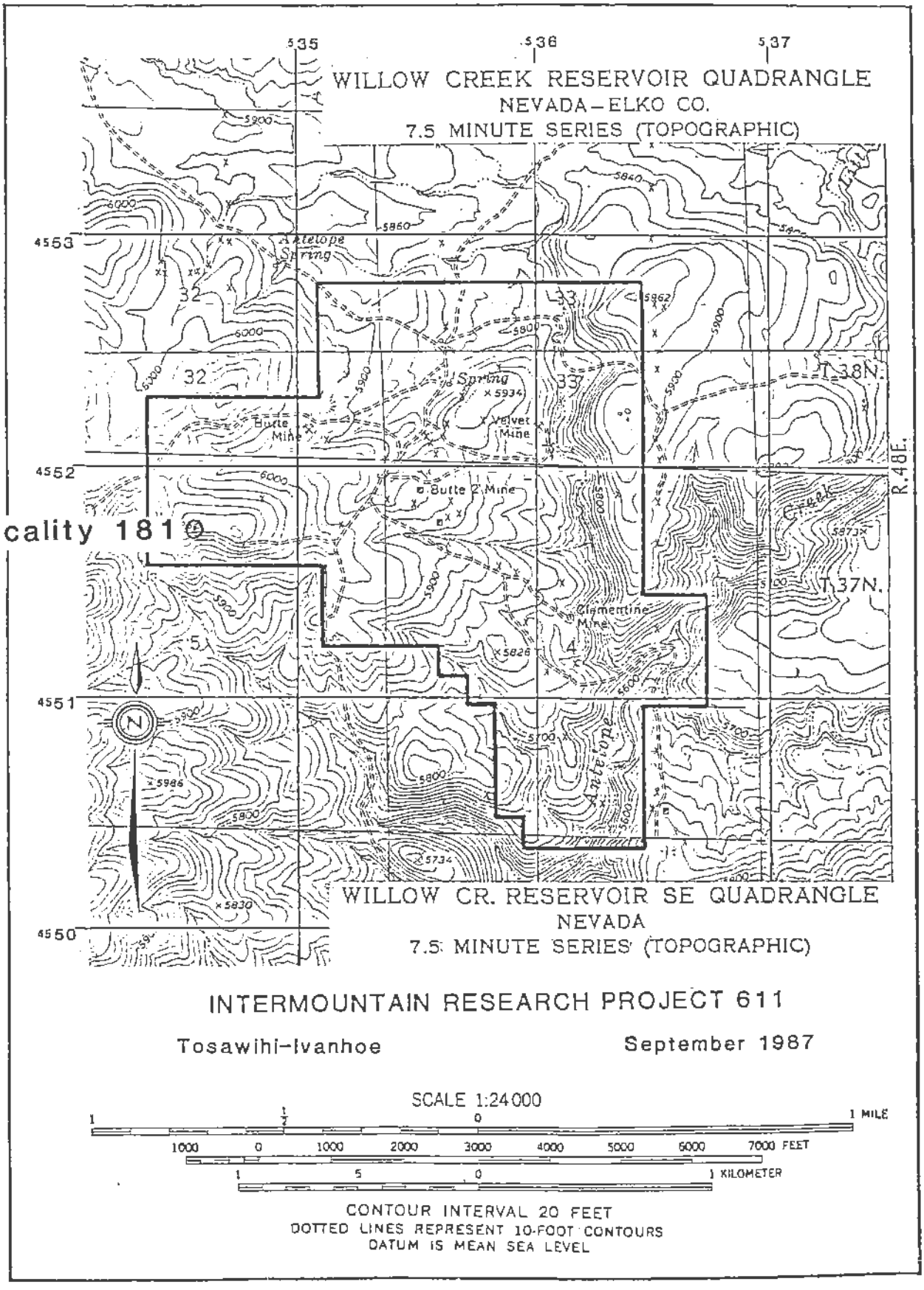
Topographic Data: Along south edge of nonsilicified bedrock outcrop at top of ridge.

Quarry Data: No on-site opalite source.

Description: Small flaking station (feature 15-2) comprised of a light density of large secondary and biface thinning flakes.

Site Condition: Pristine.

Remarks: See reduction stations at localities 178-180.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 182 Type: Outcrop Quarry Complex

UTM: 534660E/4551840N

Size: 15m NS/ 60m EW Max. Area (m^2): 900

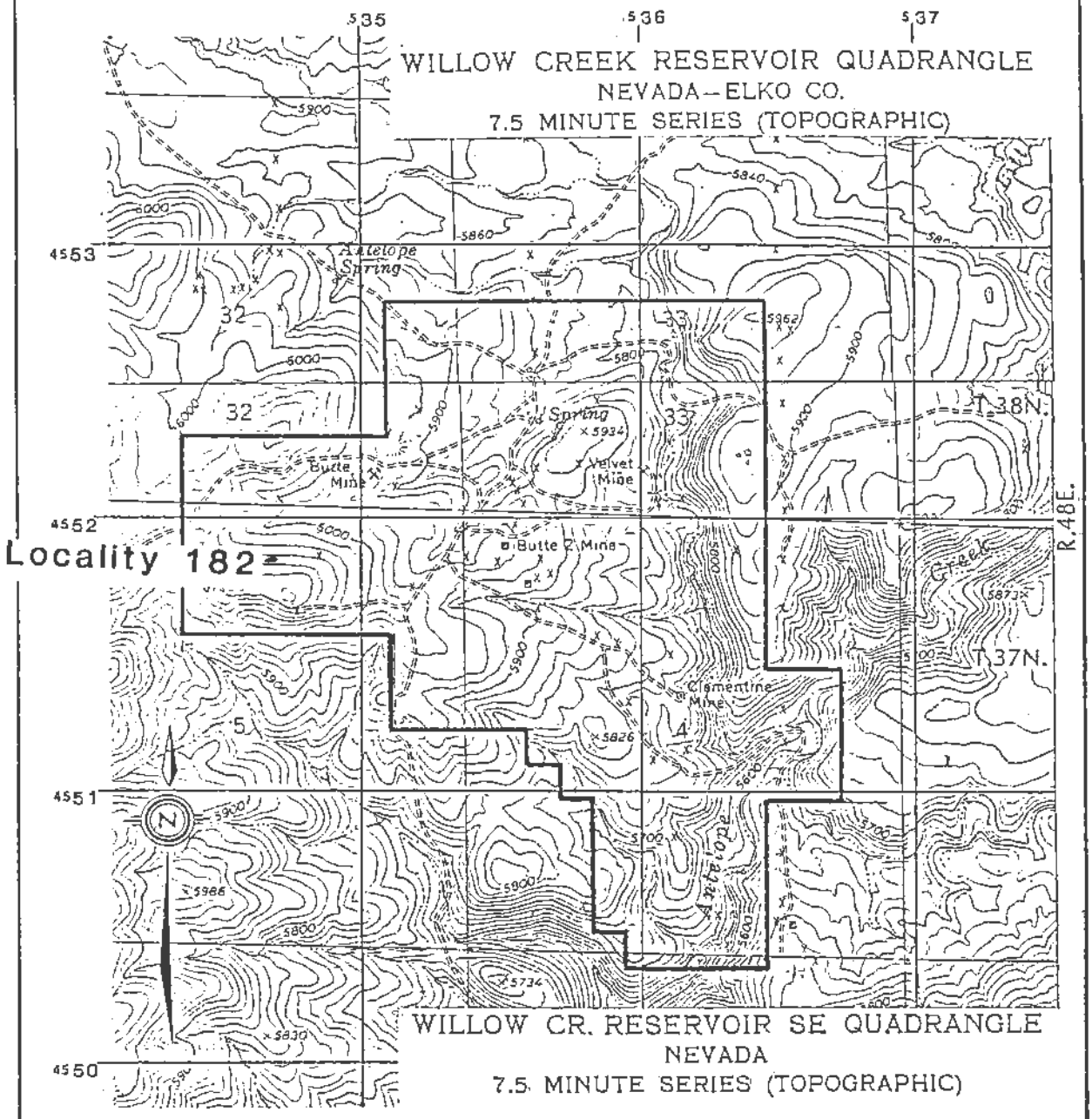
Topographic Data: Low bedrock ledge outcrop on moderately steep (16%), north-facing ridge slope.

Quarry Data: Exposed bedrock is fractured and weathered and appears to be generally low to mediocre quality; cores and flakes suggest some higher quality toolstone was also available.

Description: Small outcrop quarry with several small pits excavated into the base of the outcrop (feature 18-1). A dense scatter of reduction flakes, cores, and nodules is located along the edge of the quarried bedrock feature.

Site Condition: Undisturbed.

Remarks:



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 183 Type: Small Reduction Station/ Soil Mound

UTM: 534720E/4551860N

Size: 3m x 2m Max. Area (m^2): 6

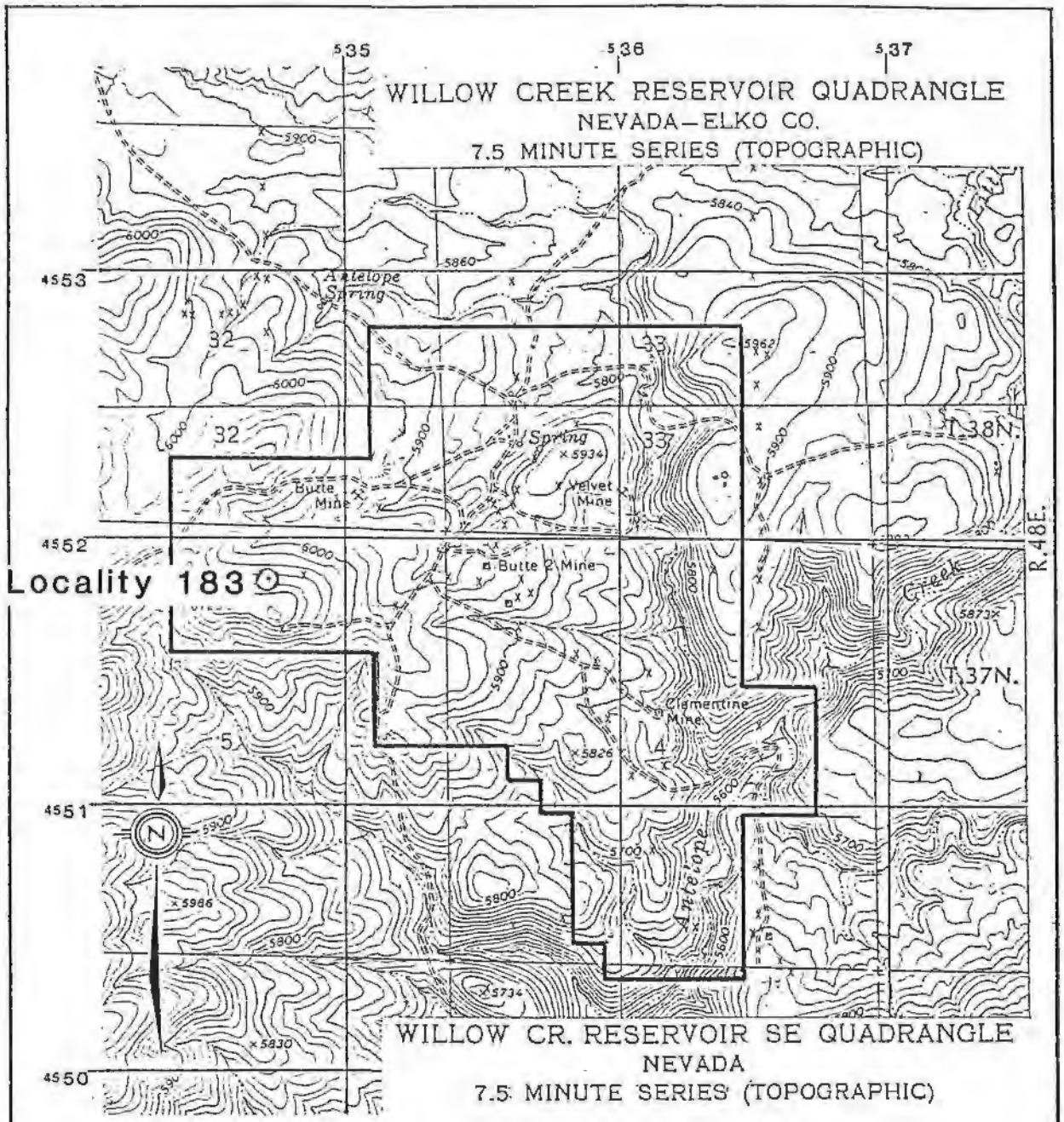
Topographic Data: On moderately steep (16%), north-facing ridge slope.

Quarry Data: No on-site opalite source.

Description: Small flaking station comprised of about 200 white secondary and biface thinning flakes (feature 20-1); associated with grassy mound indicating deeper soils.

Site Condition: Undisturbed.

Remarks: Relationship (if any) to enigmatic grassy mound is unclear.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 184 Type: Small Reduction Station

UTM: 534740E/4551100N

Size: 1.5m x 2.5m Max. Area (m^2): 4

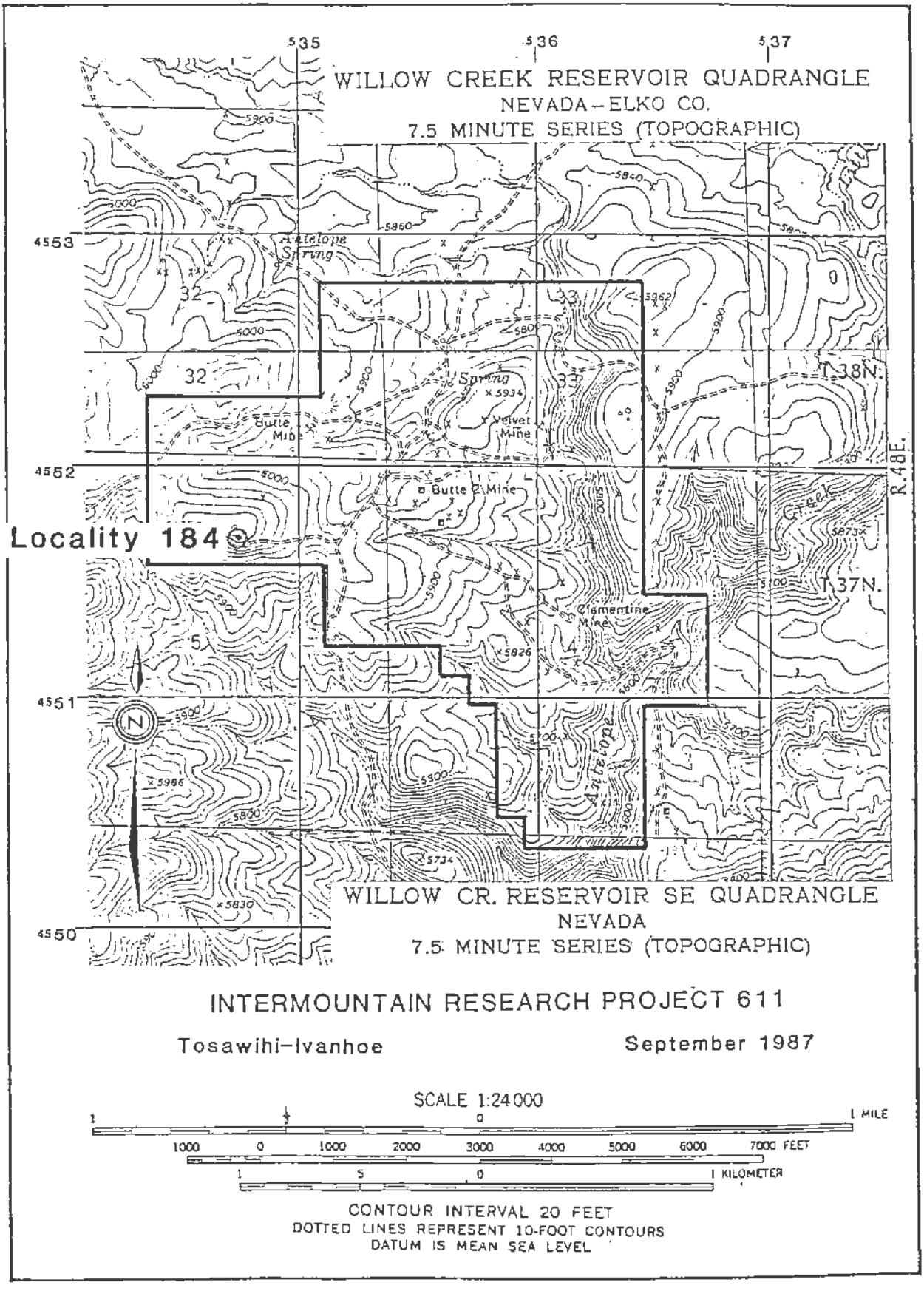
Topographic Data: Located along unsilicified bedrock outcrop at summit of ridge, facing south.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 21-2) comprised of about 60 white opalite secondary flakes (but no tools or bifaces), and a few obsidian flakes.

Site Condition: Undisturbed.

Remarks: One of several localities extending along bedrock ridge crest (cf. localities 185-187); similar unrecorded features may be located between survey transects.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 S 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 185 Type: Small Reduction Station

UTM: 534780E/4551680N

Size: 2m x 5m Max. Area (m^2): 10

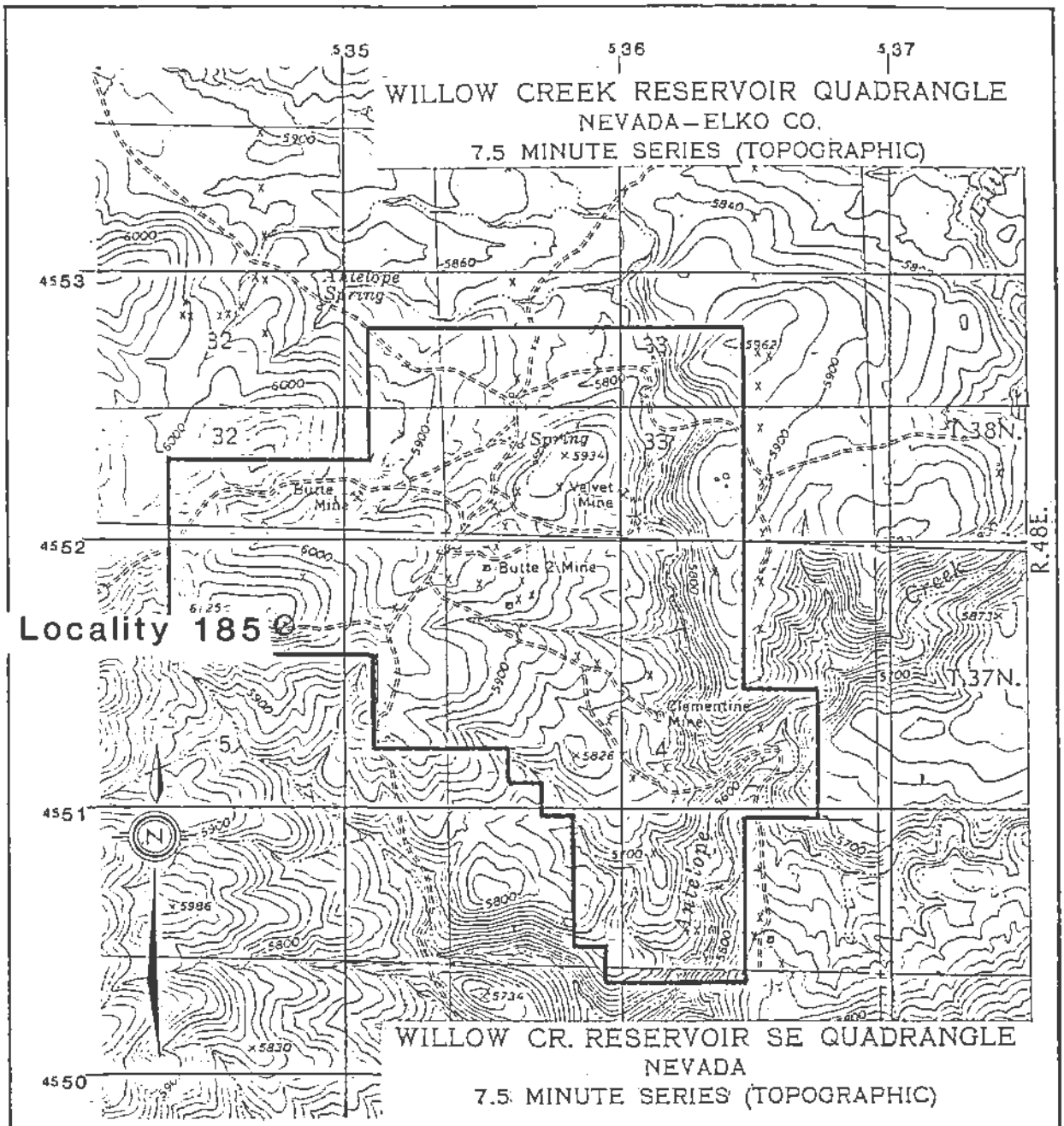
Topographic Data: Located along unsilicified bedrock outcrop at summit of ridge, facing south.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 22-7) comprised of about 500 small flakes and shatter and two core fragments; all of white opalite.

Site Condition: Undisturbed.

Remarks: One of several localities extending along bedrock ridge crest (cf. localities 184-187); similar unrecorded features may be located between survey transects.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 186 Type: Small Reduction Station

UTM: 534780E/4551720N

Size: 1m x 1m Max. Area (m^2): 1

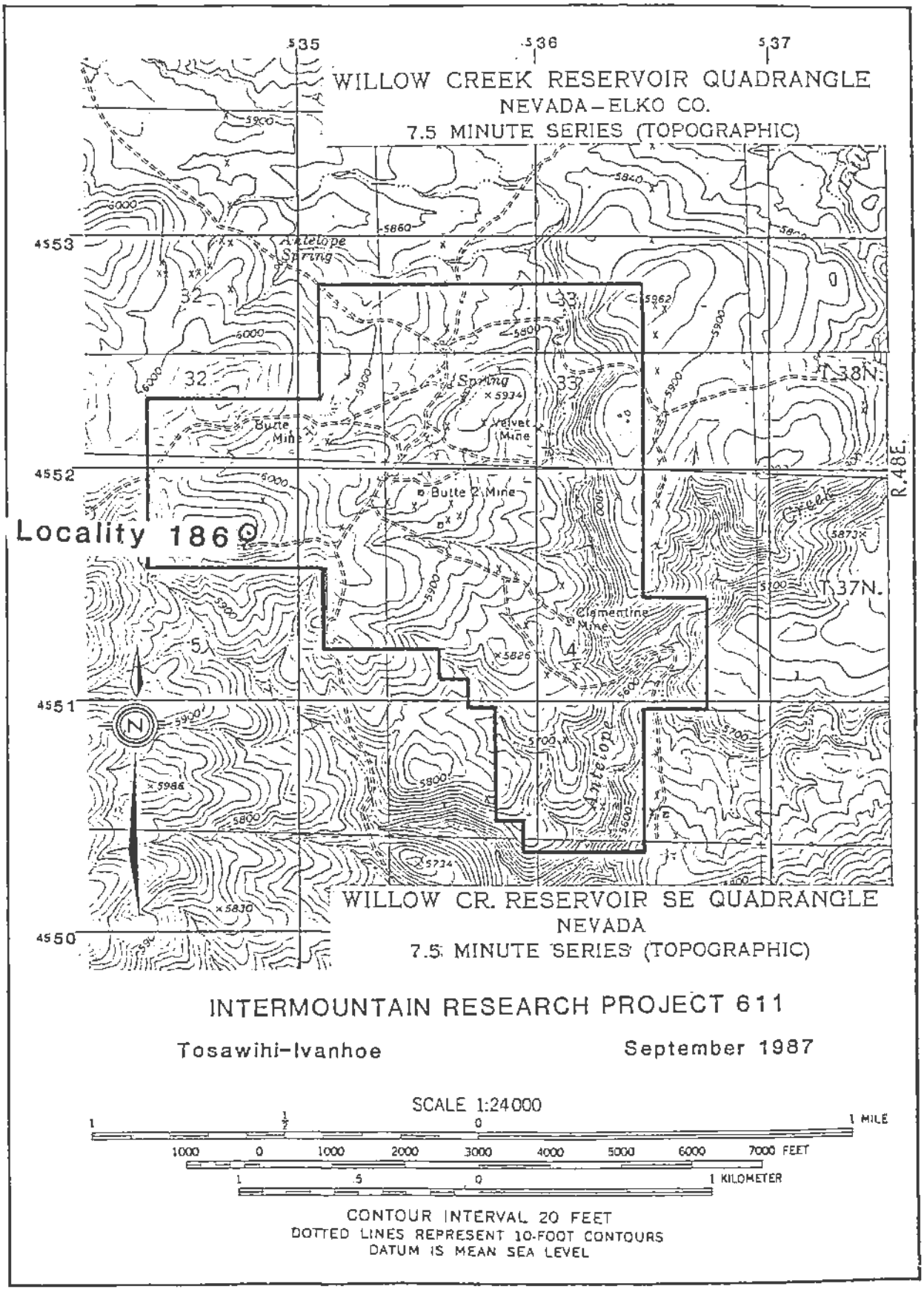
Topographic Data: Located along unsilicified bedrock outcrop at summit of ridge, facing south.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 23-5) comprised of fewer than 100 biface thinning flakes of white-grey opalite.

Site Condition: Undisturbed.

Remarks: One of several localities extending along bedrock ridge crest (cf. localities 184-187); similar unrecorded features may be located between survey transects.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 187 Type: Small Reduction Station

UTM: 534820E/4551780N

Size: 2m x 2m Max. Area (m^2): 4

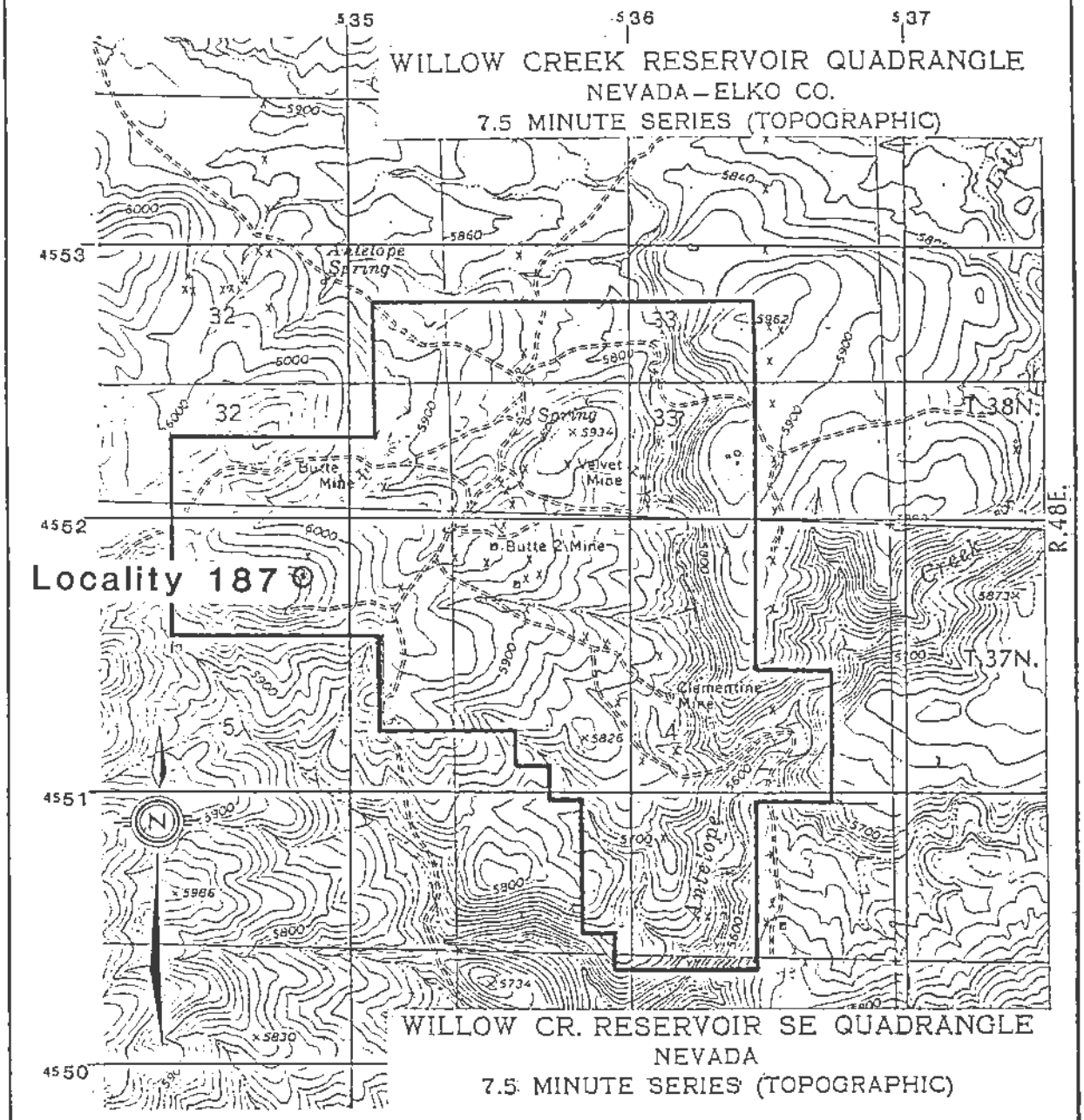
Topographic Data: Located along unsilicified bedrock outcrop at summit of ridge, facing south.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 24-4) comprised of about 200 white and yellow opalite flakes; both large and small, secondary and biface thinning flakes.

Site Condition: Undisturbed.

Remarks: One of several localities extending along bedrock ridge crest (cf. localities 184-187); similar unrecorded features may be located between survey transects.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 188 Type: Large Quarry Pit Complex

UTM: 535120E/4551860N

Size: 150m NS/ 460m EW Max. Area (m^2): 69,000

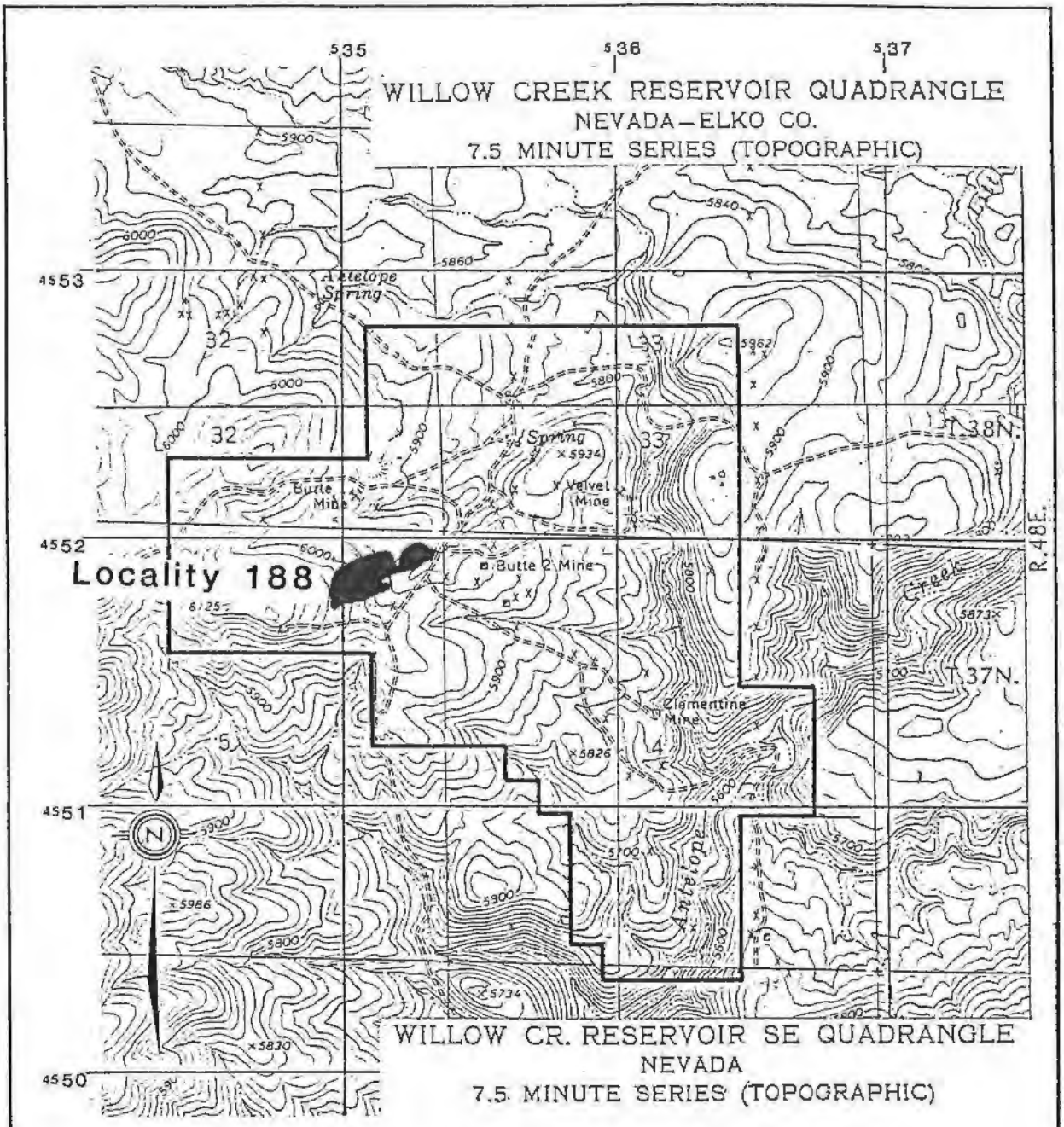
Topographic Data: Located on the axis (bedrock-controlled) of a ridge slope, strongly sloping (11%), across south edge of saddle at base of ridge, and extending along moderately sloping (7%) south edge of adjacent knob.

Quarry Data: Some of the highest quality toolstone in the Tosawihi Quarry District was obtained from this locality; several different colors are present, but a translucent butterscotch to opaque yellow is the most distinctive (and apparently widespread) type; white opalite is also common. Opalite occurs as surface talus along ridge axis, as well as in occasional low bedrock exposures, but cobbles in colluvium were the most commonly quarried source of toolstone.

Description: Large intensively used quarry pit complex with at least 40 pits and/or pit complexes identified. At the upper west end of the locality, a series of shallow pits along a low bedrock ledge seem to be older features (based on the extent of vegetative cover in pits and the rounded contours of pits) (see features 26-2, 26-3, 26-4). The distinctive butterscotch and yellow pits, on the other hand, are located somewhat lower on the slope (cf. features 30-4 to 30-11). Several more finished bifaces, with incipient hafting elements, were also noted (see feature 26-5 and collected specimen 30-5a-12). Large numbers of modified basalt cobble tools, of all sizes, are present in this locality. Here, basalt cobbles were also reduced to manufacture small flake or core tools (cf. 30-11). Features recorded in Locality 188 include 25-1, 26-2, 26-3, 26-4, 26-5, 27-4, 27-5, 27-6, 28-1, 28-2, 28-3, 28-4, 29-3, 29-4, 30-4, 30-5, 30-6, 30-7, 30-8, 30-9, 30-10, 30-11, 31-2, 31-3, 31-4, 32-8, 33-4, 35-6, 37-7, 38-7, 39-4, 39-5, and 39-6.

Site Condition: A road cuts along the north edge of site and some slight historic exploration, but in the main pristine.

Remarks: This is one of most significant localities in the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 189 Type: Small Reduction Station

UTM: 534860E/4551740N

Size: 15m NS/6m EW Max. Area (m^2): 90

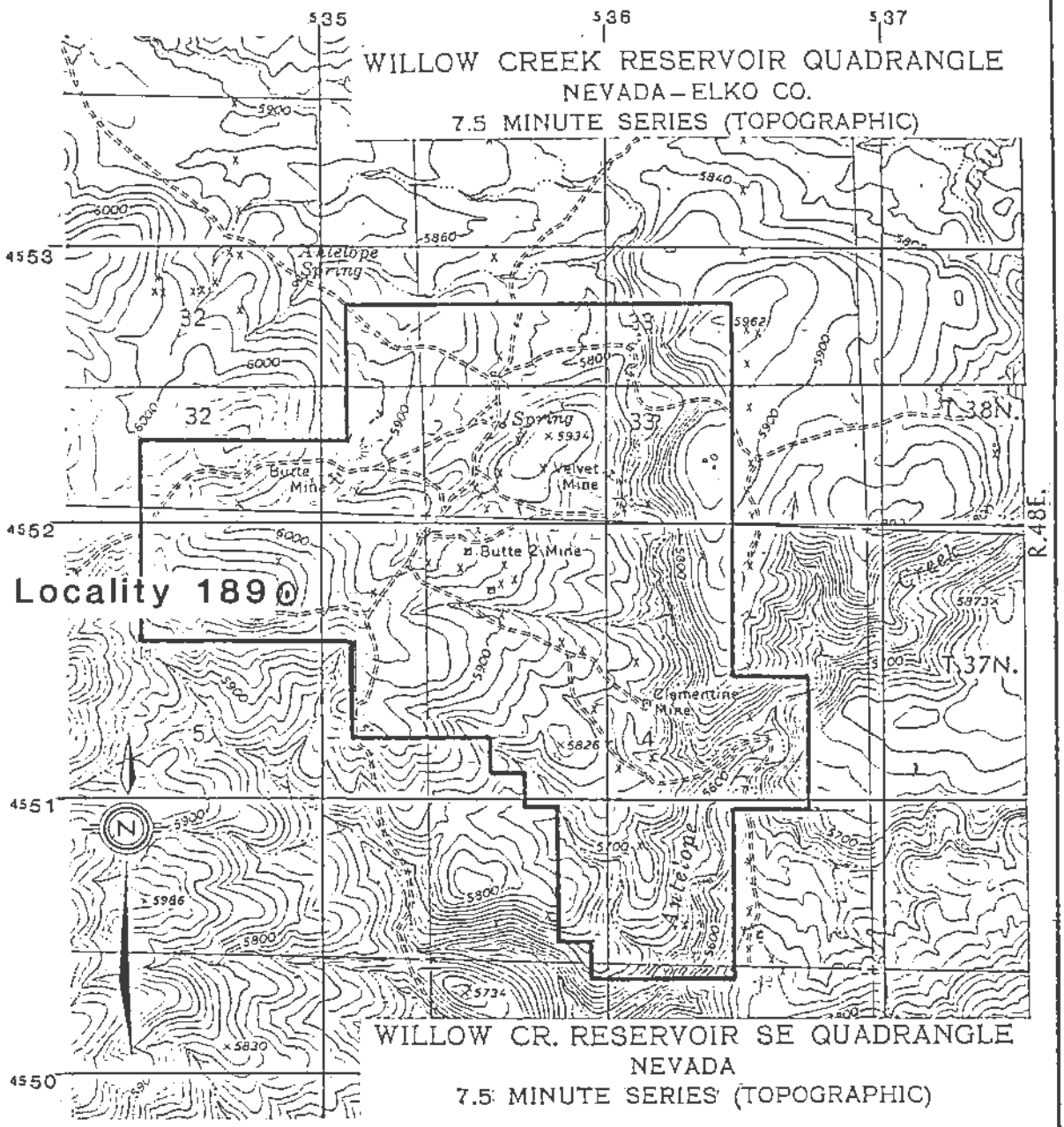
Topographic Data: Edge of nonsilicified bedrock outcrop overlooking moderately steep (16%), east-facing ridge slope.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 26-1) comprised of ca. 300 white opalite secondary and biface thinning flakes.

Site Condition: Pristine.

Remarks: Two nearby reduction stations (localities 190-191) are located along same outcrop feature; several similar reduction stations were recorded along the outcrop at ridge summit (cf. localities 184-187).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 190 Type: Small Reduction Station

UTM: 534920E/4551720N

Size: 15m x 20m Max. Area (m^2): 300

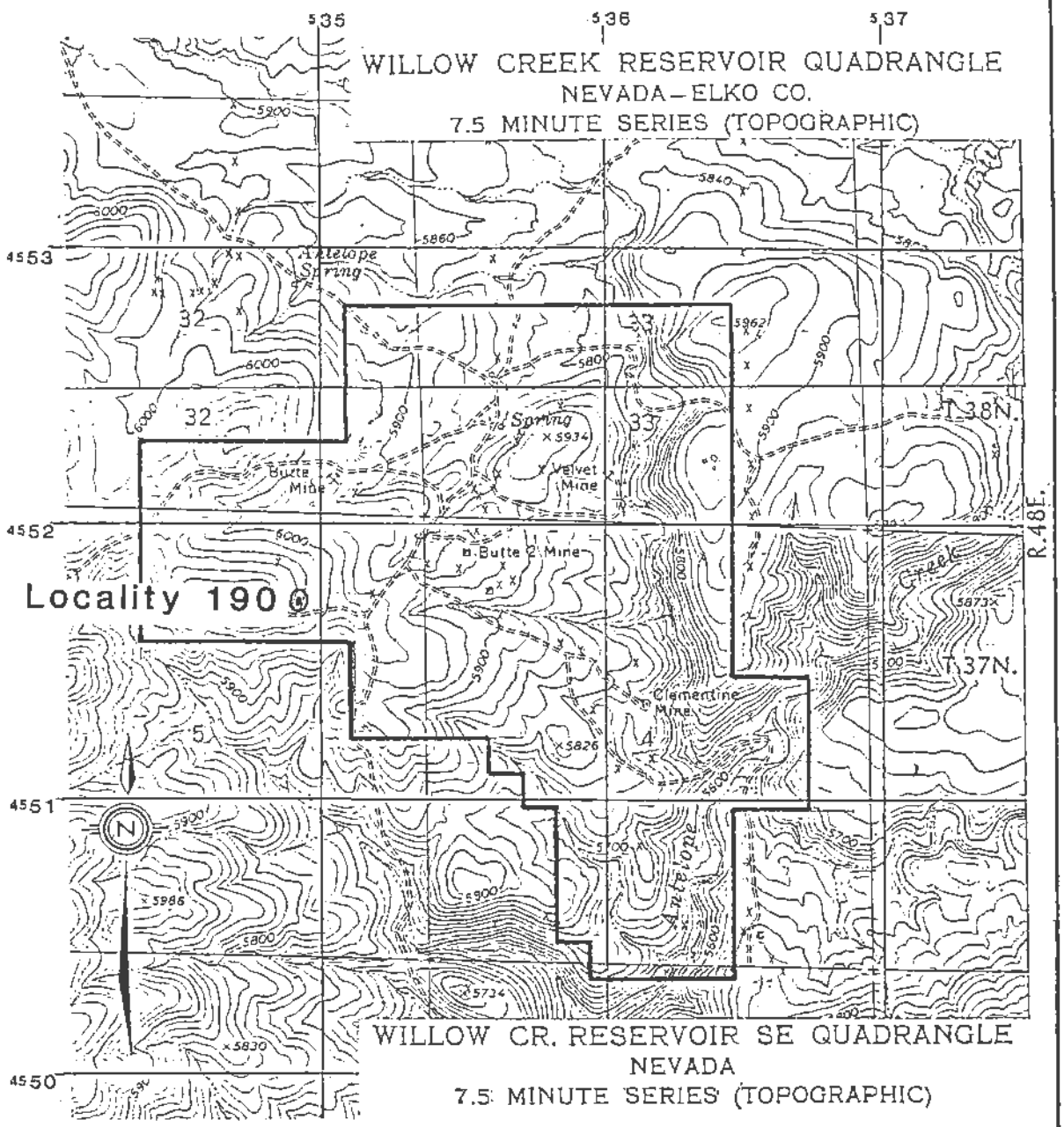
Topographic Data: Edge of nonsilicified bedrock outcrop overlooking moderately steep (16%), southeast-facing ridge slope.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 27-2) comprised of a light density of large white opalite flakes.

Site Condition: Pristine.

Remarks: Two nearby reduction stations (localities 189, 191) are located along same outcrop feature; several similar reduction stations were recorded along the outcrop at ridge summit (cf. localities 184-187).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 191 Type: Small Reduction Station

UTM: 534900E/4551780N

Size: 5m x 5m Max. Area (m^2): 25

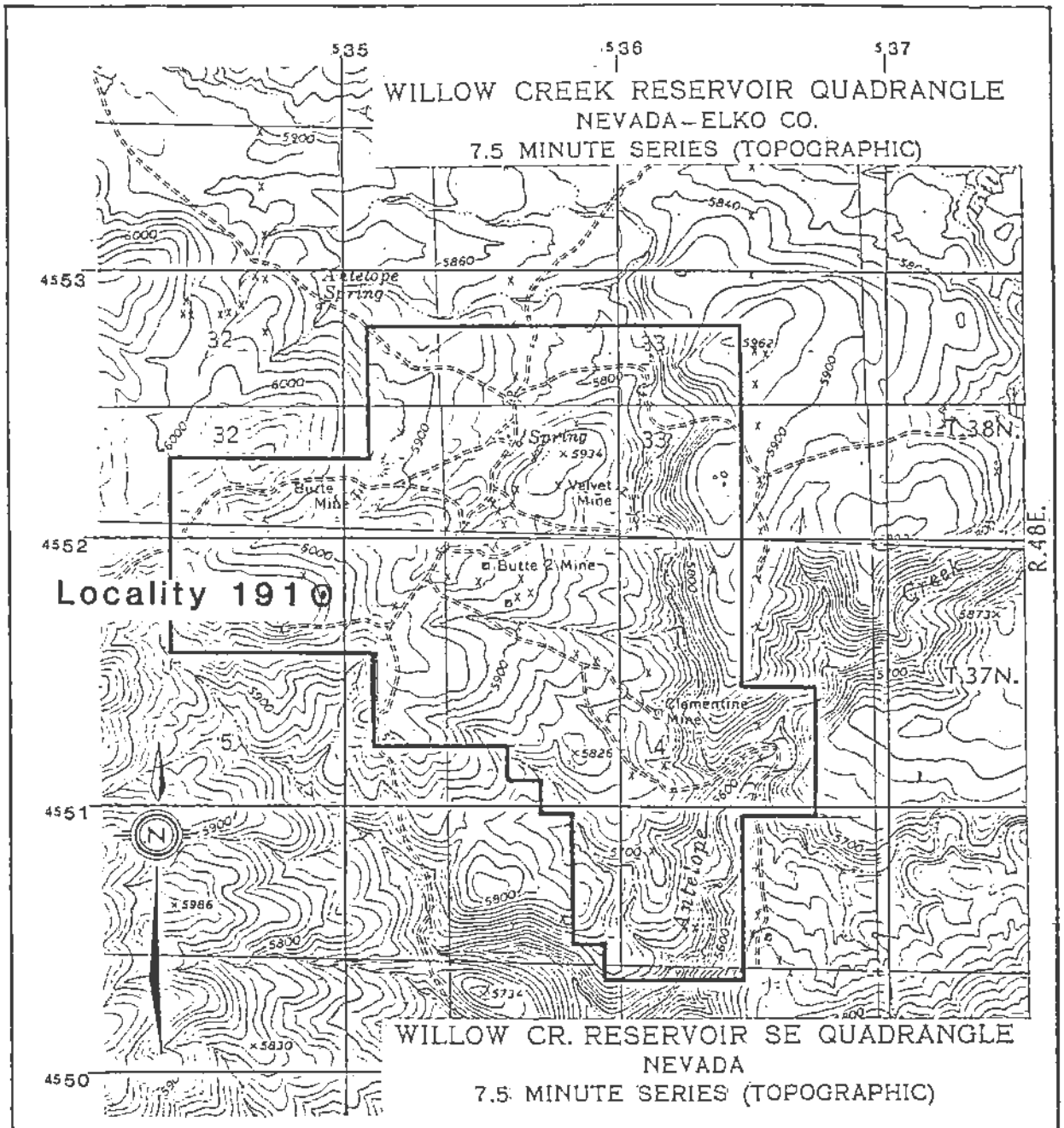
Topographic Data: Edge of nonsilicified bedrock outcrop overlooking moderately steep (16%), east-facing ridge slope.

Quarry Data: No on-site opalite source.

Description: Small reduction station (feature 27-3) comprised of a contained, moderate density of large white opalite flakes.

Site Condition: Pristine.

Remarks: Two nearby reduction stations (localities 189, 190) are located along same outcrop feature; several similar reduction stations were recorded along the outcrop at ridge summit (cf. localities 184-187).



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 192 Type: Isolated Quarry Pit

UTM: 534980E/4551740N

Size: pit=4.5m x 4.5m (x 20cm deep) Max. Area (m^2): 50

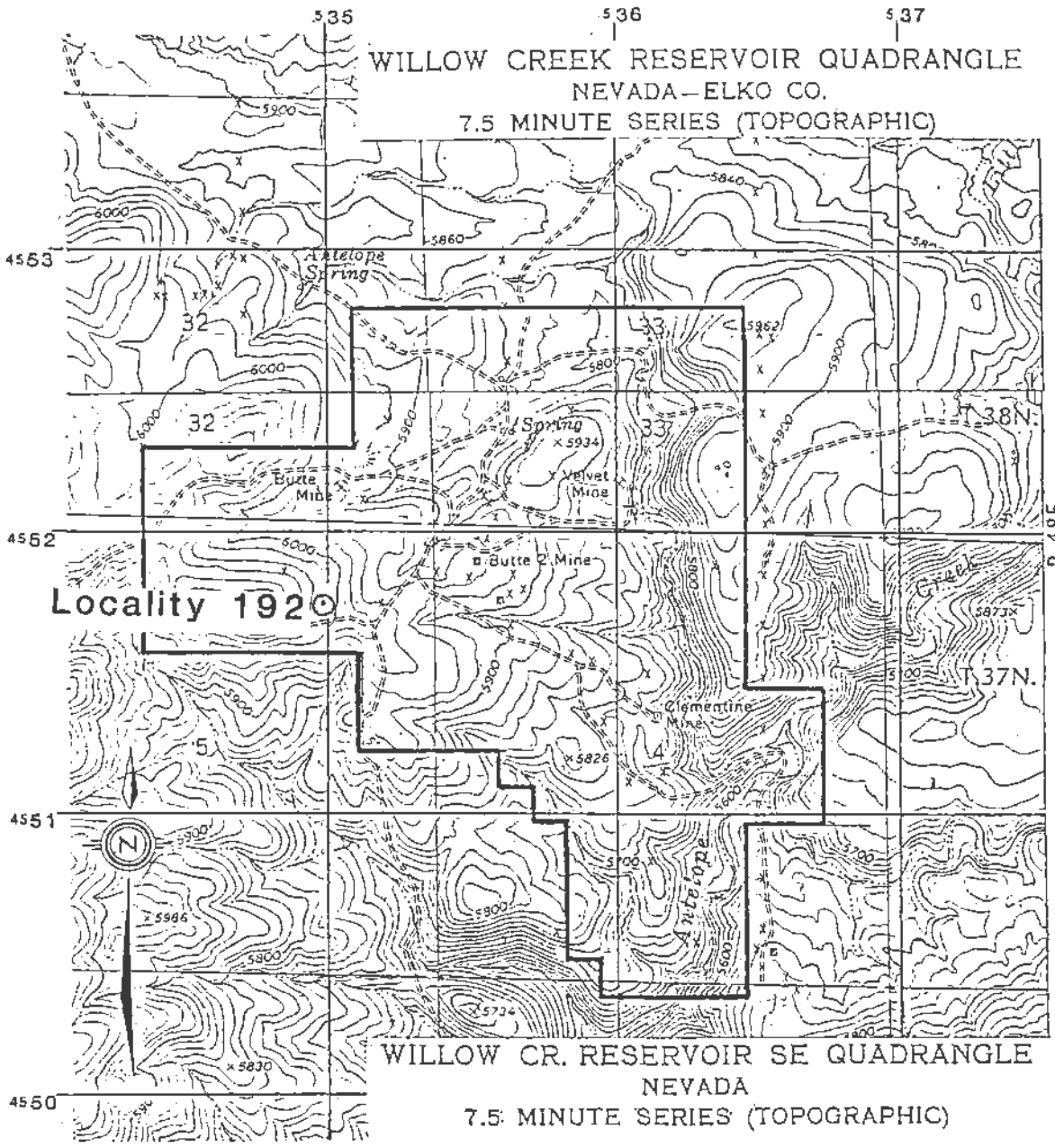
Topographic Data: Moderately steep (16%), east-facing ridge slope.

Quarry Data: Transluscent material; source not indicated.

Description: Isolated quarry pit with moderate density of primary debitage, biface thinning flakes, and a few bifaces (feature 29-5).

Site Condition: No apparent disturbance.

Remarks: Needs further field assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Butterscotch Ridge

Locality No.: 193 Type: Small Cobble-Assay Station

UTM: 535000E/4551740N

Size: pit= 10m NS/ 30m EW Max. Area (m^2): 300

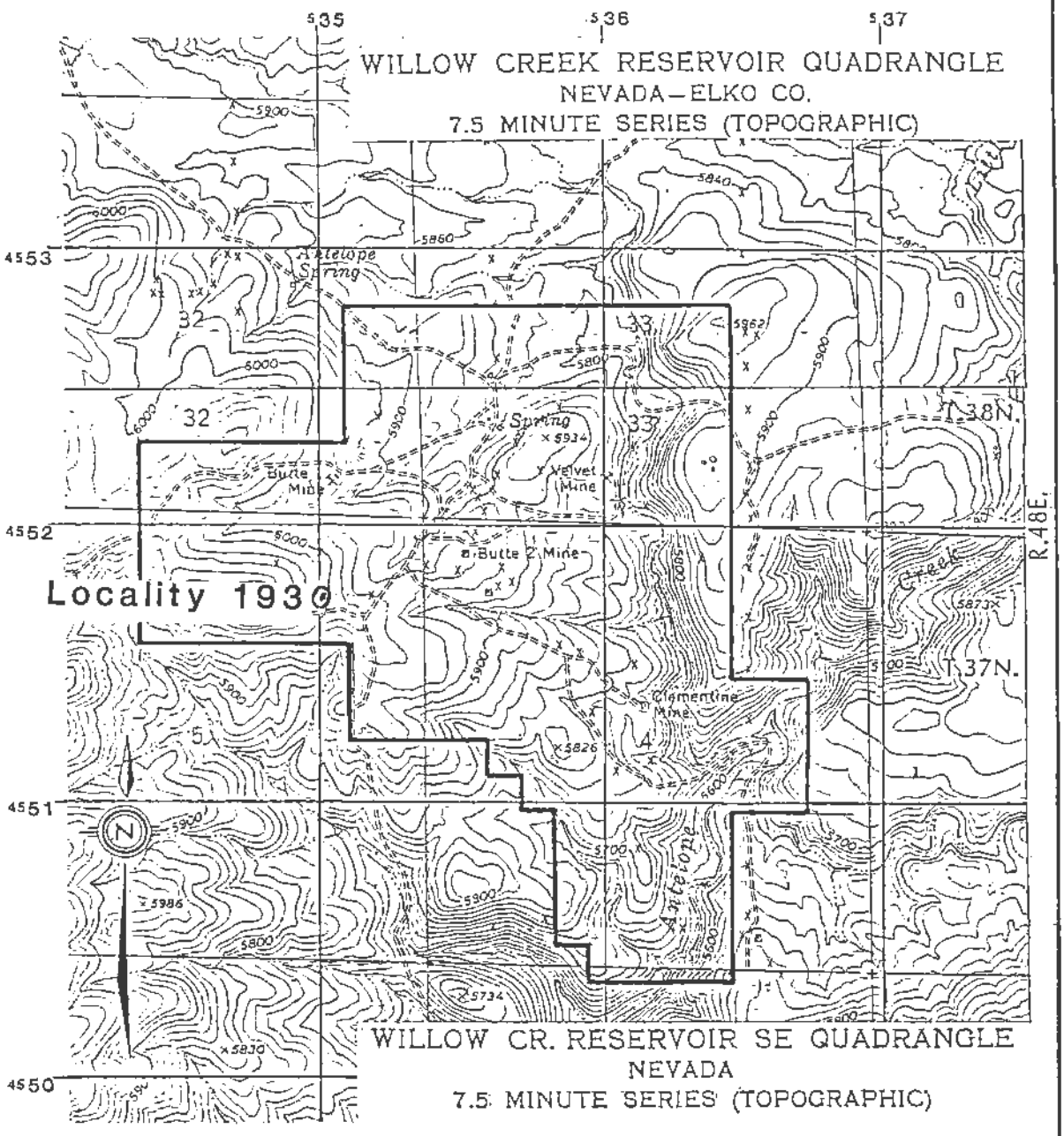
Topographic Data: Strongly sloping (13%), east-facing ridge slope.

Quarry Data: Cobbles on surface are poor quality toolstone.

Description: Small cobble-assay quarry (feature 30-12) with shatter and irregular cobbles as the most common reduction items.

Site Condition: No apparent disturbance.

Remarks: Seems to reflect assay and initial exploration rather than toolstone reduction per se.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Tosawihi Ridge

Locality No.: 194 Type: Small Reduction Station

UTM: 535260E/4551720N

Size: 2m x 2m Max. Area (m^2): 4

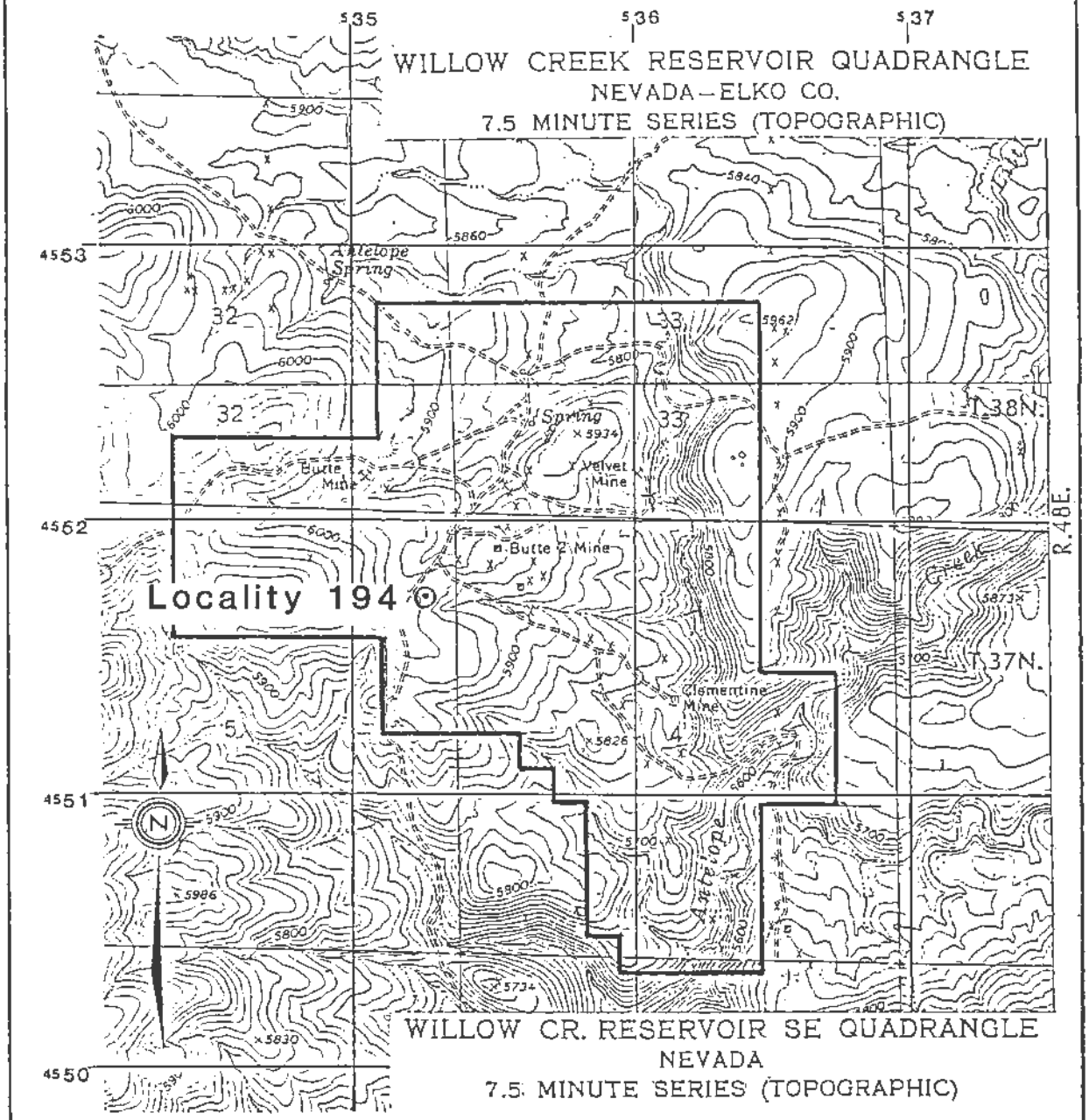
Topographic Data: Edge of saddle along northeast-trending ridge top.

Quarry Data: No on-site source.

Description: Small reduction station (feature 38-8) comprised of ca. 100 secondary flakes.

Site Condition: Pristine.

Remarks: Similar to nearby reduction stations at Localities 195 and 196.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Tosawihi Ridge

Locality No.: 195 Type: Small Reduction Station

UTM: 535260E/4551620N

Size: 3m x 3m Max. Area (m^2): 9

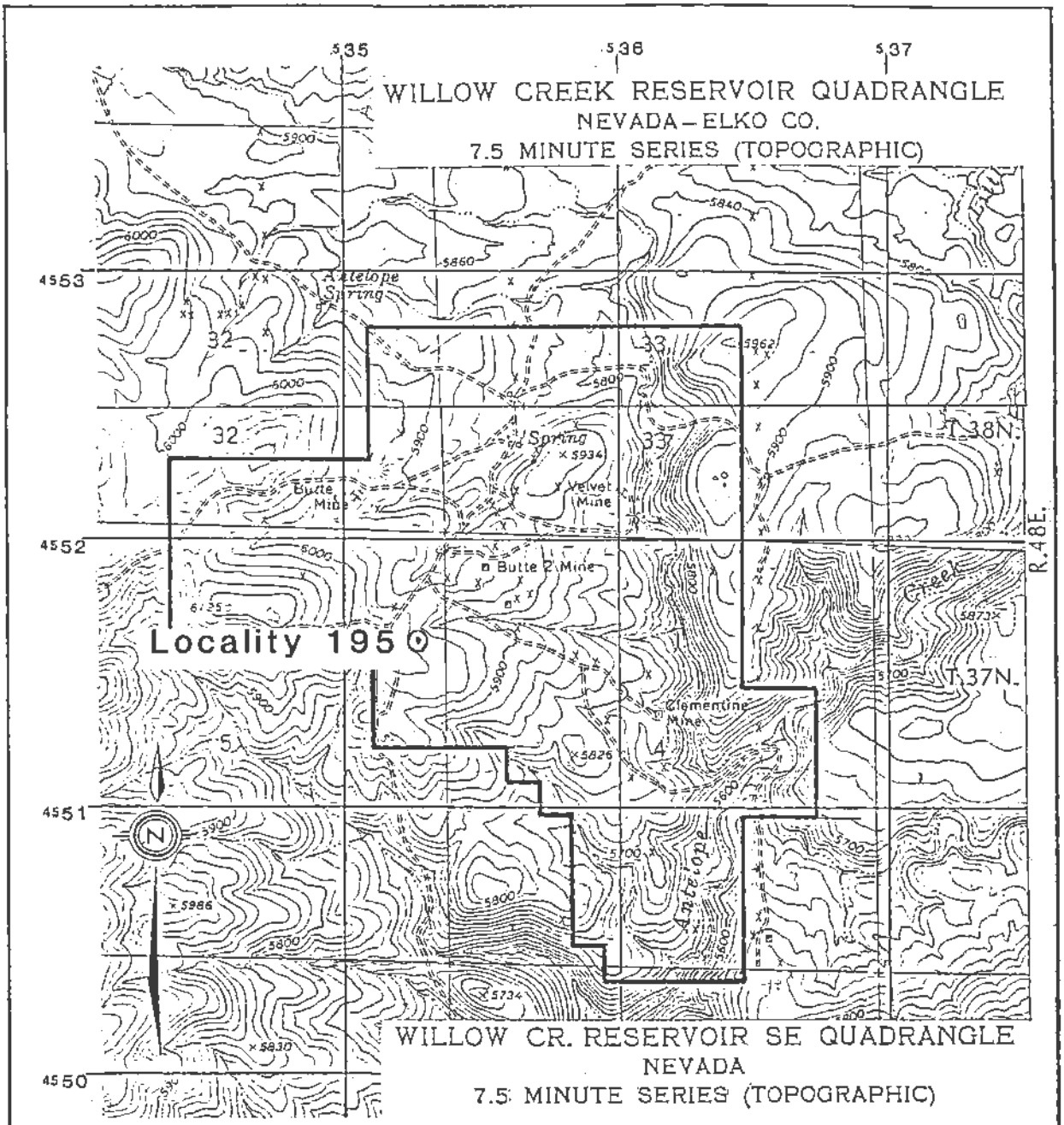
Topographic Data: Bench along ridge top, extreme edge of saddle along northeast-trending ridge top.

Quarry Data: No on-site source.

Description: Small reduction station (feature 38-9) comprised of 1 broken biface and ca. 200 secondary and biface thinning flakes.

Site Condition: Pristine.

Remarks: Similar to nearby reduction stations at Localities 194 and 196.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 196 Type: Small Reduction Station

UTM: 535360E/4551620N

Size: 2m x 0.5m Max. Area (m^2): 1

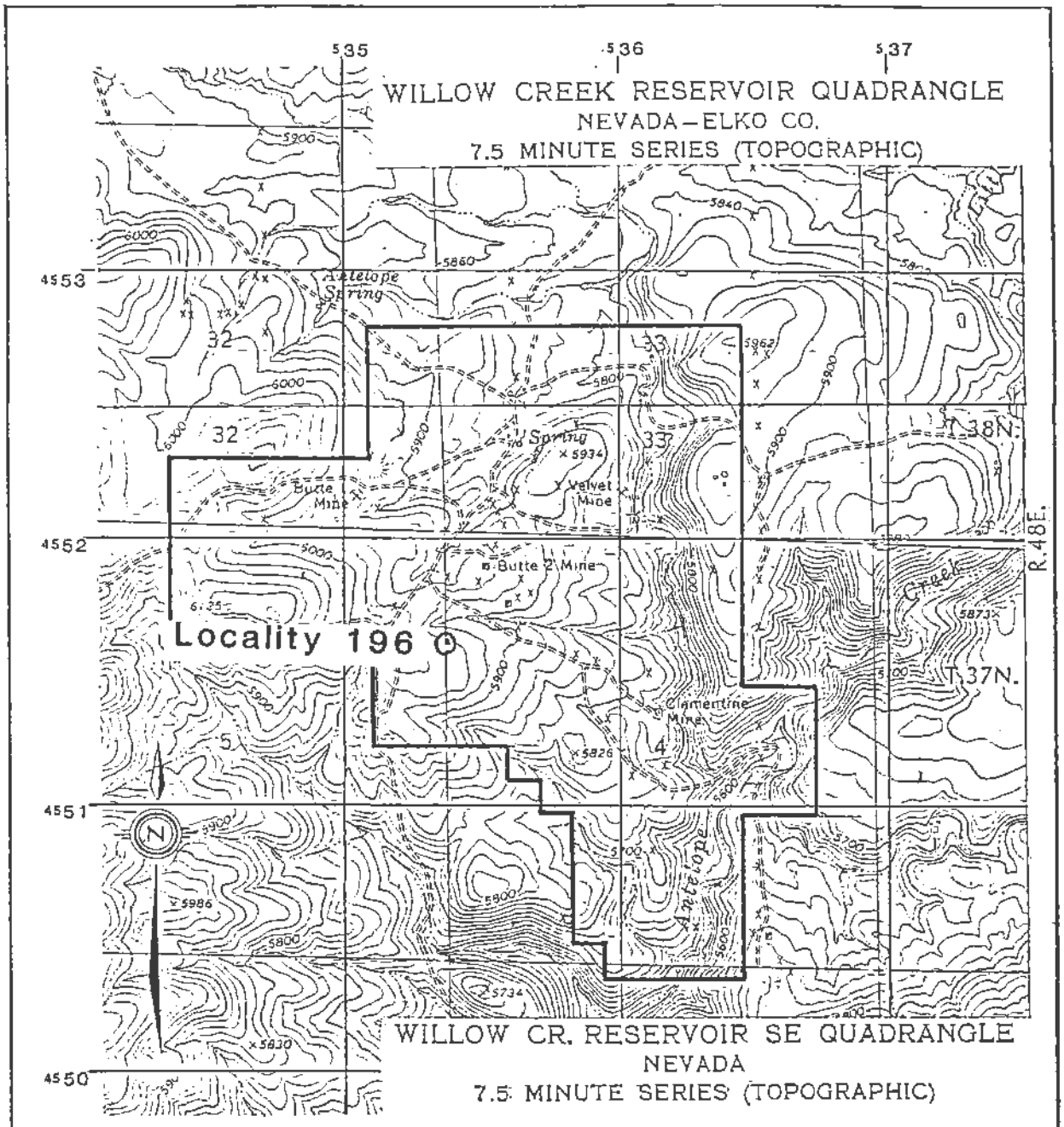
Topographic Data: Small flat on strongly sloping (10%), northeast-facing ridge.

Quarry Data: No on-site source.

Description: Small reduction station (feature 40-5) comprised of ca. 100 large flakes and 1 biface fragment.

Site Condition: Pristine.

Remarks: Similar to nearby reduction stations at Localities 194 and 195.



INTERMOUNTAIN RESEARCH PROJECT 611

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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 197 Type: Bedrock Outcrop Quarry/ Elongated Pit Feature

UTM: 535360E/4551580N

Size: pit=15m x 8m (xlm deep) Max. Area (m^2): 450

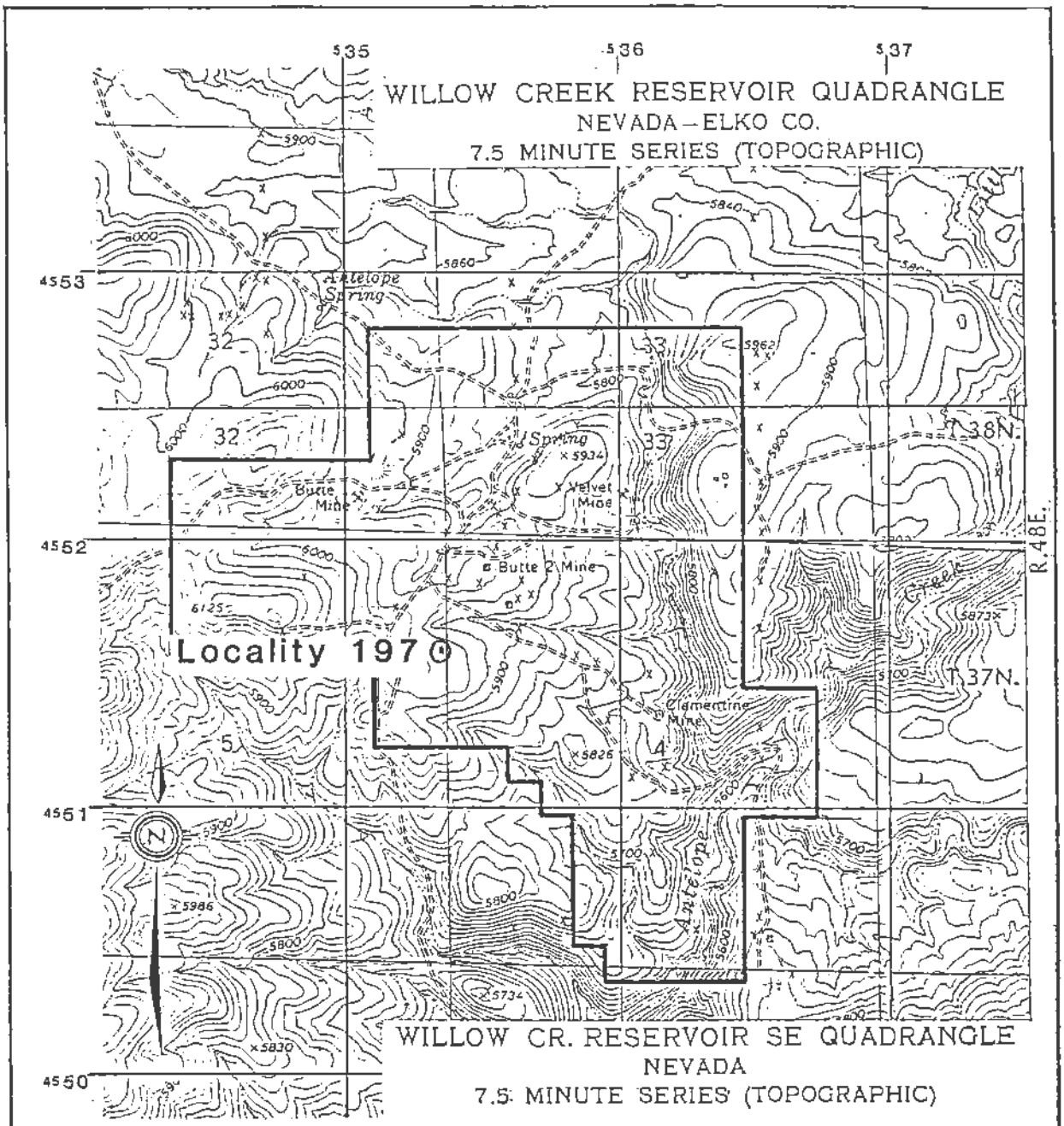
Topographic Data: Low bedrock outcrop along edge of ridge, northeast-facing, strongly sloping (10%).

Quarry Data: Variable quality outcrop; tan to light grey.

Description: Quarry is characterized by an elongated pit feature excavated into the base of a low bedrock outcrop (feature 39-8); a moderate to high density of reduction materials are associated with the pit and along its downslope berm.

Site Condition: Apparently undisturbed.

Remarks: Is located in a moderate density scatter extending to the south and east around the perimeter of Locality 44; segregated localities 197-205 may be feature components in related cluster. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 198

Type: Isolated Quarry Pit/ Cobble Field

UTM: 535320 E/4551440N

Size: pit=6m x 0.5m

Max. Area (m^2): 25

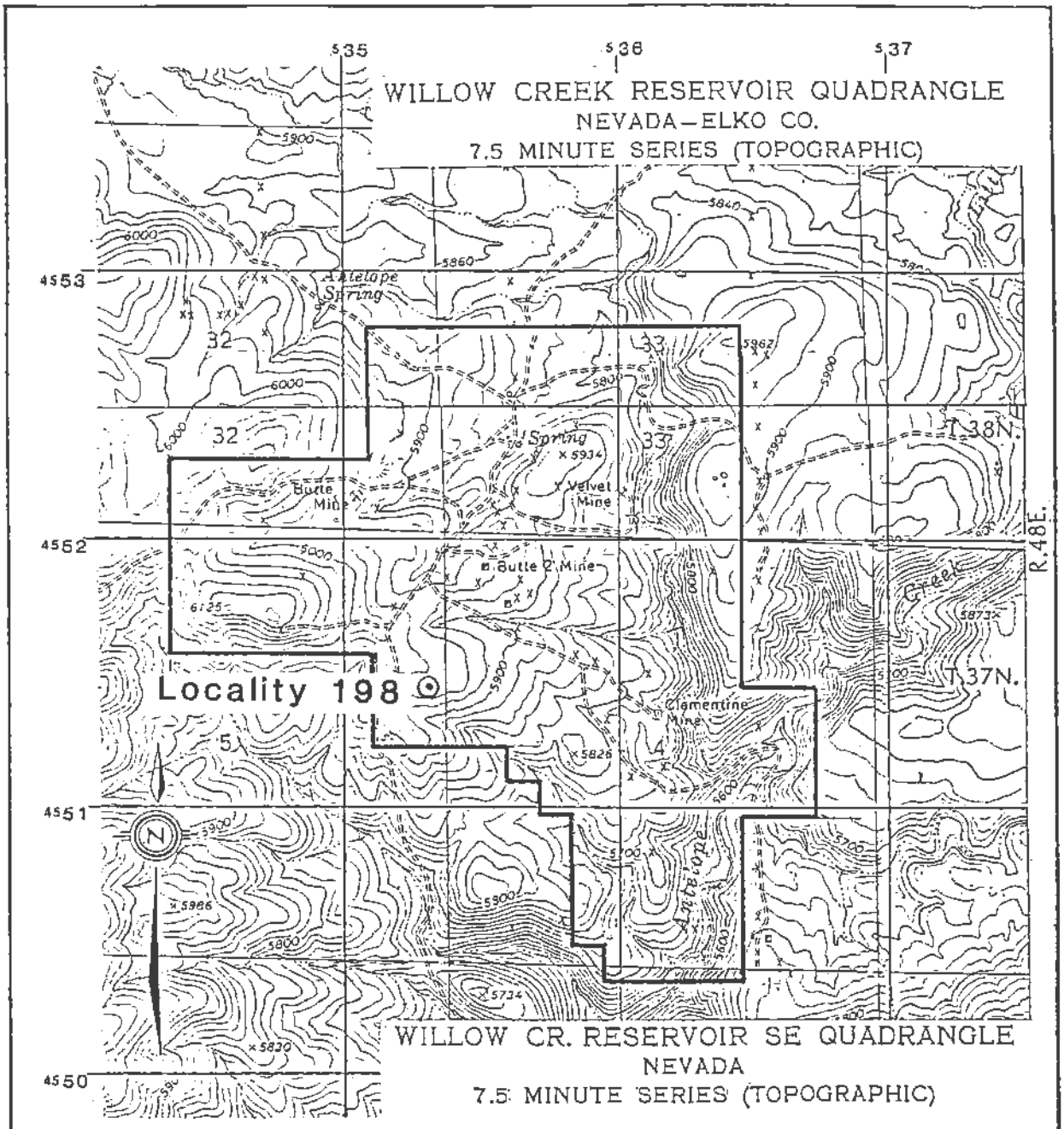
Topographic Data: South edge of ridge top, moderately sloping (6%).

Quarry Data: Cobbles and boulders on surface; poor quality materials.

Description: Small quarry pit (feature 39-11) in large cobble field; a moderate density of primary and secondary reduction flakes in pit with numerous assayed cobbles in surrounding scatter.

Site Condition: Undisturbed.

Remarks: Is located in a moderate density scatter extending to the south and east around the perimeter of Locality 44; segregated localities 197-205 may be feature components in related cluster. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 199 Type: Small Quarry Pit Complex/ Cobble Field

UTM: 535320E/4551420N

Size: 30m NS/20m EW Max. Area (m^2): 600

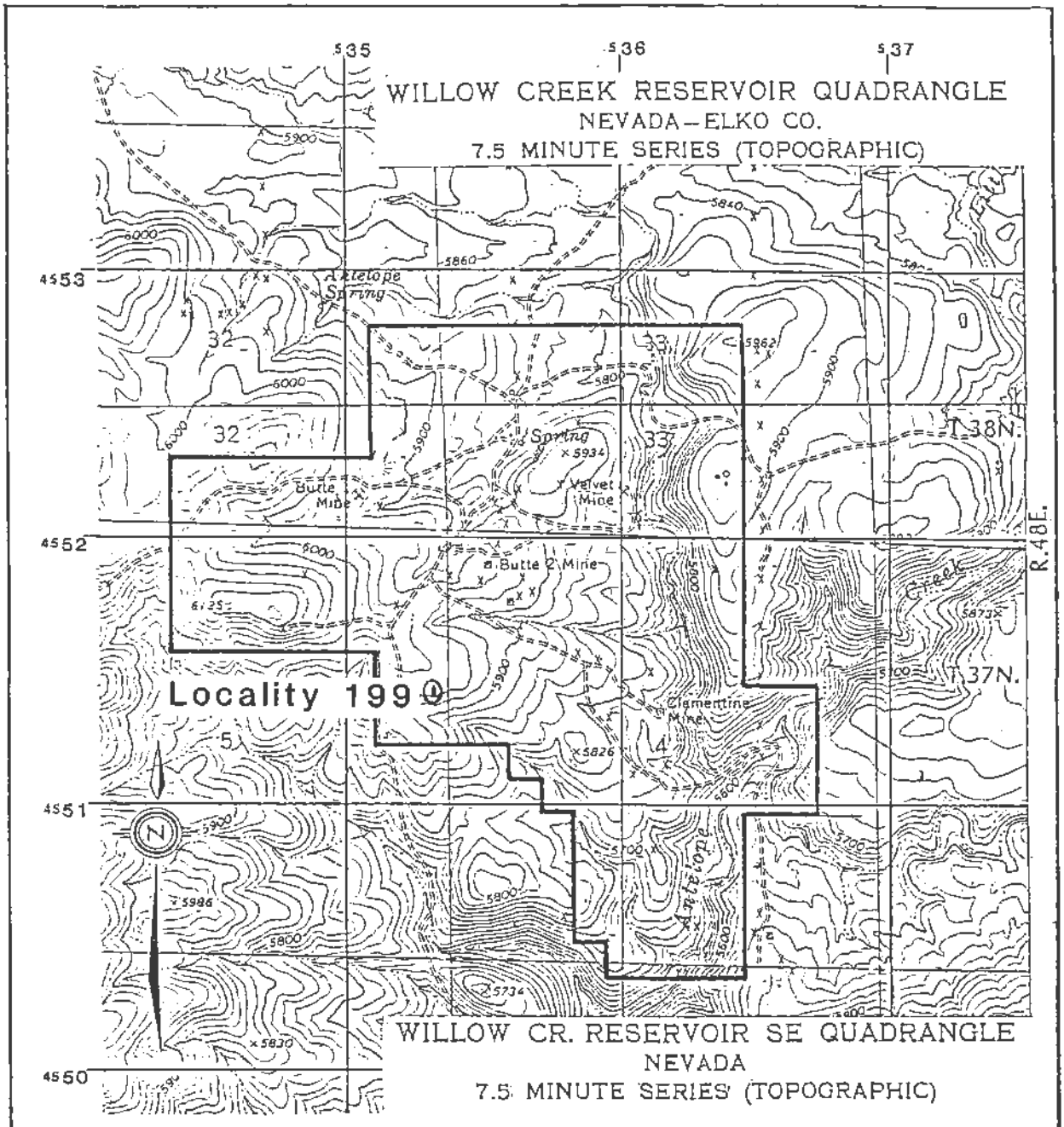
Topographic Data: Bench along south edge of ridge top, moderately sloping (8%).

Quarry Data: Cobbles and boulders on surface; grey to tan opalite.

Description: Small quarry pit complex (feature 39-12) with two pits (each about 3m in diameter) surrounded by moderate density of flakes and numerous cores and bifaces; basalt flakes and a hammerstone fragment also noted. Complex is located in a large, poorly defined cobble field.

Site Condition: Undisturbed.

Remarks: Is located in a moderate density scatter extending to the south and east around the perimeter of Locality 44; segregated localities 197-205 may be feature components in related cluster. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 200 Type: Small Reduction Station

UTM: 535320E/4551380N

Size: 5m x 5m Max. Area (m^2): 25

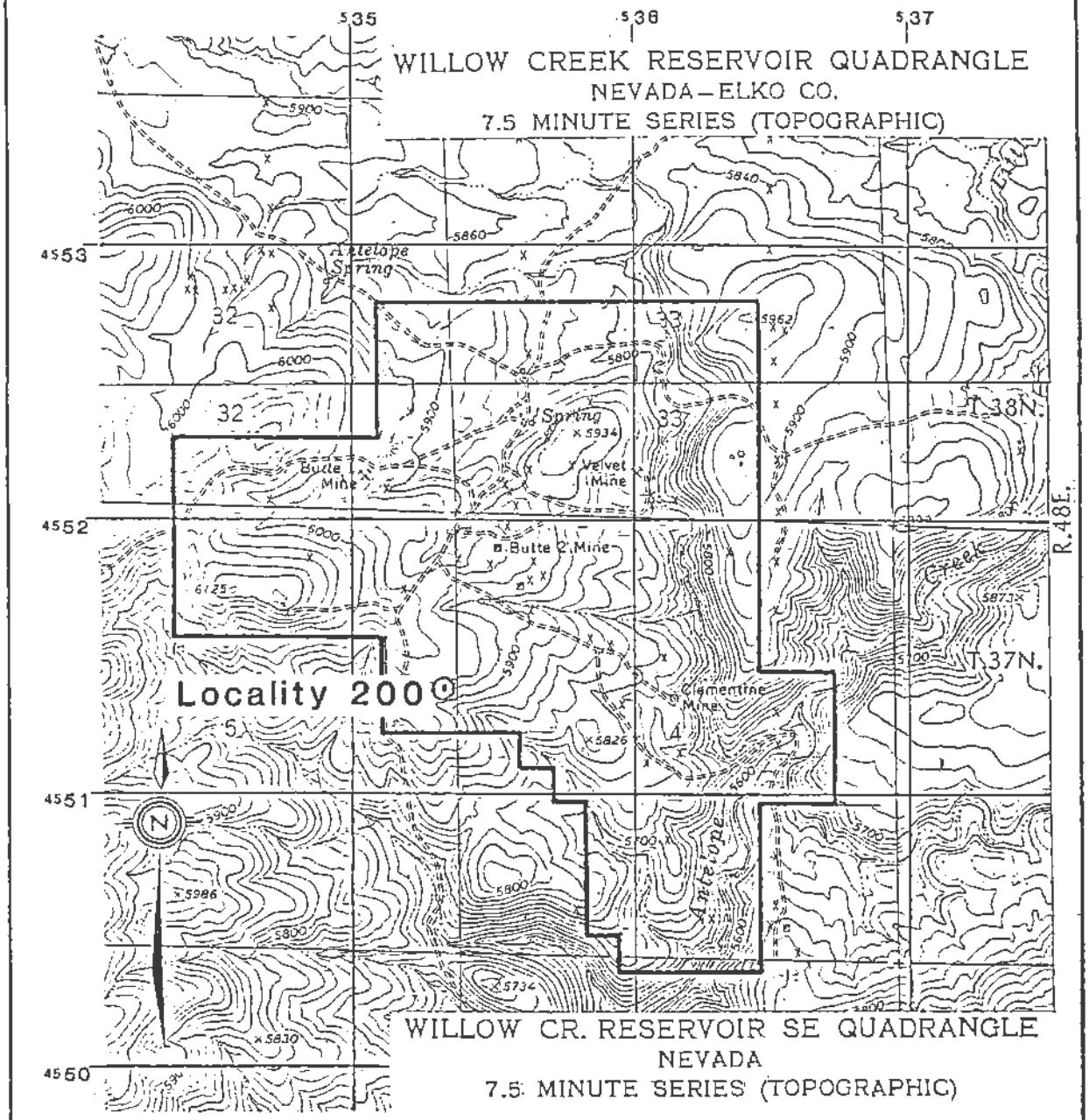
Topographic Data: Bench along south edge of ridge top, moderately sloping (8%).

Quarry Data: Reduction station is located in a large cobble field quarry.

Description: Small reduction station (feature 39-13) located in a large cobble field quarry; one bifacial core and a moderate flake scatter.

Site Condition: Undisturbed.

Remarks: Is located in a moderate density scatter extending to the south and east around the perimeter of Locality 44; segregated localities 197-205 may be feature components in related cluster. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 201 Type: Outcrop Quarry Complex

UTM: 535360E/4551360N

Size: 60m NS/20m EW Max. Area (m^2): 1,200

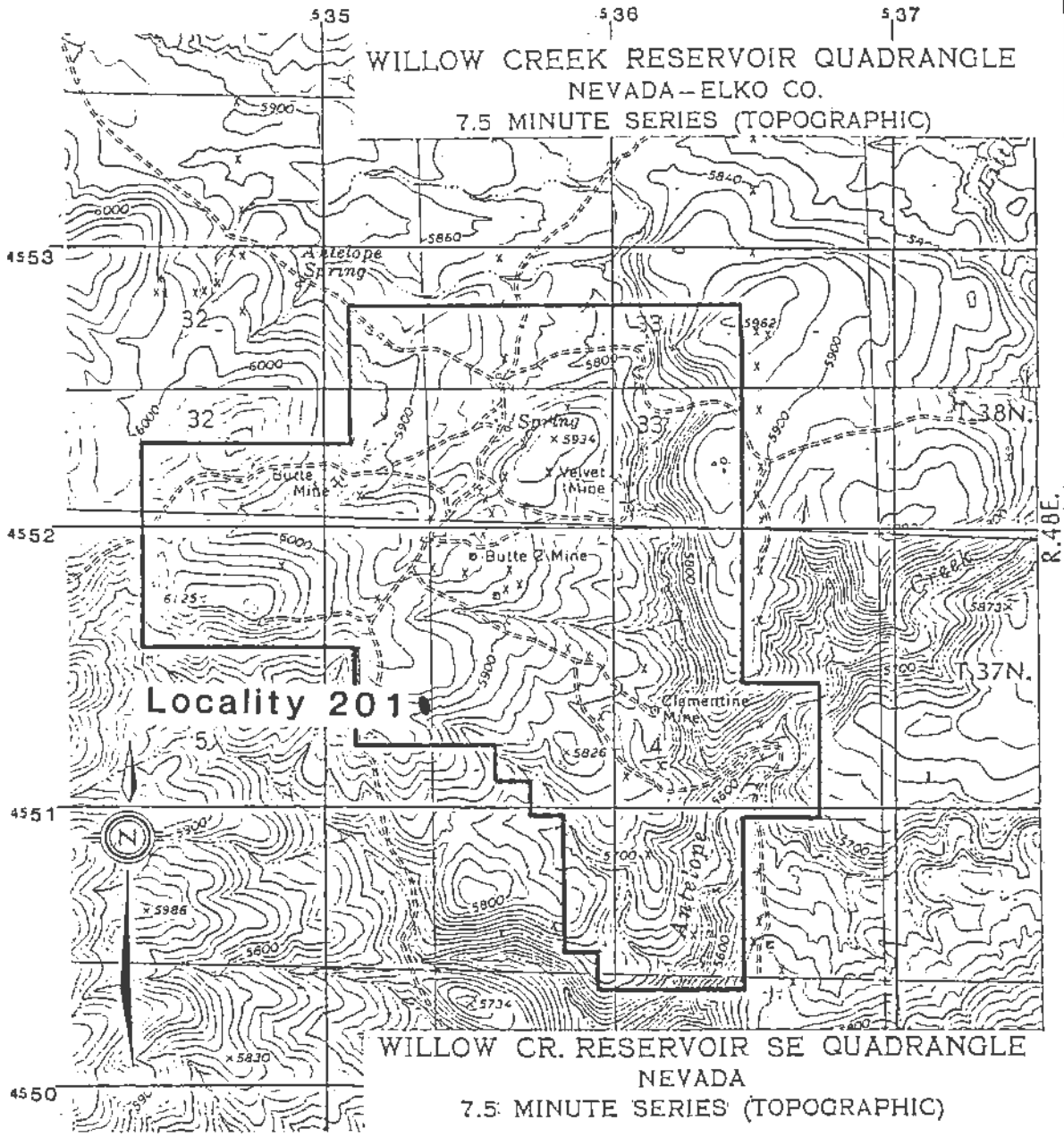
Topographic Data: Talus exposure along moderately sloping (13%), south facing ridge slope, at edge ephemeral drainage.

Quarry Data: Extensive talus cobbles along bedrock outcrop at the edge of an ephemeral drainage.

Description: Ill-defined outcrop talus quarry feature (41-1) with assay cobbles, primary debitage, and numerous bifaces all within a large area of high density reduction debris.

Site Condition: Undisturbed.

Remarks: Locality is plotted as a high density talus feature in a moderate density scatter continuous with Locality 44 near upper ridge slope as well as with bedrock ledge quarries along ephemeral drainage (localities 42, 43). Needs further assessment to determine geologic relationships and quarry source data.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 202 Type: Isolated Quarry Pit

UTM: 535400E/4551400N

Size: 15m x 15m Max. Area (m^2): 225

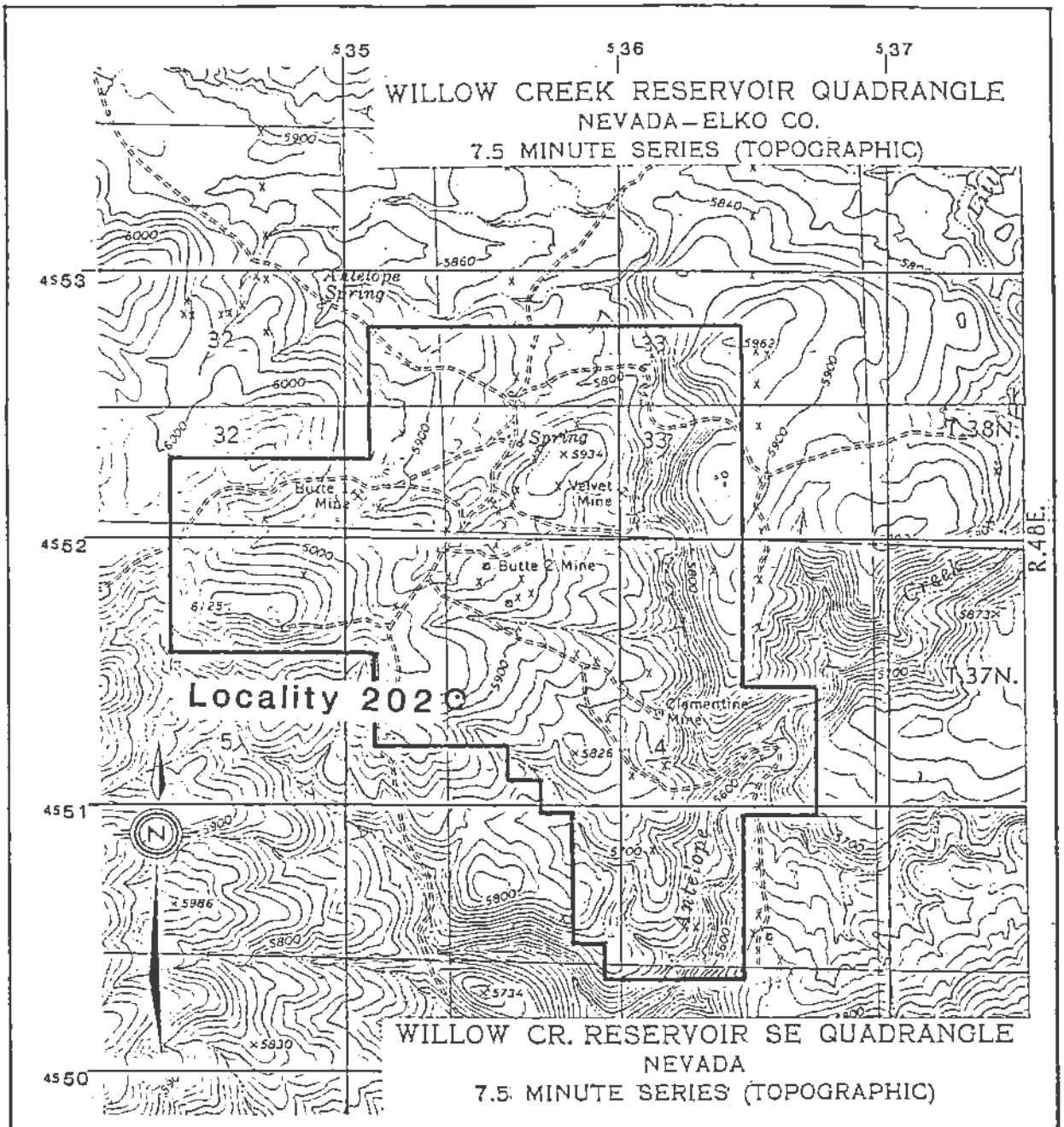
Topographic Data: Moderately steep (17%) slope, south-facing, overlooking ephemeral drainage.

Quarry Data: Ill-defined cobble and boulder field.

Description: Isolated quarry pit feature in high density flake scatter; both primary (shatter, assayed cobbles) and secondary (flakes) are represented (feature 42-2).

Site Condition: Undisturbed.

Remarks: Located in a moderate density scatter extending to the south and east around the perimeter of Locality 44; segregated localities 197-205 may be feature components in related cluster. Needs further assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 203 Type: Reduction Station Complex

UTM: 535440E/4551300N

Size: 20m NS/ 70m EW Max. Area (m^2): 1,400

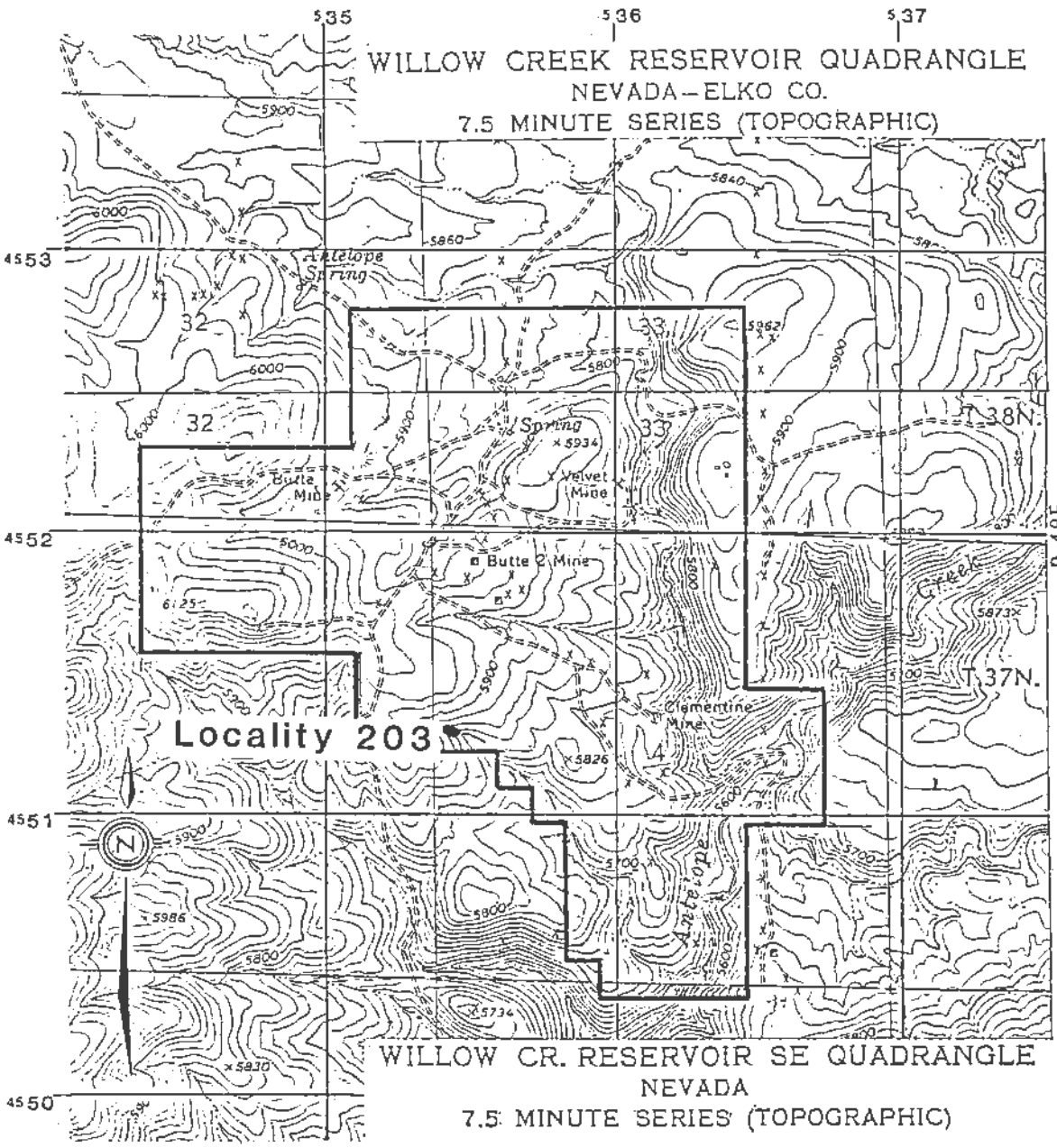
Topographic Data: Base of drainage on moderately steep (17%) slope, facing east.

Quarry Data: No on-site source.

Description: Small, high density dense reduction scatter (feature 44-5) with large numbers of cores and bifaces.

Site Condition: Undisturbed.

Remarks: Locality is in plotted in a moderate density scatter continuous with Locality 44 near upper ridge slope as well as with bedrock ledge quarries along ephemeral drainage (localities 42, 43). Needs further assessment to determine geologic relationships and quarry source data.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 204 Type: Outcrop Quarry Complex

UTM: 535500E/4551320N

Size: 40m NS/ 30m EW Max. Area (m^2): 1,200

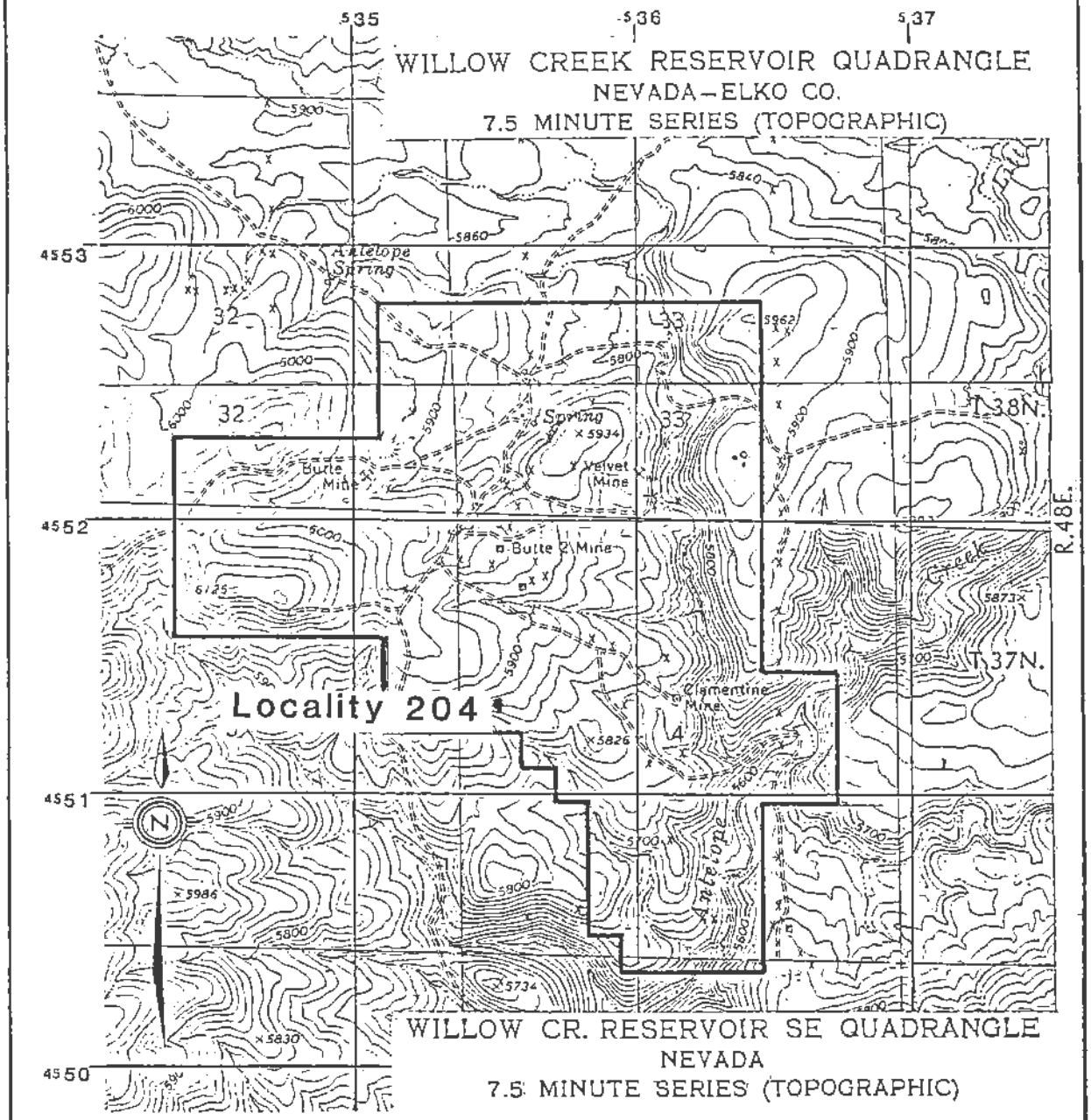
Topographic Data: On moderately steep (24%) slope, facing south, at edge ephemeral drainage.

Quarry Data: Dense talus cobbles with scattered surface boulders.

Description: Small, moderate to high density dense reduction scatter (feature 46-8) in thick talus; area is nearly devoid of vegetation (bedrock controlled?).

Site Condition: Undisturbed.

Remarks: Locality is plotted as a high density talus feature in a moderate density scatter continuous with Locality 44 near upper ridge slope as well as with bedrock ledge quarries along ephemeral drainage (localities 42, 43). Needs further assessment to determine geologic relationships and quarry source data.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Holmes Ridge

Locality No.: 205 Type: Small Quarry Pit Complex

UTM: 535340E/4551440N

Size: 30m NS/ 15m EW Max. Area (m^2): 450

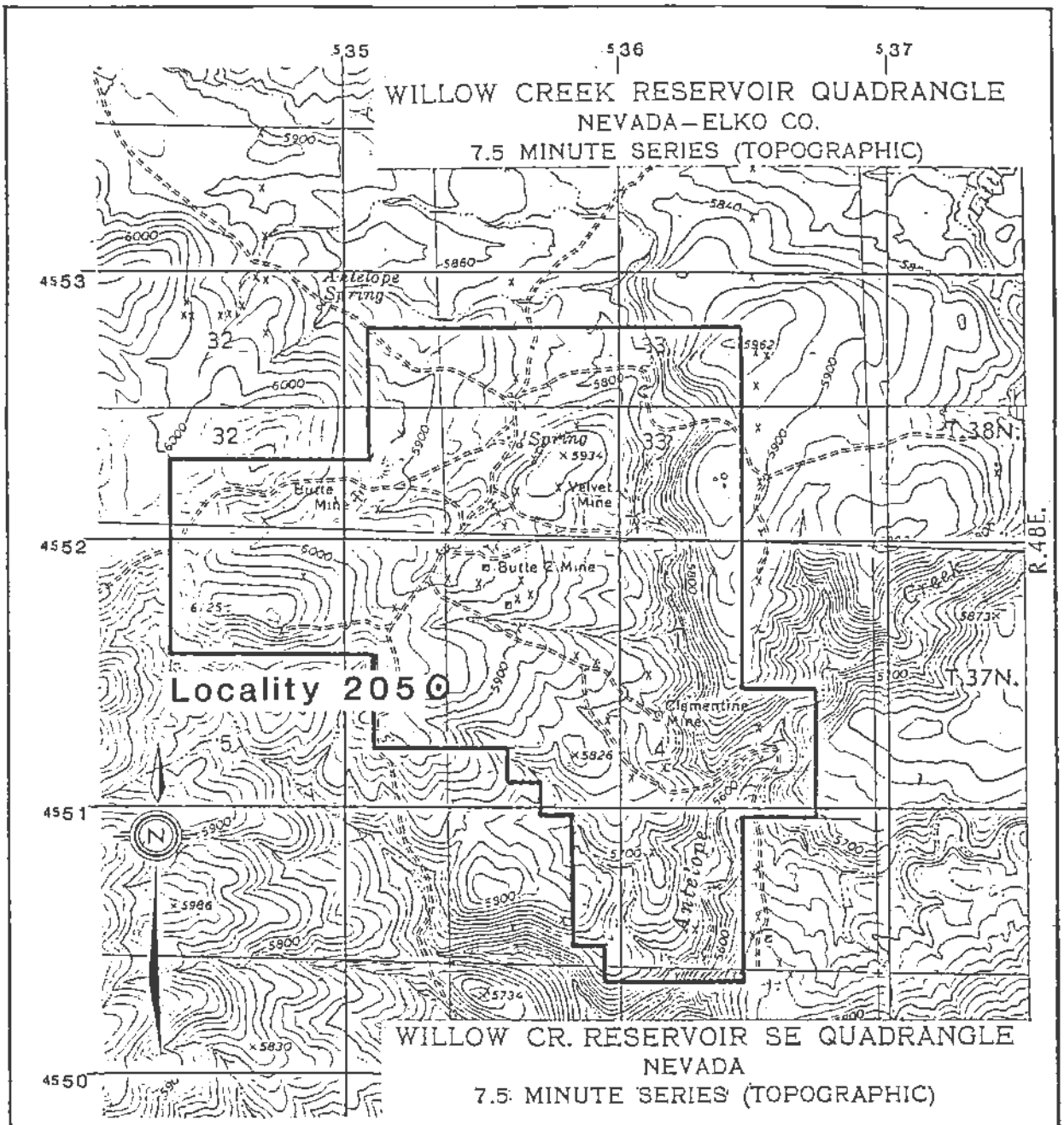
Topographic Data: Edge of ridge, moderately sloping (6%), facing south; white with chalcedony-like inclusions.

Quarry Data: Scattered surface boulders and cobbles; cobbles in colluvium.

Description: Small pit complex of two distinct pits (features 40-6, 40-7), each surrounded by a moderate to high density scatter of white opalite flakes.

Site Condition: Undisturbed.

Remarks: Located in a moderate density scatter extending to the south and east around the perimeter of Locality 44; segregated localities 197-205 may be feature components in related cluster. Needs further assessment of geologic relationships.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Holmes Ridge

Locality No.: 206 Type: Isolated Quarry Pit

UTM: 536160E/4551060N

Size: 60m NS/38m EW Max. Area (m^2): 2,280

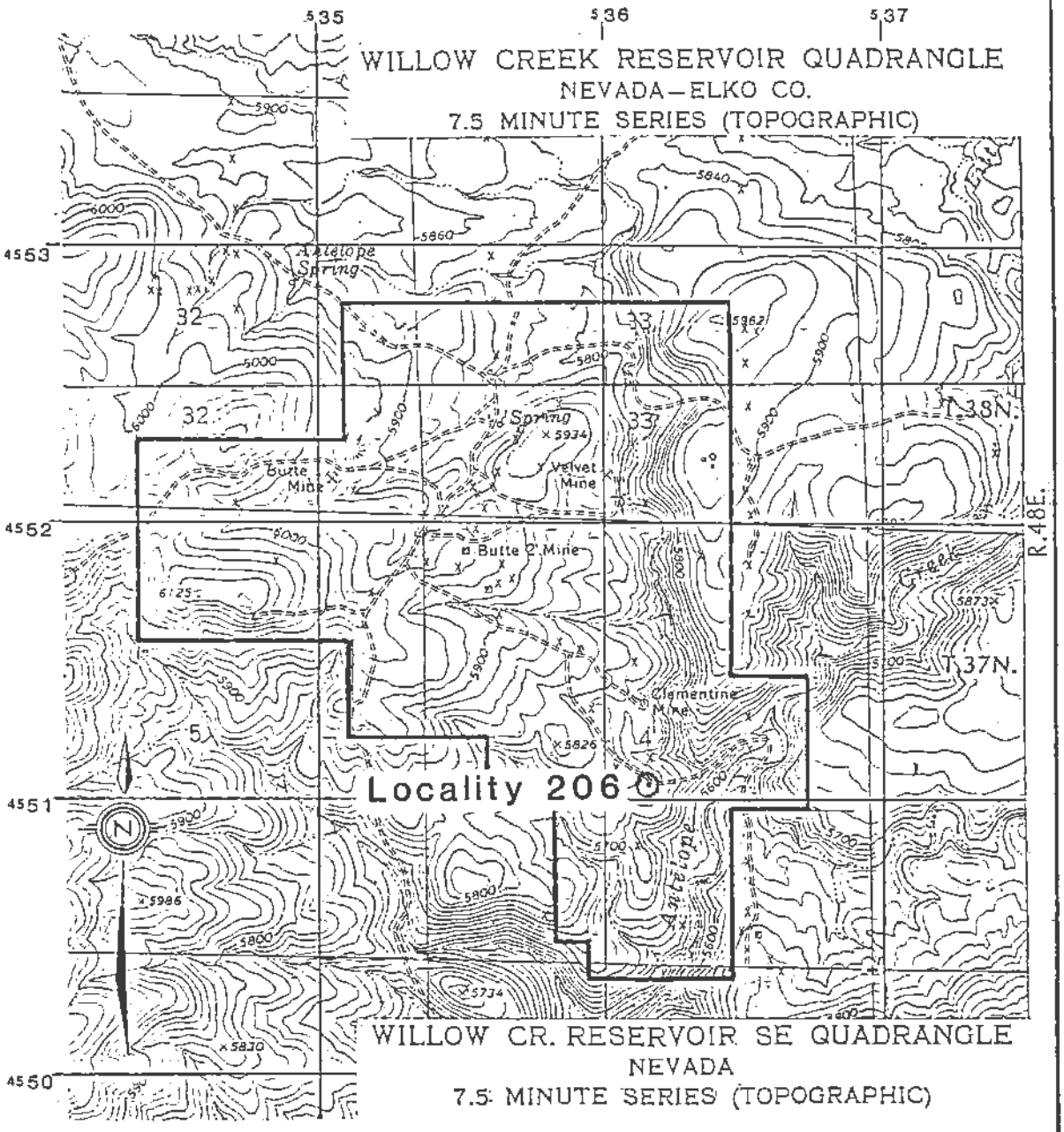
Topographic Data: Flat bench overlooking near edge rimrock, overlooking confluence of Velvet and Little Antelope canyons.

Quarry Data: Poor quality opalite bedrock exposed at ground surface.

Description: Small quarry pit (designated Pit 1 in transit mapping notes) within a large diffuse flake scatter, much of which is natural or historically produced shatter and angular fragments.

Site Condition: Disturbed by historic mining activities and road construction.

Remarks: Few distinct flakes were noted in the scatter of opalite surrounding the pit.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Twin Butte

Locality No.: 207 Type: Isolated Quarry Pit

UTM: 534880E/4551640N

Size: 6m x 5m Max. Area (m^2): 30

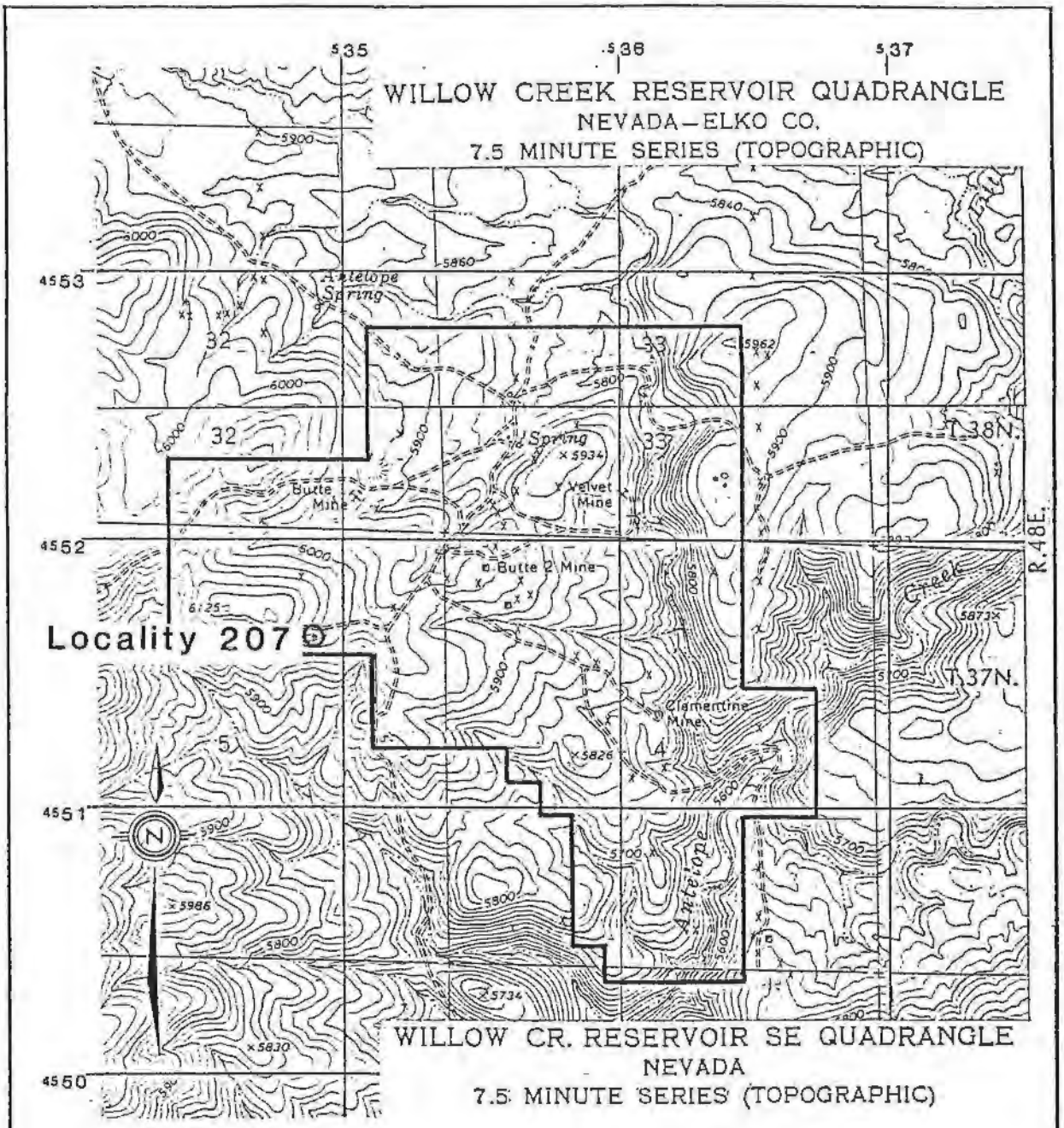
Topographic Data: On moderately steep (16%), southeast-facing ridge slope.

Quarry Data: Cobbles in colluvium.

Description: Isolated quarry pit (feature 27-1) near a boulder outcrop. A light density scatter of off-white and pink grainy opalite surrounds pit; basalt flakes were also noted.

Site Condition: Undisturbed.

Remarks: Seems to be an outlier on a slope where no other opalite sources were present.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Lower Velvet Canyon

Locality No.: 208 Type: Lithic Scatter (Undetermined Type)

UTM: 536260E/4550960N

Size: 75m NS/ 90m EW Max. Area (m^2): 5,000

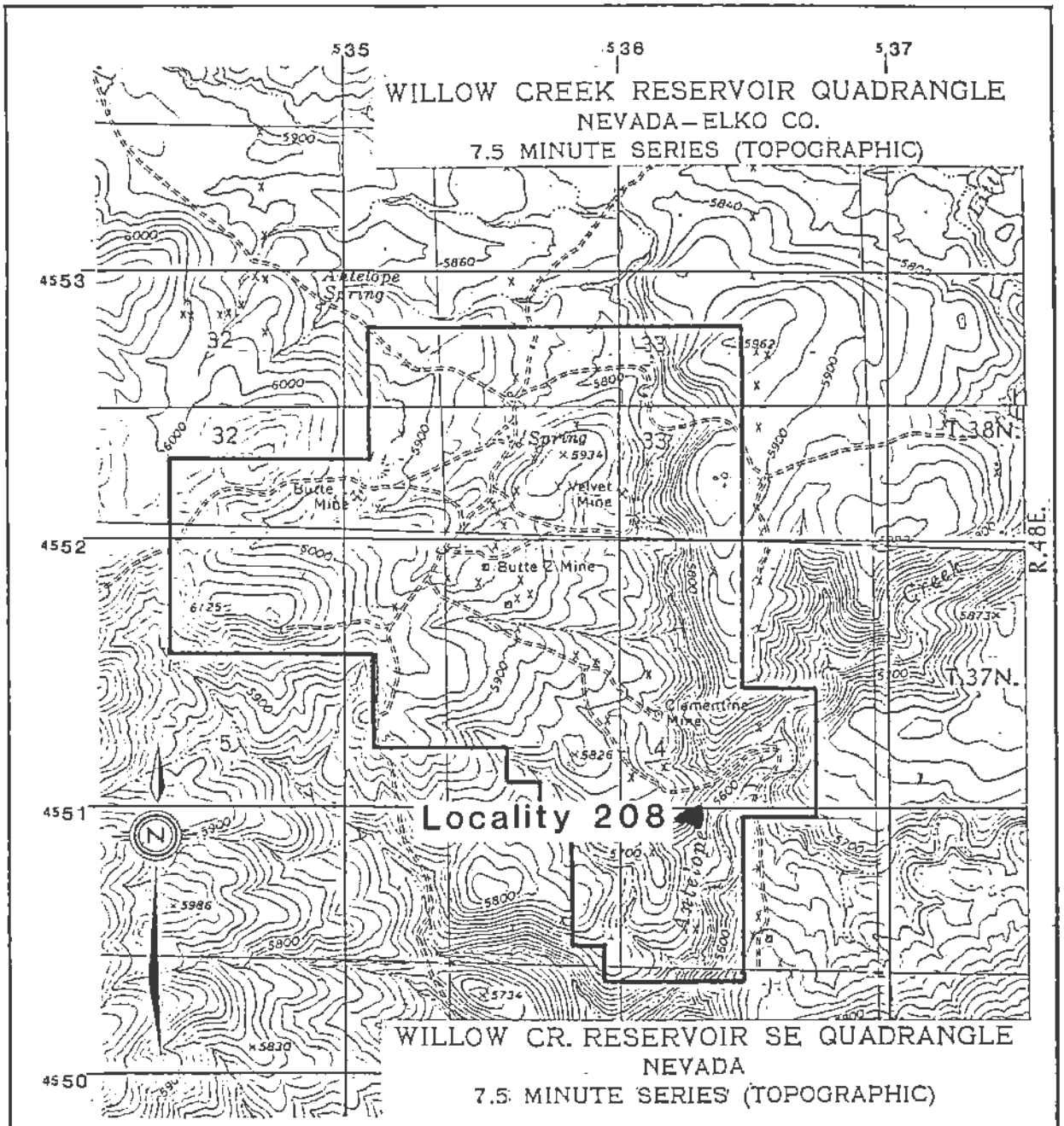
Topographic Data: Steep (35%) slope below nonsilicified bedrock outcrop, on west side Velvet Canyon.

Quarry Data: Unknown.

Description: A moderate density flake scatter with no recorded quarry features. Cone-shaped scatter along steep slope suggests an intensively quarried feature is located near the top of the slope scatter (similar to Locality 176).

Site Condition: Unknown.

Remarks: Identified through density plots; needs further field assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No: 209 (Owl Ridge) Type: Small Reduction Station

UTM: 536200E/4552140N

Size: 2.5m x 2m Max. Area (m^2): 5

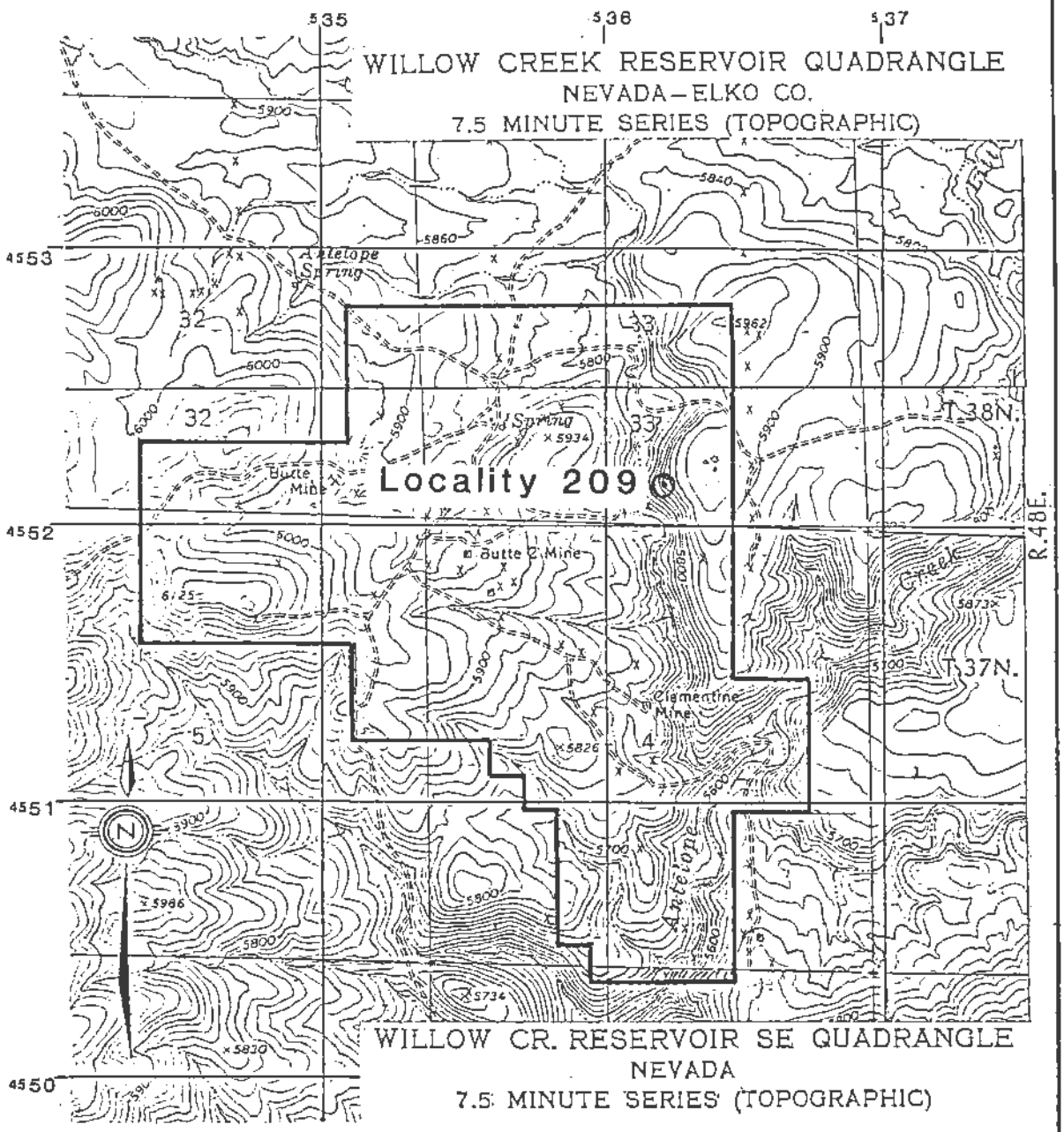
Topographic Data: Steep (45%) colluvial slope, west-facing, edge of Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small, reduction station of ca. 250 chert flakes (feature 69-1).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Middle Owl Ridge

Locality No.: 210 Type: Rockshelter (Reduction Station)

UTM: 536340E/4552000N

Size: shelter=4m wide/3m high Max. Area (m^2): 10

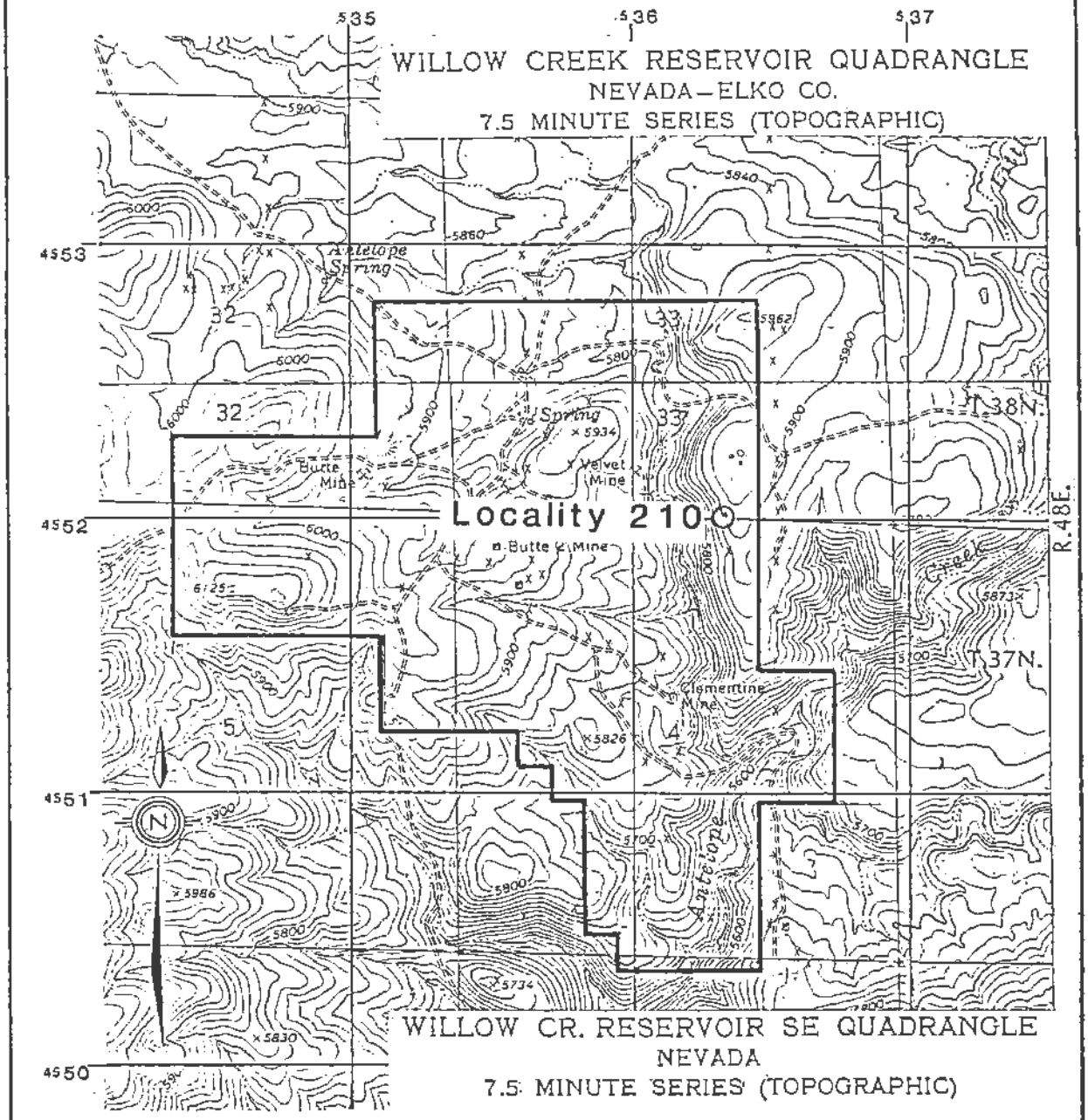
Topographic Data: Small rock alcove at base of rimrock at upper edge of moderately steep (25%), west-facing slope near top of Owl Ridge.

Quarry Data: No on-site opalite source.

Description: Small, light density scatter of ca. 100 white chert flakes (feature 73-K1).

Site Condition: Pristine.

Remarks: One of several similar small reduction stations edging the high rimrock along Owl Ridge on the east edge of the Tosawihi Quarry District.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe **September 1987**

SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 211 Type: Rockshelter (Undetermined Type)

UTM: 536080E/4552300N

Size: not listed Max. Area (m^2): 50

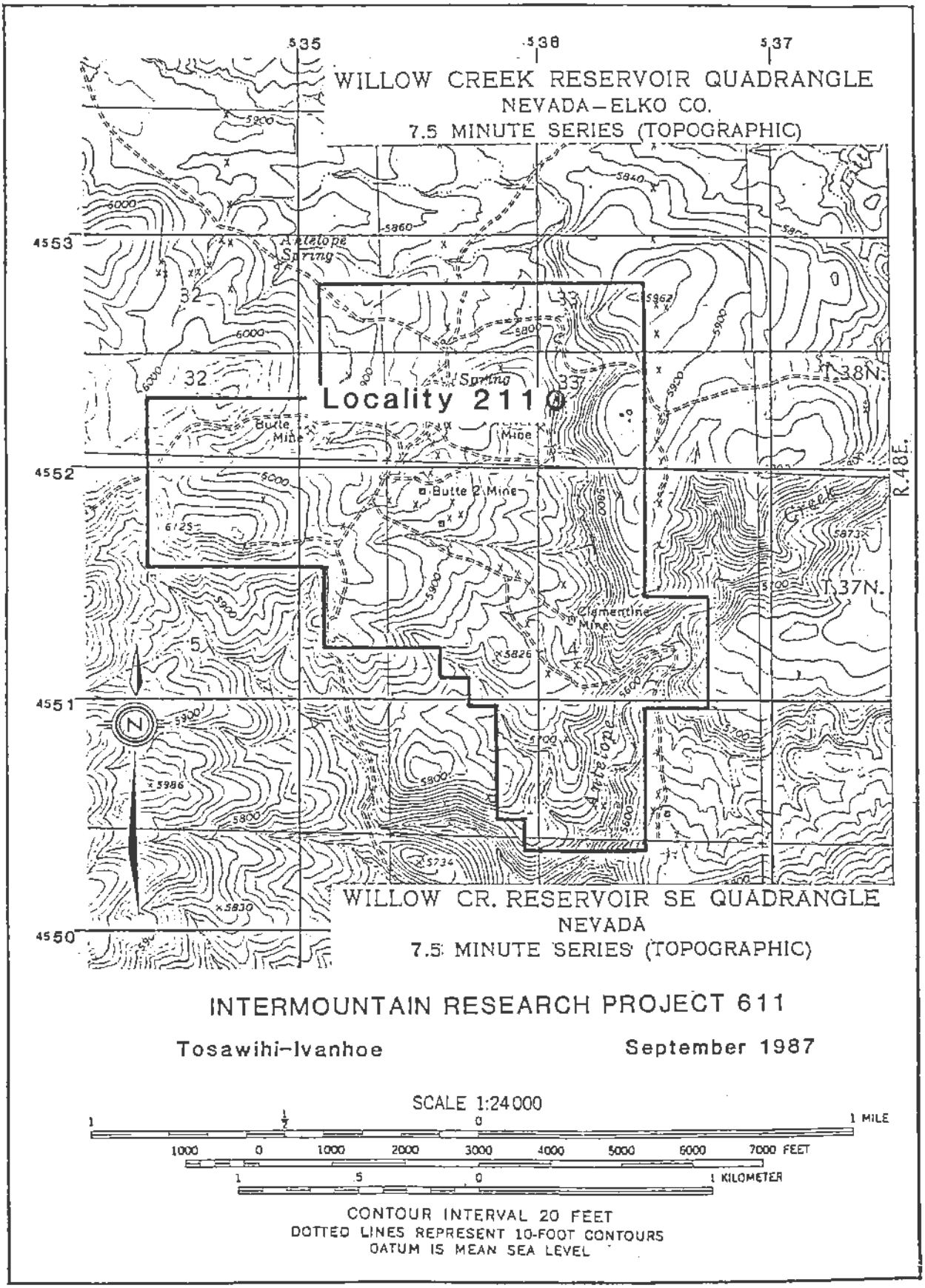
Topographic Data: Steep canyon slope (50%), west side Velvet Canyon.

Quarry Data: No on-site opalite source.

Description: Small rock overhang with light flake density inside and moderate to heavy scatter on apron (feature 64-3). Needs further assessment to determine kind of use(s).

Site Condition: Undisturbed.

Remarks: Thick flake accumulation on apron suggests possibility for depth; warrants test excavation.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi–Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 212 Type: Rockshelter (Undetermined Type)

UTM: 536100E/4552240N

Size: 3m x 2m Max. Area (m^2): 50

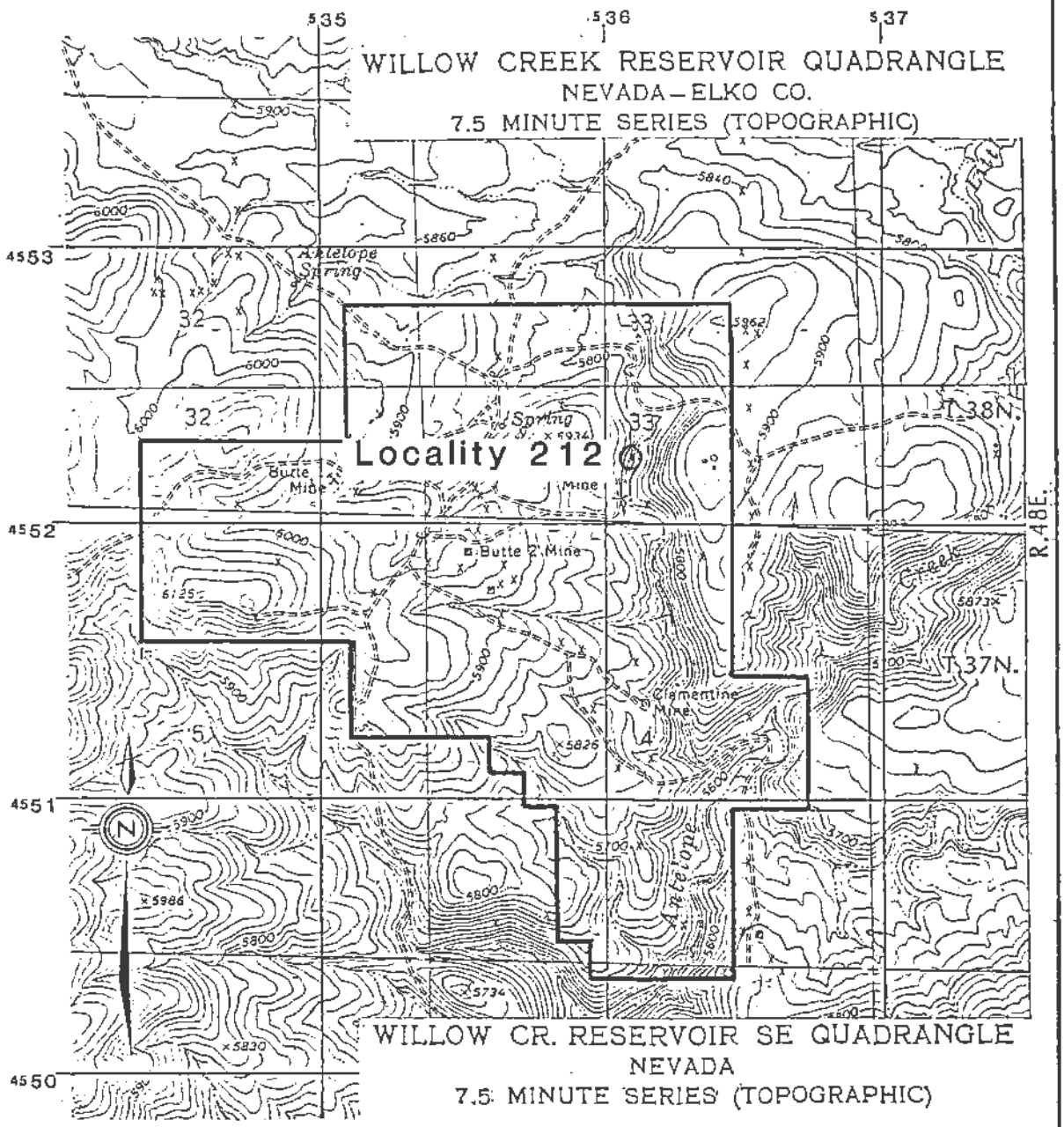
Topographic Data: At edge steep canyon slope (50%), west side Velvet Canyon, near base of drainage.

Quarry Data: No on-site opalite source.

Description: Small rock overhang with light flake density flake scatter (feature 65-1).

Site Condition: Some intrusive materials from fissure in roof.

Remarks: Needs further field assessment.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 213 Type: Rockshelter/? Adit

UTM: 536160E/4551860N

Size: 4m wide/4m deep/ 6m high Max. Area (m^2): 50

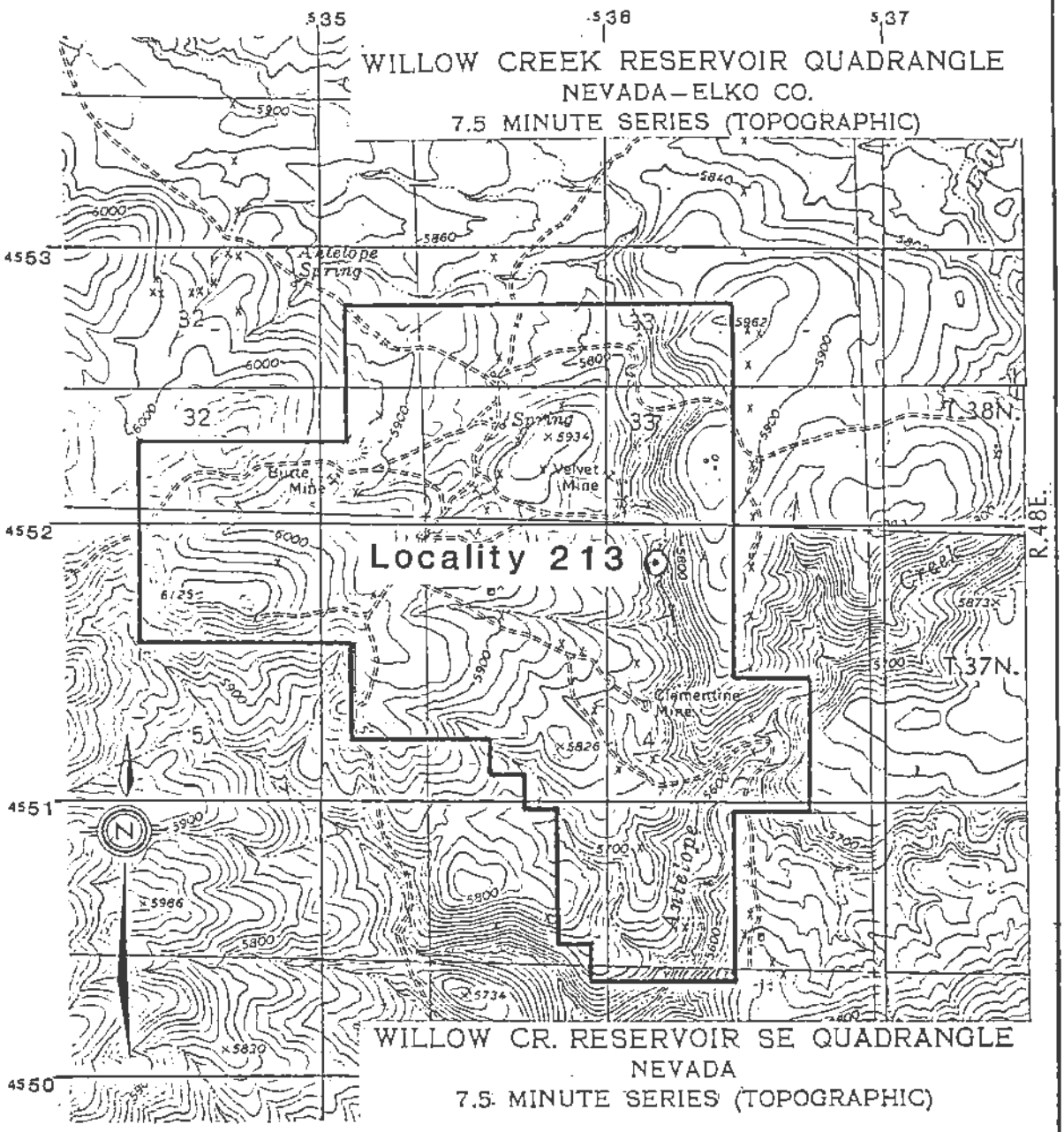
Topographic Data: At base of Velvet Canyon, in quarried outcrop ledge.

Quarry Data: Large bedrock quarry on top of outcrop.

Description: Rockshelter (feature 66-1) in base of intensively quarried bedrock outcrop (see Locality 85); no cultural materials noted in shelter but a packrat nest is located in a narrow vertical crevice. Alcove may have served as prehistoric adit.

Site Condition: No conspicuous disturbance.

Remarks: Test apron for possible cultural accumulation (bedrock and stream channel suggests only limited potential for depth).



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SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 214 Type: Isolated Adit (?)

UTM: 536120E/4552120N

Size: 5m wide/30cm deep/ 1.5m high Max. Area (m^2): 50

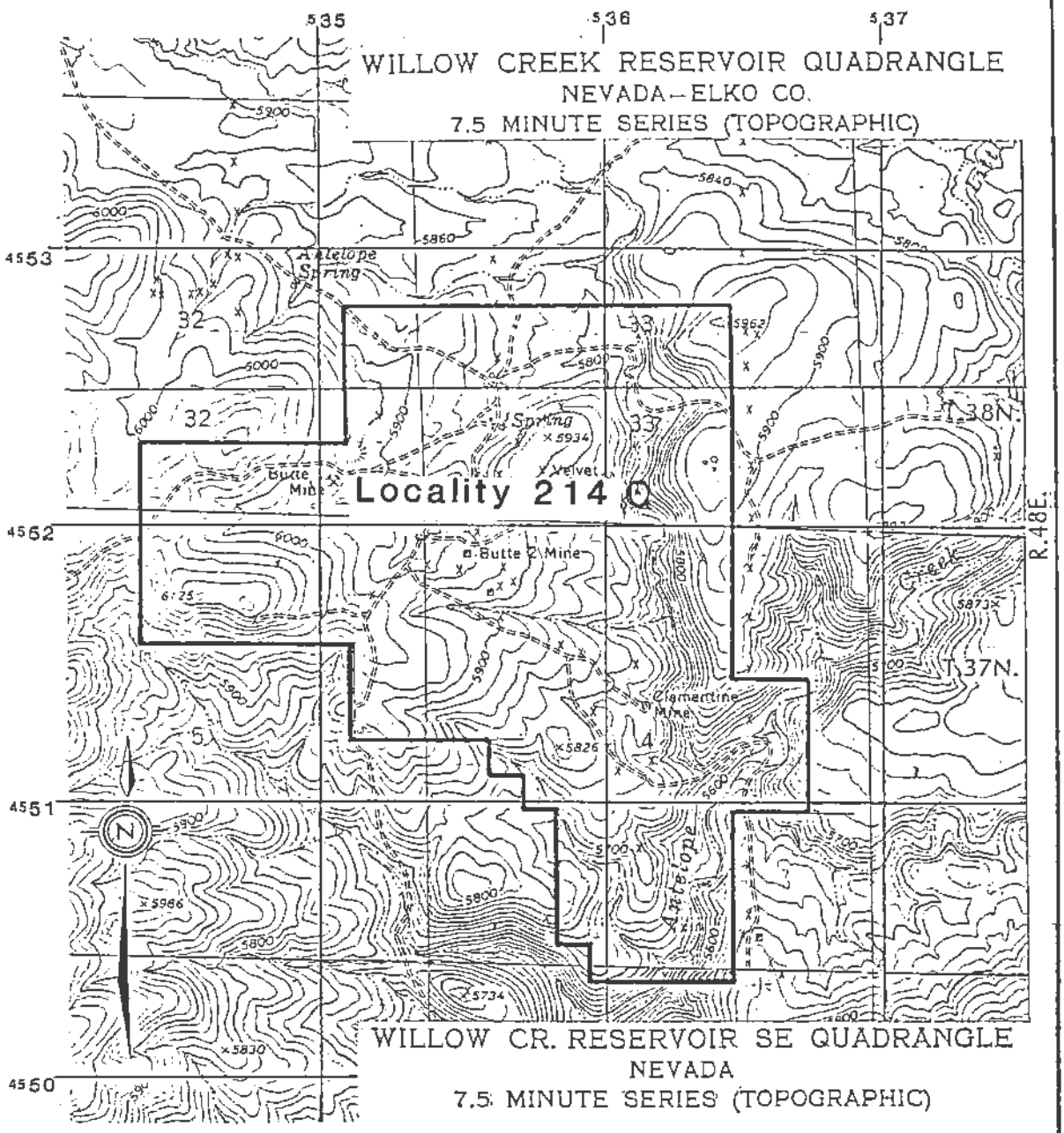
Topographic Data: At base of Velvet Canyon, in quarried outcrop ledge.

Quarry Data: Adit into bedrock outcrop.

Description: Adit (feature 66-2) into bedrock outcrop intensively quarried bedrock outcrop (see Locality 85); thick accumulation of reduction flakes surrounding adit feature.

Site Condition: No conspicuous disturbance.

Remarks: One of several significant features in the Locality 85 Bedrock quarry; see nearby Locality 214 adit.



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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Upper Velvet Canyon

Locality No.: 215 Type: Isolated Adit (?)

UTM: 536100E/4552140N

Size: 6m wide/1m deep/ 40cm high Max. Area (m^2): 50

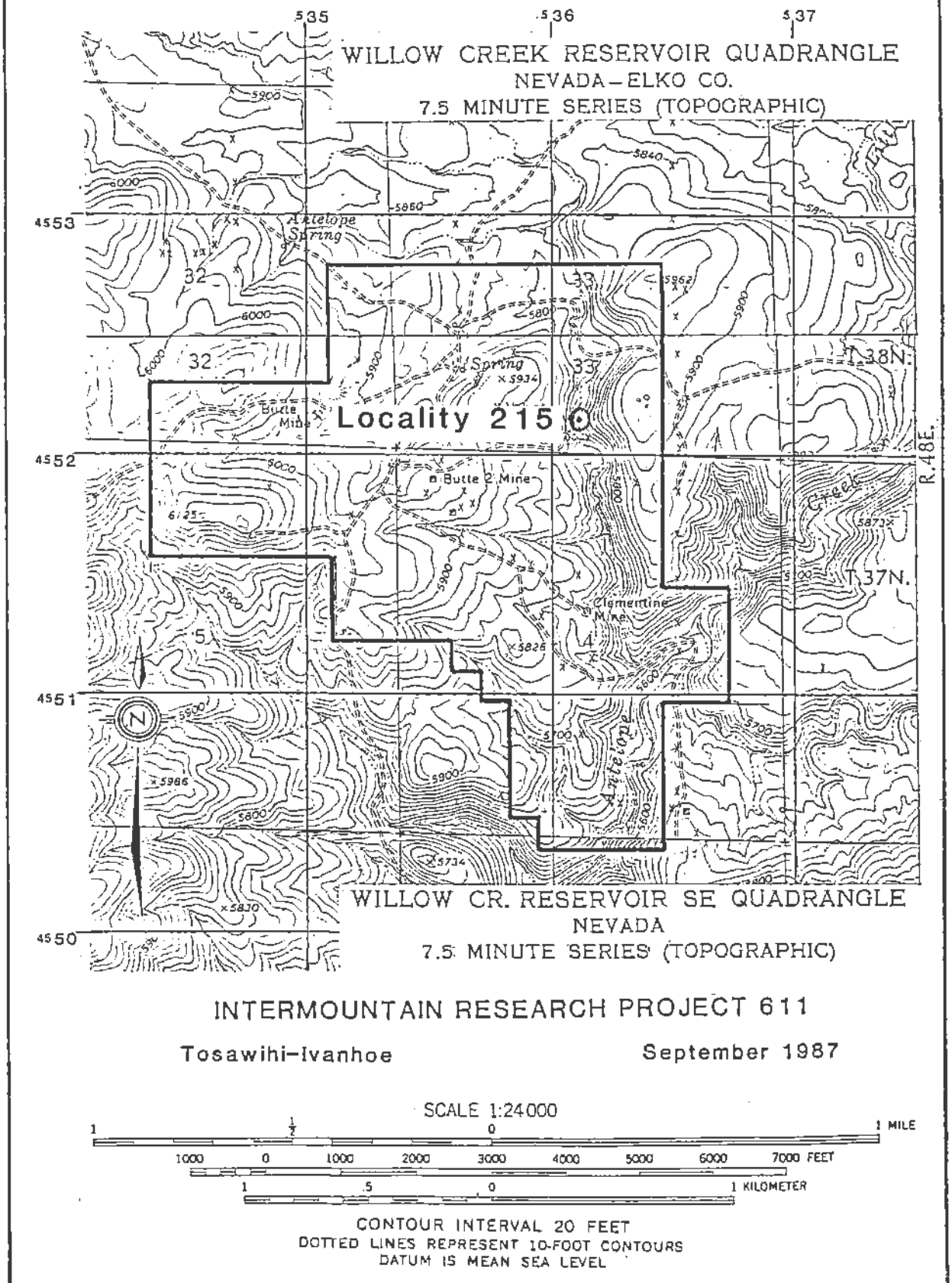
Topographic Data: At base of Velvet Canyon, in quarried outcrop ledge.

Quarry Data: Adit into bedrock outcrop.

Description: Adit (feature 66-3) into bedrock outcrop intensively quarried bedrock outcrop (see Locality 85); thick accumulation of reduction flakes surrounding adit feature.

Site Condition: No conspicuous disturbance.

Remarks: One of several significant features in the Locality 85 bedrock quarry; see nearby adit Locality 214.



INTERMOUNTAIN RESEARCH PROJECT 611

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September 1987

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Confusion Gorge

Locality No.: 216 (Standing Rock) Type: Small Reduction Station

UTM: 536160E/4550340N

Size: 10 m NS/2m EW Max. Area (m^2): 20

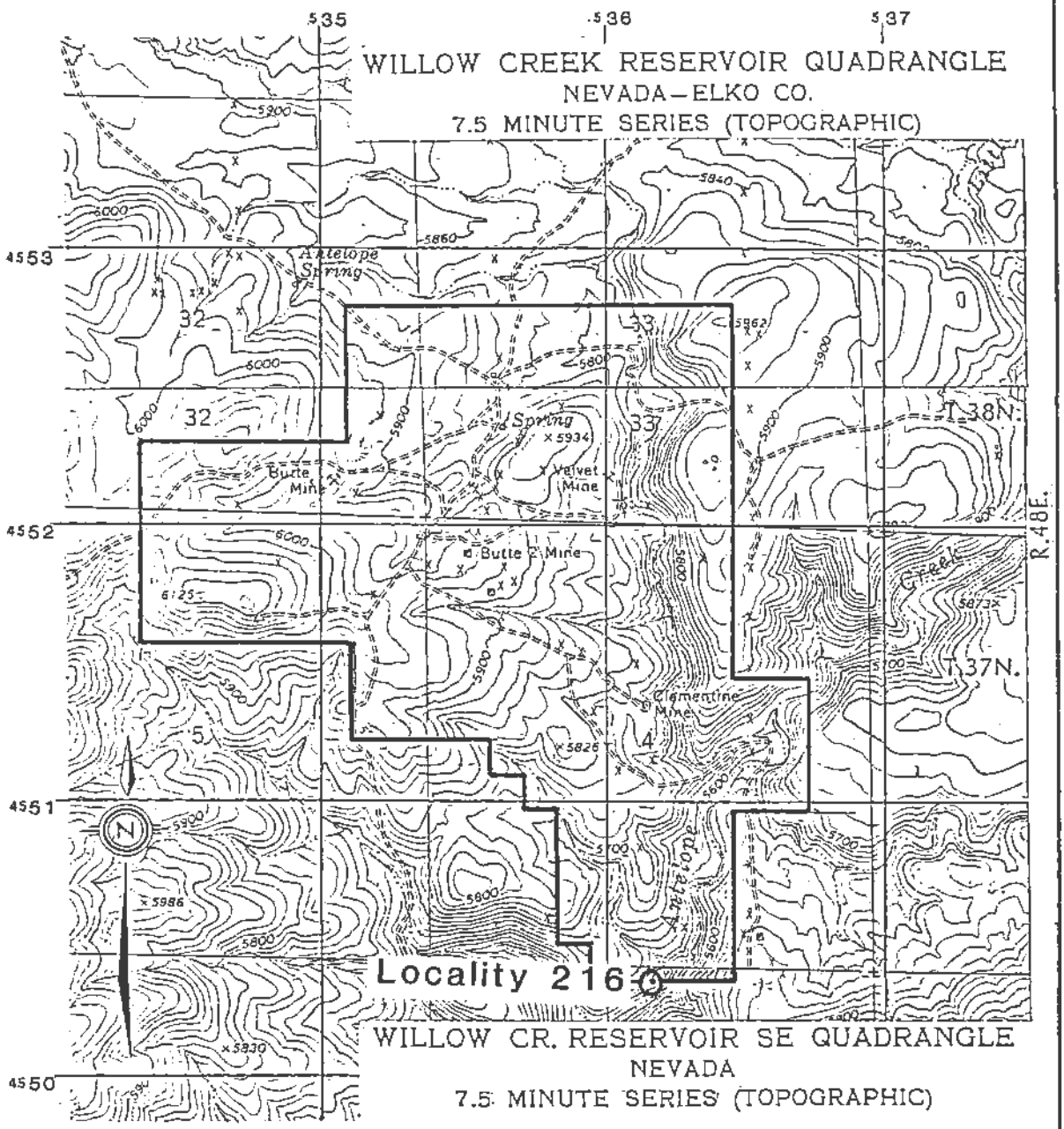
Topographic Data: Located on top of rimrock, near Standing Rock, north side of Little Antelope Canyon.

Quarry Data: Localized poor quality white chert cobbles outcrop at edge rimrock adjacent reduction station (designated Locality 1).

Description: Discrete biface thinning station adjacent to localized, poor quality white chert cobble outcrop. Station (feature 67-18) consists of light flake scatter and 11 Stage I bifaces (rejects).

Site Condition: Undisturbed

Remarks: Good opportunity to investigate production of limited number bifaces from single source, and rejection criteria for early stage bifaces (see quarry source at Locality 1).



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September 1987

SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 217

Type: Rockshelter (Reduction Station)/ Outcrop Quarry

UTM: 536340E/4550580N

Size: 3m x 1.5m

Max. Area (m^2): 20

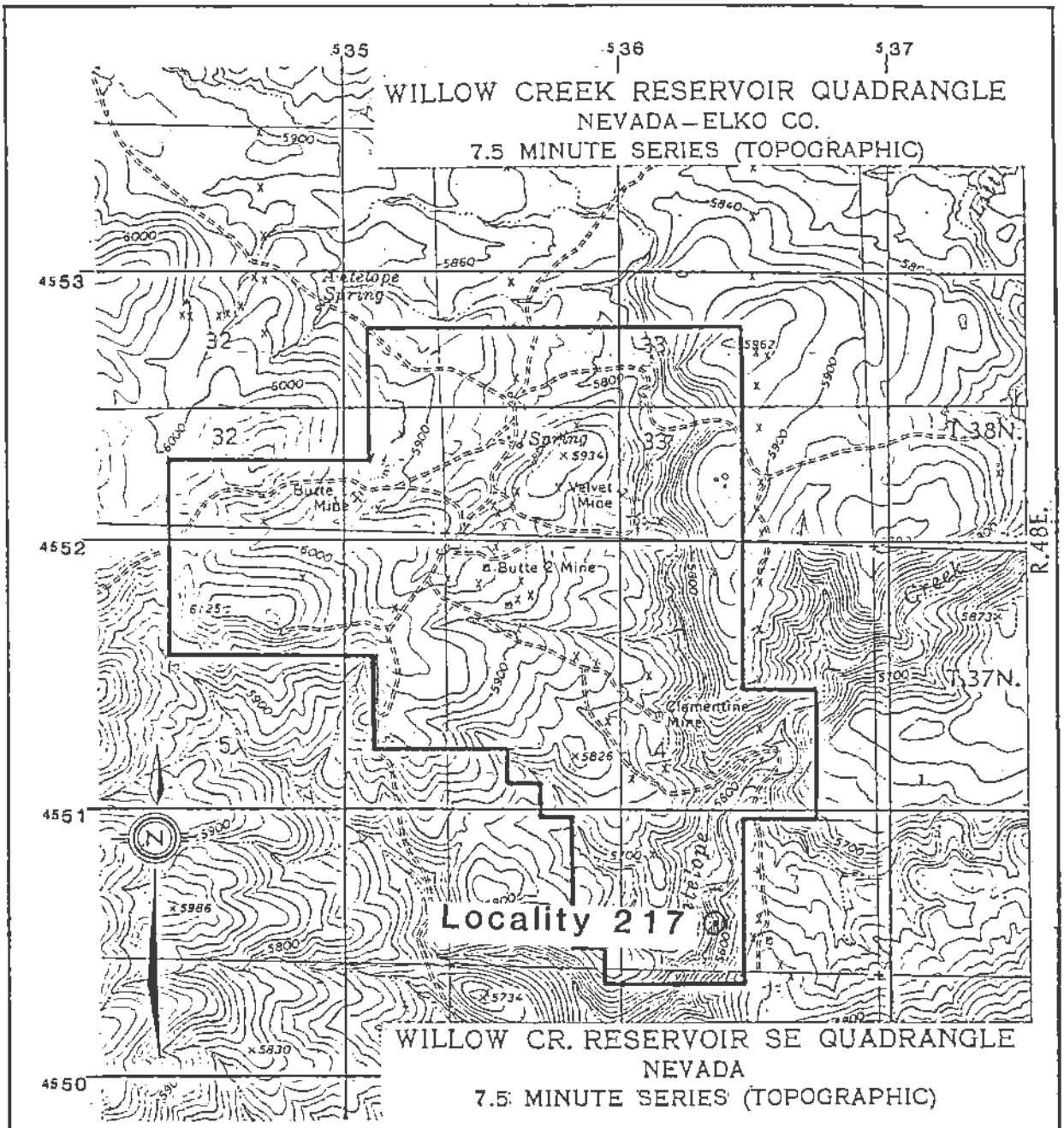
Topographic Data: Base of Little Antelope Canyon, east side drainage.

Quarry Data: Small on-site outcrop of non-silicified chert with nodules of knappable opalite. Battered outcrop suggests use of embedded nodules.

Description: Small shelter overhang where embedded nodules may have been quarried (feature 73-S3). Light scatter of primary and secondary debitage.

Site Condition: Apparently good.

Remarks: Quarrying of embedded nodules suggests high energy investment for low return, especially considering nearby good source at Locality 15. Was this a prehistoric prospect rather than a quarry per se? Or, perhaps historic prospecting has obscured the issue.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Bedrock Bend

Locality No.: 218 Type: Rockshelter/Adit

UTM: 536340 E/4550620 N

Size: Max. Area (m^2):

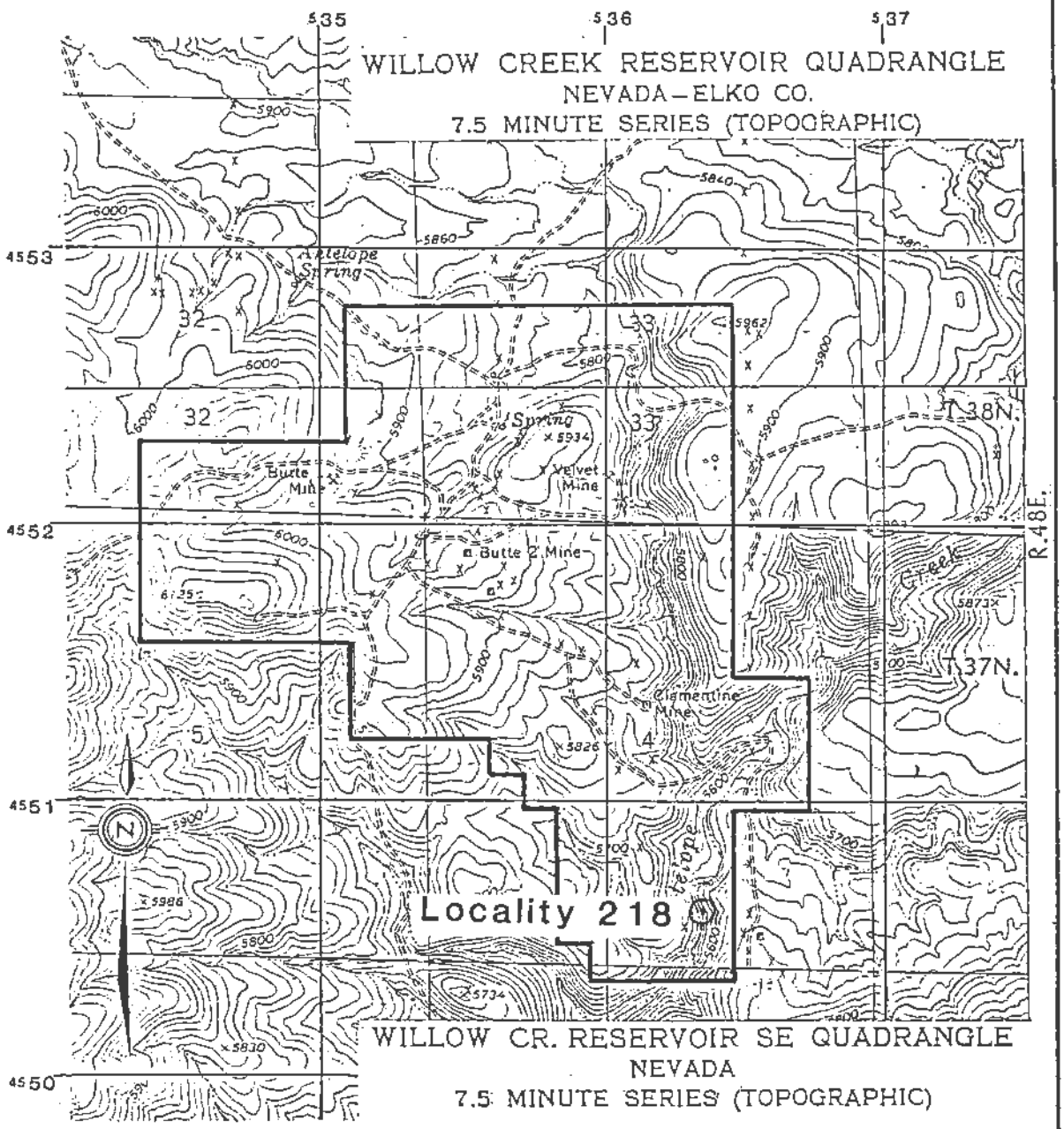
Topographic Data: Base of Little Antelope Canyon, east side of drainage.

Quarry Data: Battered outcrop of variable quality opalite.

Description: Shelter is located in an a battered opalite outcrop (quite variable in quality); prehistoric adit extends into back of shelter. Artifacts include bifaces and hammerstones with quantities of both primary reduction debitage and biface thinning flakes. Thick accumulation on platform apron suggests subsurface potential.

Site Condition: Good.

Remarks: Interesting adit/quarry/shelter feature, but needs further assessment of potential historic modifications.



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

SITE LOCALITY RECORD
TOSAWIHI QUARRIES (26Ek3032)

Area: Northern Tosawihi Ridge

Locality No.: 219 Type: Isolated Artifact

UTM: 535520E/4552240N

Size: N/A Max. Area (m^2): N/A

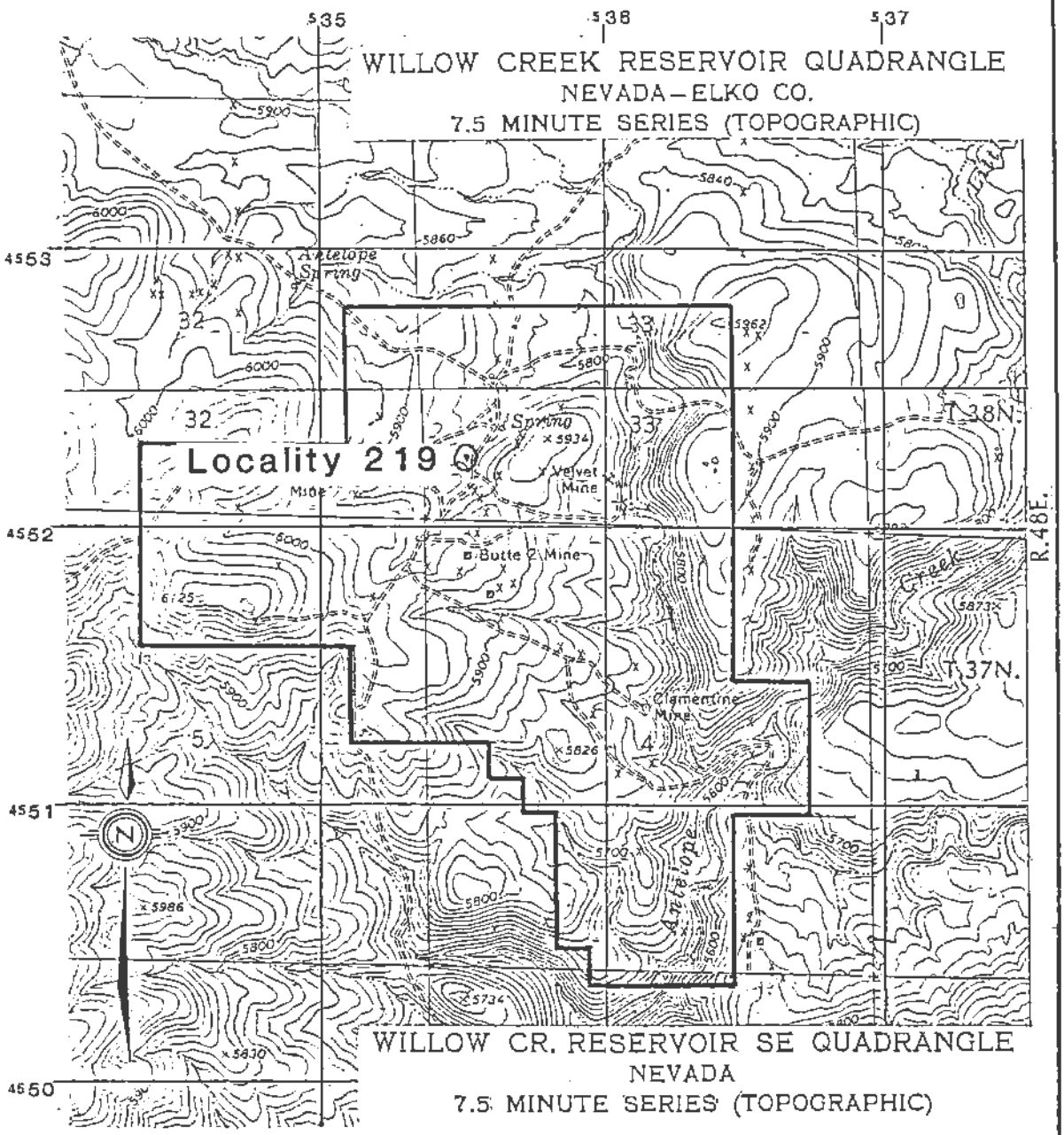
Topographic Data: On moderately steep (25%), northwest-facing ridge slope overlooking Tosawihi Spring.

Quarry Data: N/A

Description: Isolated Elko Series projectile point of obsidian (collected); located near the edge of pit feature 48-1 in Locality 152.

Site Condition: N/A

Remarks:



INTERMOUNTAIN RESEARCH PROJECT 611

Tosawihi-Ivanhoe

September 1987

SCALE 1:24000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL